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MORINGAOLEIFERA AND OBESITY: A REVIEW

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Abstract: *Moringaoleifera Lam [Moringaceae] is a highly valued plant, distributed in many countries of the tropics and subtropics. It has an impressive range of medicinal uses with high nutritional value. Different parts of this plant contain a profile of important minerals, and are a good source of protein, vitamins, β -carotene, amino acids and various phenolics. In addition to its compelling water purifying powers and high nutritional value, M. oleifera is very important for its medicinal value. Various parts of this plant such as the leaves, roots, seed, bark, fruit, flowers and immature pods act as cardiac and circulatory stimulants, possess antitumor, antipyretic, antiepileptic, anti-inflammatory, antiulcer, antispasmodic, diuretic, antihypertensive, cholesterol lowering, antioxidant, antidiabetic, hepatoprotective, antibacterial and antifungal activities, and are being employed for the treatment of different ailments in the indigenous system of medicine. Obesity arises from increase size of individual adipose cells due to lipid accumulation and from increased number of adipocytes arising from differentiation of adipose precursor cells to mature adipocytes under the appropriate nutritional and hormonal influence. An herbal formulation LI85008F also known as adipromin has potent antiadipogenic activity in mouse adipocytes invitro.LI85008F is comprised of three medicinal plants, Moringaoleifera, Murrayakoeingii and Curcuma longa.*

Keywords: *Moringaoleifera, obesity, BMI, antioxidant, adipocytes, antihypertensive.*

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INTRODUCTION:

Moringaoleifera Lam belongs to an'on-generic' family of shrubs and tree, Moringaceae and is considered to have its origin in Agra and Oudh, iri the northwest region of India, south of Himalayan Mountains. Although the name "Shigon" for M. oleifera is mentioned in the "ShushrutaSanhita" which was written in the beginning of the first century A.D., there is evidence that the cultivation of this tree in India dates back many thousand years. The Indian knew that the seeds contain edible oil and they used them for medicinal purposes. It is probable that the common people also knew of its value as a fodder or vegetable In English it is commonly known as Horse radish, Drumstick tree, Never Die tree, West Indian Ben tree, and Radish tree. Moringaoleifera was originally an ornamental tree in the Sudan, planted during British rule in the alleys along the Nile, public parks, and the gardens of foreigners. It seems likely that the Arab women of Sudan discovered this remarkable clarifier tree. SamiaJahn's (A German scientist) first laboratory tests confirmed the presence of a very efficient coagulant in seeds from Moringaoleifera and later seeds from another Moringa species from Kenya (*Moringastenopetala*) revealed similar flocculating properties. Moringaceae is a single-genus family with 14 known species thus far, which are indigenous to Africa, Madagascar, Arabia, and India. Half of them are relatively common and already sporadically cultivated, yet only Moringaoleifera (horse radish or drum stick tree) because of its many uses is planted in the whole tropical belt. It is multipurpose tree for semi-arid and drought prone areas. Even though it is a non-nitrogen fixing tree, its different parts can be useful for other purposes. Pods, leaves and seeds can be eaten as vegetable and are highly nutritious. The extracted oil from the seeds is used for cooking, soap making, cosmetics, fuels and lamps. Wood pulp may be used for paper making. The leaves can be also used as fertilizer. Powered seeds are used to heal bacterial skin infection (all parts of the plant are used in a variety of traditional medicines). Coagulation with Moringa seeds: Moringa seeds contain between 30-42 % oil and press cake obtained as a by-product of the oil extraction process contains a very high level of protein. As an alternative to conventional coagulants, Moringaoleifera seeds can be used as a natural coagulant in house hold water treatment as well as in the community water treatment systems. The seed kernels of Moringaoleifera contain significant quantities of low molecular weight, (water soluble proteins) which carry a positive charge. Moringa trees have been used to combat malnutrition, especially among

infants and nursing mothers. Leaves can be eaten fresh, cooked, or stored as dried powder for many months without refrigeration, and reportedly without loss of nutritional value. Moringa leaves contain more Vitamin A than carrots, more calcium than milk, more iron than spinach, more Vitamin C than oranges, and more potassium than bananas. In fact, the nutritional properties of Moringa are now so well known that there seems to be little doubt of the substantial health benefit to be realized by consumption of Moringa leaf powder in situations where starvation is imminent. Nonetheless, the outcomes of well controlled and well documented clinical studies are still clearly of great value. Phytochemicals are chemicals produced by plants it refers to only those chemicals which may have an impact on health, or on flavour, texture, smell, or colour of the plants, but are not required by humans as essential nutrients. It is rich in compounds containing the simple sugar, rhamnose, and it is rich in a fairly unique group of compounds called glucosinolates and isothiocyanates. It is reported to have hypotensive, anticancer, and antibacterial activity include 4- (4'-O-acetyl-α-L-rhamnopyranosyloxy)benzyl isothiocyanate, 4-(α-L-rhamnopyranosyloxy)benzyl isothiocyanate , niazimicin,pterygospermin , benzyl isothiocyanate, and 4-(α-L-rhamnopyranosyloxy) benzyl glucosinolate. Also rich in a number of vitamins and minerals as well as other more commonly recognized phytochemicals such as the carotenoids (including β-carotene or pro-vitamin A). The benefits for the treatment or prevention of disease or infection that may accrue from either dietary or topical administration of Moringa preparations are not quite so well-knownMoringa preparations have been cited in the scientific literature as having antibiotic, antitrypanosomal, hypotensive, antispasmodic, antiulcer, anti-inflammatory, hypo- cholesterolemic, and hypoglycemic activities, as well as having considerable efficacy in water purification by flocculation, sedimentation, antibiosis elevation of a variety of detoxication and antioxidant enzymes and biomarkers as a result of treatment with Moringa or with phytochemicals isolated from Moringa.

In 1997, the World Health Organization (WHO) described obesity as an epidemic hazard worldwide, based on the data analysis of body mass index (BMI). Since then, obesity incidence increased at an alarming rate and is becoming a major public health concern.Indeed, obesity facilitates the development of metabolic disorders (e.g. diabetes, hypertension), and cardiovascular diseases in addition to chronic diseases (e.g. stroke, osteoarthritis, sleep apnea, cancers, and inflammation-based pathologies).According to

studies in different countries, an obese person incurs health care expenditures at least 25% higher than a healthy person. Adding production losses to health care costs, obesity accounts for a considerable percentage loss of gross domestic product in most countries (>1% in US, >3.6% in China). Obesity could be iatrogenic, i.e. secondary to drug treatments (antipsychotic, antidepressant, antiepileptic, steroids, and insulin), or due to certain diseases (Cushing syndrome, hypothyroidism, and hypothalamic defects). Obesity as a primary disorder follows a positive energy balance. The identification of the primary causes of this imbalance remains challenging and comprises the majority of cases usually diagnosed after causes for secondary obesity are ruled out. This chronic disease results from complex interactions of genetic, behavioural, and environmental factors correlating with economic and social status and lifestyles. In fact, obesity is more frequent in populations living in environments characterized by a long-term energy positive imbalance due to sedentary lifestyle, low resting metabolic rate, or both. Causes of obesity involve genes, metabolism, diet, physical activity, and the socio-cultural environment that characterizes 21st century living style. The identification of potential molecular targets susceptible to be manipulated from external factors, particularly food and drug agents may assist people in gaining control over appetite allowing obesity prevention. Nutritional genomics could determine which specific nutrients bring phenotypic changes that influence the obesity risk and could establish which interactions are the most important. Global strategies are focused on dietary and lifestyle modifications, i.e. restrict calorie intake and increase physical activity to slow obesity development. Researches demonstrated the potential of natural products to counteract obesity. Multiple natural product combinations may result in a synergistic activity that increases their bioavailability and action on multiple molecular targets, offering advantages over chemical treatments. The anti-obesity effects of these compounds are mediated by regulation of various pathways, including lipid absorption, energy intake and expenditure, increasing lipolysis, and decreasing lipogenesis, differentiation and proliferation of preadipocytes.

The word obesity comes from the Latin obesitas, which means stout, fat, or plump. Medically, obesity is a condition in which excess body fat has accumulated to the extent that it may have an adverse effect on health, leading to reduced life expectancy and/or increased health problems. Body weight is not a good indicator as it does not distinguish between fat

and muscle mass. Various measures, including body mass index (BMI) and Waist to Hip Ratio (WHR) have been developed to identify those at risk of serious health problems. Body mass index is a measurement which correlates weight and height: BMI= Mass (kg)/[Height (m)] WHR is used as a measurement of obesity, which in turn is a possible indicator of other more serious health conditions, WHO states that abdominal obesity is defined as a waist–hip ratio above 0.90 for males and above 0.85 for females. Women with waist–hip ratios of more than0.8, and men with more than 1.0, are at increased health risk because of their fat distribution. WHR has been shown to be a better predictor of cardiovascular disease than Waist Circumference and body-mass index.

WHR ¼ Waist Circumference=Hip circumference

At individual level, the combination of excessive food energy intake and lack of physical activity is thought to explain most of obesity causes. In limited cases, obesity is due to genetic factors, medical reasons, or psychiatric illness. On the other hand, increasing rates of obesity at a societal level are felt to be due to easily accessible and palatable diet, increased reliance on cars, and mechanized manufacturing. A 2006 review identified ten other possible contributors to the recent increase of obesity including insufficient sleep, endocrine disruptors, decreased variability in ambient temperature, decreased rates of smoking, as smoking suppresses appetite, increased use of medications that can cause weight gain (e.g., atypical antipsychotics), proportional increases in ethnic and age groups that tend to be heavier, pregnancy at a later age (which may cause susceptibility to obesity in children), epigenetic risk factors passed on generationally, natural selection for higher BMI, and assortative mating leading to increased concentration of obesity risk factors. Obesity rates in the US (1971–2000) increased from 14.5% to 30.9%. During the same period, there was an increase in the average amount of food consumed (average increase for women 335 and 168 cal./day). Most of this extra food energy was due to the increase in carbohydrates rather than fat consumption, there is a large shift toward less physically demanding work worldwide. Currently, at least 60% of the world's population gets insufficient exercise, due to increased use of mechanized transportation and a greater prevalence of labour-saving technology at home.[25] The WHO indicates people worldwide are taking up less active recreational pursuits. In both children and adults, there is an association between television viewing time and the risk of obesity. Like many other medical

conditions, obesity is the result of interplay between genetic and environmental factors. Polymorphisms in various genes controlling appetite and metabolism predispose to obesity when sufficient food energy is present. People with two copies of the FTO gene (fat mass and obesity associated gene) have been found on average to weigh 3–4 kg more and have a 1.67 fold greater risk of obesity compared to those without the risk allele. Some cases of obesity are related to single-gene mutations, e.g. melano-cortin-4 receptor (MC4R) gene,[28] dopamine receptor D4 (DRD4)[29], peroxisome proliferator- activated receptor y2 (PPARy2)[30] or the leptin genes. The study of infectious agent's effect on metabolism is still in its early stages. The gut flora in obese and lean individuals can affect the metabolic potential. This apparent alteration is believed to confer a greater capacity to gain energy contributing to obesity. An association between viruses and obesity has been found in humans and several different animal species. Leptin and ghrelin are internal mediators that affect feeding and appetite. Ghrelin is produced by the stomach modulating short-term appetitive control (i.e., to eat when the stomach is empty and to stop when the stomach is stretched). Leptin is produced by white adipose tissue to signal fat storage reserves in the body and mediates long-term appetitive controls (i.e., to eat more when fat storages are low and less when fat storages are high). It plays a critical role in the regulation of body weight and energy balance by inhibiting food intake and stimulating energy expenditure.[39] Although, administration of leptin may be effective in a small subset of obese individuals who are leptin deficient. Most obese individuals are thought to be leptin resistant and have been found to have high levels of leptin.[40] This resistance is thought to explain in part why administration of leptin has not been shown to be effective in suppressing appetite in most obese people.[41] Although leptin and ghrelin are produced peripherally, they control appetite through their actions on the central nervous system. Thus, a deficiency in leptinsignalling either via leptin deficiency or leptin resistance leads to overfeeding and may account for some genetic and acquired forms of obesity.

Effect of Moringa on Diabetes mellitus Accumulated data demonstrate the association between obesity and noninsulin-dependent diabetes mellitus, which is the most common primary form of diabetes and impaired glucose tolerance. In obese individuals, adipose tissue releases high amounts of non-esterified fatty acids, glycerol, pro-inflammatory cytokines, and hormones. They are linked with the development of insulin resistance, which

generate compensatory hyperinsulinemia with overstimulation of pancreatic cells and reduction of insulin receptors. On Hypertension Epidemiological studies have demonstrated that 65–75% of the risk of hypertension is accounted for by obesity.Endocrinological studies of the adipose tissue revealed links between obesity and hypertension, likely consequent to the fact that the adipose tissue secretes bioactive molecules and immunomodulators. Obesity is the most common cause of dislipidemia. Lipid oversupply in a state of obesity, hyperinsulinemia, and/or insulin resistance results in increased non-esterified fatty acid availability and, in turn, higher TG stores in non-adipose tissues, e.g. the muscle, liver, and pancreas. [46, 47] Fatty acid-induced disorders are referred to as lipotoxicity. Thus, elevated TG level is often accompanied by a slight increase in total cholesterol and a marked drop in high-density lipoprotein (HDL) cholesterol. Moreover, low-density lipoproteins (LDL) rich in TG, partially metabolized by hepatic lipase, are converted into small LDL, with higher atherogenic potential. Obesity increases the risk of heart failure, sudden cardiac death, angina or chest pain, and abnormal heart rhythm.[49] Increased electrical alterations in obesity lead to frequent ventricular dysrhythmias even in the absence of heart dysfunction.The annual sudden cardiac death rate was nearly 40 times higher in obese people than in non-obese population. Obesity is the major component of the metabolic syndrome (multiple metabolic disorders). This syndrome is characterized by the co-occurrence of multiple metabolic disorders, namely overall and abdominal obesity, insulin resistance, hypertension, hyperglycemia, impaired glucose tolerance, and the combination of low HDL cholesterol and elevated TG level. Psychological damage caused by overweight and obesity ranges from lowered self-esteem to frank clinical depression. Indeed, rates of anxiety and depression are three to four times higher among obese individuals.Obesity significantly increases the risk of Alzheimer's disease. A strong correlation exists between BMI and high levels of amyloid, i.e. the protein that accumulates in the Alzheimer's brain, destroying nerve cells and producing cognitive and behavioural problems. Diet, exercise, pharmacotherapy, behavioural therapy, and lifestyle modification each can produce a modest weight loss in the severely obese. Pharmacotherapy, in addition to diet and exercise, has been demonstrated to facilitate a weight loss of 2–10% per year.Long-term maintenance of significant weight loss continues to be the most challenging problem in the medically based treatment for obesity.

Bariatric or Weight Loss Surgery (WLS) was previously categorized as malabsorptive, restrictive, or a combination of both. However with a greater understanding of the extensive neural-hormonal effects of WLS on satiety, hunger and metabolism, the above mentioned broad categories are no longer appropriate. In fact, today Bariatric or WLS is perhaps better referred to as Metabolic Surgery. The most common metabolic surgical procedures include Rouxen-Y gastric bypass, adjustablegastric band, sleeve gastrectomy, and biliopancreatic diversion. The National Institute of Health consensus has suggested the following guidelines for surgery in obese patients:

a- Patients with BMI more than 40.

b- Patients with BMI more than 35

They have serious medical problems such as sleep apnea, that would be improved with weight loss. The potential of natural products for treating obesity is under exploration. This may be an excellent alternative strategy for developing future effective, safe anti-obesity drugs.A variety of natural products, including crude extracts and isolated pure natural compounds can induce body weight reduction and prevent diet-induced obesity. Therefore, they have been widely used in treating obesity. Dietary phytochemicals might be employed as anti-obesity agents because they may suppress the growth of the adipose tissue, inhibit differentiation of preadipocytes, stimulate lipolysis, and induce apoptosis of existing adipocytes, thereby reducing adipose tissue mass. Natural products with lipase inhibitory effect. Dietary fat is absorbed by the intestine when it has been subjected to the action of pancreatic lipases. Pancreatic lipase is a key enzyme in dietary triacylglycerol absorption, hydrolysing triacylglycerols to monoacylglycerols and fatty acids. Few substances interact directly with the lipases as orlistat. It is a derivative of the naturally-occurring lipase inhibitor from Streptomyces toxytricini.Orlistat inhibits by forming a covalent bond to the lipase's serine active site. Although it is clinically approved for obesity treatment, it has certain unpleasant gastrointestinal side-effects. Natural products provide a vast pool of pancreatic lipase inhibitors. A wide variety of plant products such as saponins, polyphenols, flavonoids, and caffeine possess lipase inhibitory effects . Several carbohydrates also possess pancreatic lipase inhibitory effects,for example chitin/ chitosan. Many metabolites from microorganisms, including lipstatin from S. toxytricini and panclicins from Streptomyces sp. Also possess pancreatic lipase inhibitory activity. Different types of tea (e.g., green, oolong,

and black tea) are among the most widely-studied materials for lipase inhibitors. Various polyphenols (e.g., L-epicatechin, epicatechingallate (ECG), epigallocatechin (EGC) and epigallocatechingallate (EGCG)) isolated from tea leaves showed strong inhibitory activity against pancreatic lipase . These polyphenols acquire galloyl moieties within their chemical structures and/or polymerization of their flavan-3-ols for enhanced pancreatic lipase inhibition. Adipocytes play a central role in the maintenance of lipid homeostasis and energy balance by storing triglycerides and releasing free fatty acids in response to change in energy demands. Natural products that specifically target adipogenesis inhibition had been considered promising potentials in obesity treatment. Fatty acids, particularly polyunsaturated fatty acids (PUFA) act as signal transducing molecules in adipocyte differentiation. Thus, PUFA play a central role in suppressing lipogenesis and regulating adipocyte differentiation through suppression of late-phase adipocyte differentiation. Several natural products have apoptotic effects on maturing pre-adipocytes (eg. esculetin, resveratrol, quercetin, genistein, EGCG, capsaicin, and conjugated linoleic acids). Natural lipid metabolism regulators (increased lipolysis). The pharmacological targeting of lipolysis can be achieved by stimulating triglyceride hydrolysis in order to diminish fat stores, thereby combating obesity. The flavonoids from Nelumbonucifera leaves are examples of the natural products involved in b-adrenergic receptor activation. Many natural products show anti-obesity activities with varying mechanisms. Perhaps the recommended approach to search for more efficient obesity treatments and achieving the synergistic effects of natural products should seek treatments using multiple products or products that have multiple activities.*Moringa* is a good example of a natural drug which possesses multi-functional anti-obesity activities. Researches have proved the anti-obesity activity of catechins which is due to the combined actions of appetite reduction, greater lipolytic activity and energy expenditure, and less lipogenic activity and adipocyte differentiation.

Moringa leaves are low in fat and nutritious. Because they are packed with so many nutrients, they offer you a healthy alternative to eating many higher calorie foods, according to the *Moringa* Garden Circle. *Moringa* leaves provide 42 percent of the recommended daily minimum requirement for protein, and 125 percent of the recommended daily minimum requirement for calcium. The B-vitamins in *Moringa* leaves also help you digest and convert foods to energy and may increase your metabolism.*Moringa* leaves may be eaten raw,

cooked or taken as a tea, making them a convenient food and nutrition source. Most evidence pertaining to *Moringa* leaves and weight loss is anecdotal, however, so consult your health care professional before using *Moringa* leaves for weight loss

DISCUSSION:

The lethal dose (LD_{50}) value of the M. oleifera indicated that the extract (methanol) was safe and nontoxic up to 5 g/kg [2, 3]. Previous experiments have reported the antiulcer, diuretic, anti-inflammatory, antifertility, CNS depressant, and wound healing properties of leaves of M. oleifera [1, 3, 4-6]. However, the results of the previous laboratory animal study indicated that crude extract of M. oleifera possesses hypocholesterolemic activity in rats [29]. Still no evidences are available for antiobesity potential of methanolic extract of M. oleifera. Hence, the study has been designed to demonstrate the effect of M. oleifera in high fat diet-induced obesity.

Obesity is a major risk factor for augmented morbidity and mortality and is associated with various medical ailments [7]. High fat diet-induced obesity has been considered as the most popular model among researchers due to its high similarity of mimicking the usual route of obesity episodes in human [8] and so why it is considered as a reliable tool for studying obesity as they will readily gain weight when feed high-fat diets [9]. Human studies have revealed that increased fat intake is associated with body weight gain, which can lead to obesity and other related metabolic diseases. This study thus proved that rats exposed to high-fat diet for 2 weeks cause a significant increase of animals' body weight, thus verifying the obese status [10]. Although there was a significant difference in the body weights between the high-fat and normal diet groups, no significant difference was observed in the daily food intake of animals. This observation provides us with the fact that an increase in body weight is independent of the amount of food consumed by the animals. Treatment of HFD rats with MEMOL at 200 mg/kg and 400 mg/kg p.o conversely causes a remarkable reduction of body weights when compared to the high-fat diet administered rats. The result also suggests that MEMOL supplementation at 200 mg/kg and 400 mg/kg are capable of preventing body weight gain, concomitantly helping in maintaining the current body weight. This result was in accordance with the results reported from the previous study where a dose dependent decrease in the body weight was observed [2]. Further, treatment with

MEMOL remarkably decreases the organ weight of rats feed on high-fat diet. Thus it proved the weight reducing potential of MEMOL.

Further, dyslipidemia is another important hallmark in the pathogenesis of obesity characterized by hypertriglyceridemia with decreased level of LDL and VLDL [11, 12]. Chronic dyslipidemia has been characterized as a major risk factor for cardiovascular risk, including atherosclerosis [13, 14]. In the present study apart from reduction in weight, supplementation with MEMOL was observed to attenuate significantly the levels of total cholesterol and LDL and increased the level of HDL level in rats feed with HFD. The increase in the level of HDL was found to be in a dose dependent manner; that is, supplementation with MEMOL at a dose of 400 mg/kg shows a better effect in comparison to 200 mg/kg. Similar results were obtained by Ghasi et al. [29], where treatment with crude extract of M. oleifera led to an increased serum HDL level and decreased levels of total cholesterol, LDL, and triglyceride. Thus, it can be concluded that leaves of M. oleifera possess cardioprotective potential [15]. Further, atherogenic index is regarded as a marker for various cardiovascular disorders; the higher the value, the higher the risk of developing cardiovascular disease and vice versa [16, 17]. High-fat diet exposure resulted in the increased atherogenic index. Treatment with 200 mg/kg and 400 mg/kg significantly attenuated the atherogenic index and thus provides cardioprotection. The decreased atherogenic index by MEMOL thus supports the cardioprotectant nature of M. oleifera.

In order to supplement the results, the histopathological studies were also performed. The literature review revealed that high fat diet-induced obesity and abnormal lipid metabolism all collectively are associated with inflammation, congestion, and nonalcoholic fatty liver disease (NAFLD) leading to hepatic failure causing a boost in SGOT, SGPT, and total bilirubin level in the serum [17–19]. Our results showed that consumption of high-fat diet may play a crucial role in the pathogenesis of fatty liver or hepatic steatosis associated with obesity depicted via ballooning degeneration. Elevated levels of liver enzymes are a monitor of hepatocellular damage and correlate with increased liver weight [20]. The results obtained in the present study established that high-fat diet causes hepatocellular damage, as clearly seen by the marked elevation of serum enzymes (SGOT, SGPT, and total bilirubin) activities and histopathological studies of liver exaggerated with hepatic steatosis. However,

treatment with MEMOL causes a momentary reduction in the enzyme levels, signifying the role of MEMOL in preventing liver damage caused by high-fat diet.

Insulin resistance is associated with a number of metabolic disorders such as obesity, hyperlipidemia, and hypertension. HFD intakes were shown to contribute to syndromes such as hyperlipidemia, glucose intolerance, hypertension, and atherosclerosis [21]. Numerous evidences indicated that in experimental animals, high-fat diets resulted in disturbance in glucose metabolism and impaired glucose tolerance [22, 23], and the present study also demonstrate the reduction in blood glucose level those treated with MEMOL (200 and 400 mg/kg). It has been reported that thermogenesis plays a crucial role in weight management [24, 25]. Changes in body temperature are associated with significant changes in metabolic rate [30]. In support for this, the theory has been shown in different animal models which were obese, and leptin-deficient ob/ob mouse and the polyphonic obese mouse exhibited hyperphagia, a decreased metabolic rate, and a decreased core body temperature [26, 27]. This contention is supported in our results where rats feed on HFD show decreased body temperature in comparison with normal rats. Treatment with MEMOL (200 mg/kg and 400 mg/kg) reflected a sharp increase in rectal body temperature. The increase in rectal body temperature may be attributed to the overall stimulant and thermogenic property of phytoconstituents of the extract.

Preliminary phytochemical studies of the extract of M. oleifera showed the presence of alkaloids, tannins, flavonoids and terpenoids, and steroids. *Moringa* leaves act as a good source of natural antioxidant due to the presence of various types of antioxidant compounds such as ascorbic acid, flavonoids, phenolics, and carotenoids [31, 28]. The high concentrations of ascorbic acid; oestrogenic substances and β-sitosterol; iron; calcium; phosphorus; copper; vitamins A, B and C; α-tocopherol; riboflavin; nicotinic acid; folic acid; pyridoxine; β-carotene; protein; and in particular essential amino acids such as methionine, cysteine, tryptophan, and lysine present in *Moringa* leaves and pods make it a virtually ideal dietary supplement [28]. The hypolipedemic potential is associated with the presence of β-sitosterol [27] in crude extract of M. oleifera. Therefore, further study needs to be carried out for identification of specific constituents present in M. oleiferafor its observed effects.

A growing body of evidence indicates that natural products having anti-obesity effects can be arranged into five categories based on their distinct mechanisms; they produce

decreased lipid absorption, decreased energy intake, increased energy expenditure, decreased pre-adipocyte differentiation and proliferation, or decreased lipogenesis and increased lipolysis.The present study aimed at exploring the potential role of the ethanolic extract of *Moringa*oleifera in comparison with the anti-hypercholesterolemic drug Simvastatin in ameliorating the anthropometric measurements, hyperlipidemia, oxidative stress, serum leptin, resistin and adiponectin levels in obese rats. In view of our data, both TC and AC showed significant increase in obese group. As well, BMI revealed significant increase in obese group relative to the lean control group. These findings come in line with the previously reported data that there is fat accumulation in the thoracic and abdominal regions due to the high cholesterol diet. [32] This indicates that the observed increase in body weight may be due to excessive energy intake and the adipose tissue accumulation. BMI has been stated to be a simple reliable estimate of body fat and obesity in rats. [32] As there are positive correlations between daily lipid intake and BMI as well as fat deposition.[35]Treatment of obese groups with the ethanolic extract of *Moringa*oleifera or with the anti-hypercholesterolemic drug Simvastatin, resulted in a significant reduction in both TC and AC as well as BMI in comparison with the obese group control group. The observed reduction in these anthropometric measures in obese rats as a result of treatment with ethanolic extract of *Moringa*oleifera may be due to the inhibition of dietary lipid utilization. Earlier report by Dongmeza and co-workers indicated that a higher inclusion level of *Moringa* extract or its fractions such as Saponins and tannins have been associated with the reduced energy required for protein and lipid biosynthesis leading to lower growth performance and nutrient utilization. Therefore, *Moringa* has the ability to reduce body lipid and consequently energy retention.The recorded reduction in the anthropometric parameters in obese rats treated with Simvastatin may be attributed to the role of Simvastatin in altering adiponectin levels independent of adiposity.Simvastatin has an effect on atherogenic lipoproteins overall, with a reduction in both LDL and triglyceride-rich lipoproteins, which together compose non-HDL cholesterol. Higher doses of Simvastatin have even shown to have greater effects on reducing non-HDL cholesterol and increasing HDL-C.40 The current results revealed significant increase in serum cholesterol, triglycerides and LDL levels accompanied with significant increase in serum HDL level in obese group with respect to the lean control group. Our results are in accordance with reference to [41] who

detected hypercholesterolemia and hypertriglyceridemia in obese rats. More in detail, [37] have reported that lipids in adipose tissue are largely derived from circulating triglycerides especially during high-cholesterol diet feeding. The increased serum LDL level in obese rats has been also recorded in high cholesterol diet supplemented rats.[32] This event was explained by the decreased HDL level, as recorded in our study, thus decreasing the reverse cholesterol transport from the blood stream to the liver. In addition, high cholesterol diet causes the oxidative stress leading to the increased production of reactive oxygen species (ROS). An increasing scientific literature provided ample direct and indirect evidence that the overproduction of ROS can induce cellular damage via oxidation of critical cellular components such as membrane lipids, proteins, and DNA. So, elevated level of blood cholesterol especially LDL is a known major risk factor for high cholesterol diet.[33] Most international and national lipid treatment guidelines consider LDL-C the primary goal of hypolipidemic therapy. Ethanolic extract of *Moringa*oleifera or simvastatin, used in the present study could reduce serum cholesterol, triglycerides and LDL levels while increase serum HDL level in obese group relative to obese control group. These findings indicated that *Moringa*oleifera extract has beneficial effect on lipid profile through cholesterol reducing effect.[39] have investigated its mechanism of action. Cholesterol homeostasis is maintained by the two processes, cholesterol biosynthesis in which HMG-Co-A reductase catalyzes rate limiting process and cholesterol absorption of both dietary cholesterol and cholesterol cleared from the liver through biliary secretion. The HMG-Co-A/mevalonate ratio has an inverse relationship to the activity HMG-Co-A reductase. The result of [33] indicated that the activity of this enzyme is significantly depressed by the ethanolic extract of *Moringa*oleifera. Thus, the cholesterol reducing action of the ethanol extract of *Moringa*oleifera indicated its hypolipidemic activity. *Moringa*oleifera leaf is a good source of phytochemicals including flavonoids, phenolics, carotenoids and β- sitosterol.[40,41]could isolate β-sitosterol from the stem of a hybrid variety of *Moringa*oleifera. β - sitosterol is a plant sterol with a structure similar to that of cholesterol, except for the substitution of an ethyl group at C24 of its side chain. It is believed that this compound has the ability to lower cholesterol by lowering plasma concentrations of LDL-C. [47] Therefore β-sitosterol in the leaves of *Moringa*oleifera is a bioactive phytoconstituents that accounts for the hypolipidemic influence of *Moringa*oleifera extract. Moreover, *Moringa* leaves act as a good

source of natural antioxidant due to the presence of various types of antioxidant compounds. The significant reduction in serum MDA level observed in obese group treated with *Moringa*oleifera extract could be attributed to that the *Moringa*oleifera leaf extract contains polyphenols, therefore the free radical scavenging activity of the leaf extract may depend on its phenolic components.[42] Polyphenols have been known to possess powerful antioxidant activity in vitro. They inhibit lipid peroxidation by acting as chain-breaking peroxylradical scavengers, and can protect LDL from oxidation.[48] This mechanism is the main suggested mechanism that is responsible for the depletion of oxidative stress and lipid peroxidation product (MDA) serum level as a result of treatment of obese rats with *Moringa*oleifera extract. On the other hand, the obese group treated with *Moringa*oleifera extract showed significant reduction in serum NO level as compared to the obese control group. This finding could be attributed to the bioactive phenolic glycoside, namely 4-[(2'-O-acetyl-α-L-rhamnosyloxy) benzyl] isothiocyanate (RBITC), which has been found to suppress nitric oxide synthase expression and nitric oxide (NO) production due to its antioxidant activity. Obesity increases caloric intake which represents an important factor in decreasing the mitochondrial membrane fluidity and increasing the generation of ROS.[44] Leptin, an adipocyte-derived satiety hormone, plays a crucial role in the regulation of food intake and energy expenditure through acting on its receptor expressed mainly in the hypothalamus.There is a growing body of evidence indicating that leptin plays a role in fat metabolism and correlates with insulin resistance and other markers of the metabolic syndrome, independent on total adiposity. [46]Leptin is a cytokine like polypeptide produced by the adipocytes and it is overproduced during obesity due to the generation of ROS.[47] In the present study, the treatment of obese group with the ethanolic extract of *Moringa*oleiferaelecited significant decrease in serum leptin level. *Moringa* leaves act as a good source of natural antioxidant due to the presence of various types of antioxidant compounds such as ascorbic acid, flavonoids, phenolics and carotenoids.[40] Therefore, *Moringa*oleifera has the ability to scavenge free radicals with consequent inhibition of leptin level in serum as there is a significant positive correlation between leptin concentration and ROS generation. In the present study, there was a significant decrease in serum adiponectin level in obese group with respect to that in the lean control group. Adiponectin is an adipocyte-secreted protein that circulates at high concentration.[50] Levels of adiponectin

are reduced in obesity, and the suppression correlates with insulin resistance in obesity and related disorders.[51]Replacement of deficient adiponectin has a variety of salutary effects, including reducing glucose and lipid levels, lipid oxidation rates, and reducing vascular thickening.[52,49] found that adiponectin has disturbances in fatty acid catabolism and elevated serum TNF-α when challenged with high fat/high sucrose diet, associated with an increase in insulin resistance. . Accumulated evidences have demonstrated that obesity is associated with chronic inflammation and that both obesity and inflammation favor insulin resistance.[53] Adipose tissue produces adipocytokines, including leptin, tumor necrosis factor alpha (TNF-α), interleukins and adiponectin.[54] Activation of the TNF-α system has been associated with insulin resistance through the generation of defects in the phosphorylation of the receptor and decreasing the expression of insulin-sensitive glucose transporters.[49] The current findings revealed that the treatment of obese group with the ethanolic extract of *Moringa*oleifera produced significant increase in serum adiponectin level in comparison with the obese control group. *Moringa*oleifera possesses anti-inflammatory capacity and it can inhibit the level of TNF-α. This may be due to presence of the anti-inflammatory compounds in *Moringa*oleifera namely 4-[(2'-O-acetyl-α-l-rhamnosyloxy) benzyl] isothiocyanate, 4-[(3'-O-acetyl-α-l-rhamnosyloxy)benzyl] isothiocyanate and S-methyl-N-{4-[(α-l-rhamnosyloxy) benzyl]} thiocarbamate. Thus, *Moringa*oleifera extract may elecit an improvement in the adiponectin serum level in obese rats via inhibition the TNF-α level. a significant increase in serum resistin level in obese group versus the lean control group. Resistin is a member of a class of cysteine-rich proteins collectively termed resistin-like molecules. It possess a dual role in contributing to disease risk. obesity is known to increase the release of several cytokines and other cellular mediators, such as tumor necrosis factor-α (TNF-α), interleukin (IL)-1 and IL-6. It induces resistin expression in monocytes. Recorded data showed significant depletion in the serum level of resistin in the obese group treated with ethanolic extract of *Moringa*oleifera. Hence ethanolic extract of *Moringa*oleifera could improve serum resistin level in obesity. Furthermore, it was also recorded that simvastatin reduce the expression and secretion of TNF-α in primary adipocytes isolated from hypercholesterolemia rabbits. This suggested that statins have direct anti-inflammatory effects on adipocyte. the oxidized-LDLinduced mRNA expression and secretion of TNF- α and MCP-1 are also markedly inhibited by

Simvastatin treatment. By this mechanism, Simvastatin could reduce resistin level in the serum of Simvastatin treated group.

Moringa can be used as dietary agent preventing T2D. MIC-enriched MC caused significant reduction in weight gain, hepatic adiposity, gluconeogenesis, insulin, cholesterol, and inflammatory markers; and increase in insulin signalling sensitivity and lipolysis. MICs play a major role as primary antidiabetic actives in *Moringa*. Slight differences in accumulated food intake or food aberration cannot explain the reduce weight gain in MC fed mice, because the ratio of accumulated food intake to body weight was actually higher. MICs and MC possess anti - inflammatory manifested as decreased IL-1β and TNFα expression and nitric oxide production. Only slight decreases in body weight gain was noticed in studies, indicating the anti-inflammatory effect of MICs alone are not likely responsible for anti-obesity effect observed by MC treatment. MICs are able to decrease PEPCK and G6P gene expression at low concentration. Thus MIC act via blocking rate limiting step in liver gluconeogenesis. Reduced gluconeogenesis may contribute to improved insulin sensitivity. Symptoms of T2D include impaired insulin signalling and insulin sensitivity and increased serum level of insulin, leptin, resistin, TG, and cholesterol all of which can be reduced by MC treatment. MC treatment can lead to activation of components of insulin signalling pathway in liver and muscles tissue. Mild effect of MC and MIC 1 and 4 treatment increased glycerol production in adipocytes is indicative of lipolytic break down of TG into free fatty acids and glycerol. MC treatment directly increases thermogenesis. ADRB3 plays a major role in lipolysis through interaction with catecholamine. Greater ADRB3 expression is linked to increased lipolysis which proceeds to production of ATP, rather than heat. Lower RER is indicative of increased fatty acid oxidation relative to carbohydrate oxidation. Thus, MC treatment enhances fat oxidation at expense of carbohydrate oxidation. MICs are primary biologically active anti-obesity and anti-diabetes constituents of mc whose primary mechanism of action is the inhibition of liver gluconeogenesis, which directly or indirectly result in systemically increased insulin signalling and sensitivity these effect may in turn cause increase lipolysis, higher ratio of fat/carbohydrate oxidation, ultimately resulting in reduce lipid accumulation in the liver and body. Hence MC and MICs may have beneficial effects for prevention m treatment of obesity and T2D (MC= *Moringa* concentrate; MIC= *Moringa*isothiocyanate; TNα=tumor necrosis factor alpha; IL-1β=interleukin 1 beta).

CONCLUSION:

A large number of medical conditions have been associated with obesity. So reducing the weight and to keep the body fit the excess fat is be burn off. Ozone Moringa tea helps the body get loss its weight in a healthy way.The MoringaOleifera plant has a wealth of naturally occurring nutrients along with vitamins, minerals, protein, also contains essential amino acids, chlorophyll, omega-3 oils, and other important phytonutrients. This vegetable tree is known to contain fifteen times the potassium in banana, seventeen times the calcium in milk, four times the vitamin A found in carrot, twenty five times the iron in spinach and one-half times the vitamin C in oranges.By consuming ozone the nutrients present in the Moringa naturally gets absorbed by our body. Daily intake of Ozone Moringa will provide the antioxidant daily which in turn keeps the body healthy by preventing the adverse effect caused due to fat deposition.

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