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Research Article
Role of *Rosa damascena* Mill. Flowers in the Treatment of Obesity and Obesity-Related Disorders

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Abstract

Background and Objective: The prevalence of obesity is increasing both worldwide and locally in India. It is considered a major health problem and often leads to other associated diseases such as type 2 diabetes, ischemic heart diseases, stroke and cancer. In the present study, the effects of powder of *Rosa damascena* flowers on high-fat diet-induced obesity in Wistar albino rats were examined. **Materials and Methods:** Female Wistar albino rats fed with a High Fat Diet (HFD) (p.o) for 6 weeks were used to induce obesity. Powder of *R. damascena* (214 mg kg^{-1} b.wt.) petals administered orally to HFD-fed rats for 6 weeks. Physiological parameters like body weight, food and water intake, fat pad analysis and biochemical parameters like serum lipids, glucose, Serum Glutamate Oxaloacetate Transaminase (SGOT) and Serum Glutamate Pyruvate Transaminase (SGPT), serum urea and creatinine levels were measured. **Results:** Treatment with powder of *R. damascena* flower petals to HFD-induced obese rats resulted in a significant reduction in body weight gain, fat pads, serum lipids, glucose, SGOT, SGPT and creatinine levels as compared to rats fed HFD alone. Further, the extract also showed a significant increase in High-Density Lipoprotein (HDL) levels. **Conclusion:** These results exhibit that the *R. damascena* flower possesses significant anti-obesity potential.

Key words: *Rosa damascena*, obesity, orlistat, high fat diet, weight reduction, lipid profile

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The WHO defined obesity as a condition of abnormal or excessive fat accumulation in adipose tissue, to the extent that health may be impaired[1]. Its prevalence is on a continuous rise in all age groups of many of the developed countries in the world. Statistical data revealed that the problem of obesity had increased from 12-20% in men and 16-25% in women over the last ten years. Recent studies suggest that nearly 15-20% of the middle-aged European population are obese and that in the USA alone it is responsible for as many as 3,00,000 premature deaths each year[2].In developing countries, obesity is more common in middle-aged women, people of higher socioeconomic status and those living in urban communities. Furthermore, it tends to be associated with lower socioeconomic status, especially in women and the urban-rural differences are diminished or even reversed. A complex, multifactorial disease with genetic, behavioural, socioeconomic and environmental origins, obesity raises the risk of debilitating morbidity and mortality[3,4]. Previous researches on obesity in India revealed that the prevalence of obesity to be higher among women[5-9] and economically better off persons[10-12]. In the Indian Women's Health Study the overall prevalence of central obesity among women between 25-64 year of ages was 55%. The BMI, sedentary lifestyle, family history of excess fat intake were found to be significant risk factors for central obesity[13].

Rosa damascena Mill. is the hybrid between *R. gallica* and *R. Phoenicia* and is a member of the Rosaceae family with more than 200 species and 18,000 cultivars around the world. *R. damascena* as the king of flowers has been the symbol of love, purity, faith and beauty since the ancient times[14]. The *R. damascena* Mill. is known as "*Gol-e-Mohammadi*" in Persian. This plant is called *Damask rose* because it was originally brought to Europe from Damascus[15]. The *R. damascena* (RD) has attracted considerable attention in horticulture, biochemistry and in pharmacology because of the fragrance of the flowers and the high content of its biologically active substances[16]. The plant is also reported for its various activities namely, hypolipidemic[17-19], antidiabetic[20-21], antioxidant[22-24], hepatoprotective[25-27], immunomodulatory[28], cardioprotective[29], anti-stress[30] and anticonvulsant[31-33]. The RD is being used traditionally in many Unani formulations since long back. It is one of the ingredients of such an Unani formulation named as *Safoof-e-Muhazzil*a polyherbal formulation used in the Unani System of Medicine for the treatment of obesity for ages. The formulation is a classical Unani pharmacopeial formulation used in hyperlipidemia[34]. This research work was, therefore, designed to explore the anti-obesity potential of *R. damascena* on high-fat diet-induced Wistar albino rats.

MATERIALS AND METHODS

Study area: The study was carried out from February, 2012 to March, 2013.

Plant material and authentication: The drug was purchased from a herbal distributer, Shamsi Dawakhana, Ballimaran, Delhi and authenticated by Dr H.B. Singh, Scientist F and Head, Raw Materials Herbarium and Museum, National Institute of Science Communication and Information Resources (NISCAIR), New Delhi. Voucher specimens of drugs were deposited in the Raw Materials Herbarium and Museum, NISCAIR, New Delhi, with reference number Ref. NISCAIR/RHMD/consult/-2010-11/1705/05. The petals of the drug were dried in shade at room temperature and powdered showed in Fig. 1.

Animals and diet: Female Wistar albino rats, 6-8 weeks old, weighing 100-150 g were procured from Central Animal House Facility, Jamia Hamdard, New Delhi. The study was approved by Institutional Animal Ethics Committee (ref no. 173/CPCSEA/747/20.07.2011). The animals were kept in polypropylene cages (6 in each) under standard laboratory conditions (room temperature at 25±2°C with 12 hrs light and 12 hrs dark (day and night cycle) and had free access to commercial pellet diet (Lipton rat feed Ltd., Pune, Maharastra) and tap water *ad libitum*.

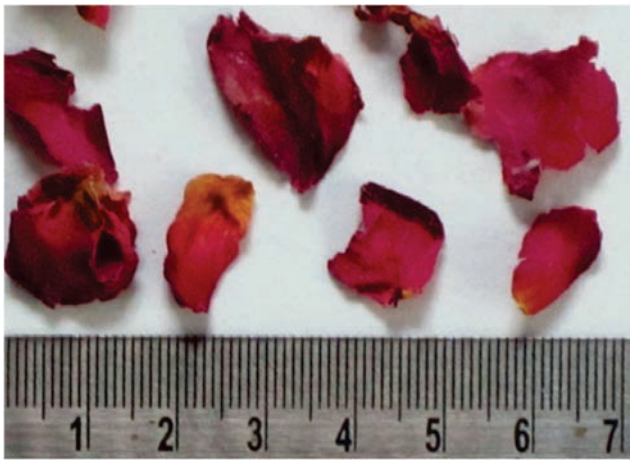

Fig. 1: Dried petals *Rosa damascena* Mill.

Preparation of doses: The powder of the drug (passed through sieve no. 120) was suspended in Carboxy Methyl Cellulose (CMC, 1%) and administered orally by gavage in volume not greater than 1 mL 100 g^{-1} b.wt., daily for 6 weeks. The prepared suspension was stored in amber-coloured bottles in the refrigerator.

Induction of obesity by feeding HFD: High Fat Diet (HFD) was purchased from the National Institute of Nutrition (NIN), Jamia Osmania, Hyderabad, Andhra Pradesh, India. The composition of HFD is given in Table 1.

Dosing schedule: The duration of the experiment was 6 weeks. The rats were divided into 4 groups of 6 animals each. The group I served as normal control receiving a normal diet only. Group II served as High Fat Diet (HFD) control receiving only a high-fat diet. Group III served as standard which received HFD and orlistat (STD) 25 mg kg^{-1} b.wt.[35]. The calculated dose of each rat was 1-1.5 mL adjusted according to the weight of each rat. The human dose of the formulation given in National Formulary of Unani Medicine as 5-10 g, the dose of RD with the mean dose 7.5 g by using the formula given by Reagan-Shaw *et al.*[36] was calculated. The details of the treatment schedule, dose and route of administration used during the experimental work are given in Table 2.

Physiological parameters

Weight measurement: The body weight of each rat was recorded once a week for six weeks using a standard weight machine with the net weight gain and calculated[35].

Table 1: Composition of high-fat diet (5 kg)

Components	Weight (kg)
Casein	1.71
L-cystine	0.015
Starch	0.86
Sucrose	0.86
Cellulose	0.25
Ground nut oil	0.125
Thallow	0.950
Mineral mixture (AIN)	0.175
Vit. Mixture (AIN)	0.055

Table 2: Details of anti-obesity studies

Groups, route of administration-oral	n
Normal control (NC)	6
Obese control (HFD)	6
HFD+Orlistat std (25 mg kg^{-1}), (STD)	6
HFD+RD, 214 mg kg^{-1}	6

N: Number of rats, NC: Normal control, HFD: High-fat diet, STD: Orlistat, RD: *Rosa damascena*

Food and water intake: Food and water intake were measured daily for 42 days in each group and the average was calculated for a week[37].

Organ and fat pad weights: The animals were sacrificed using light ether anaesthesia and then different organs like kidney, liver, heart and spleen and fat pads- mesenteric, perirenal and uterine were removed and weighed[38].

Biochemical investigations: On day 42, before sacrificing animals the blood was collected by sino-orbital puncture and serum was separated. Levels of glucose, total cholesterol, High-Density Lipoprotein cholesterol (HDL), triglycerides, SGOT, SGPT, uric acid and creatinine level were measured from the separated serum using biochemical kits provided by Span Diagnostics Ltd. (Surat, India). Estimation of Total Cholesterol (TC), High-Density Lipoprotein (HDL) and Low-Density Lipoprotein (LDL)[39-40] and triglycerides[41], Serum glucose[42], serum glutamate oxaloacetate transaminase (SGOT) and serum glutamate pyruvate transaminase (SGPT)[43]; Serum uric acid[44] and serum creatinine[45] were carried out as the methods described.

Statistical analysis: Data were expressed as mean±SEM of n = 6. Data were analyzed by one-way analysis of variance (ANOVA) and then differences among means were analyzed using the Turkeys multiple comparisons *post hoc*-test. Differences were considered significant at $p<0.05$.

RESULTS AND DISCUSSION

Body weight variation: Obesity is considered to be a disorder of energy balance, occurring when energy expenditure is no longer in equilibrium with daily energy intake, to ensure body weight homeostasis[37,46,47]. As shown in Table 3, there was a significant ($p<0.001$) increase in body weight of the High Fat Diet (HFD) group when compared to the normal control

Table 3: Effect of treatment on body weight

Groups	Total increase in body weight after 6 weeks (g)	Reduction of body weight gain vs. HFD (%)
NC	40.33±0.67	
HFD	113.67±0.88***[a]	100
STD+HFD	53.17±0.83***[b]	53.22±0.75***[b]
RD+HFD	88.17±1.82***[b]	22.43±1.34***[b]

All values are given as Mean±SEM, n = 6, [a]Compared with normal control group, [b]Compared with HFD group, [c]Compared with SMM, ns: p>0.05, *p<0.05, **p<0.01, ***p<0.001, NC: Normal control, HFD: High fat diet, STD: Orlistat, RD: *Rosa damascena*

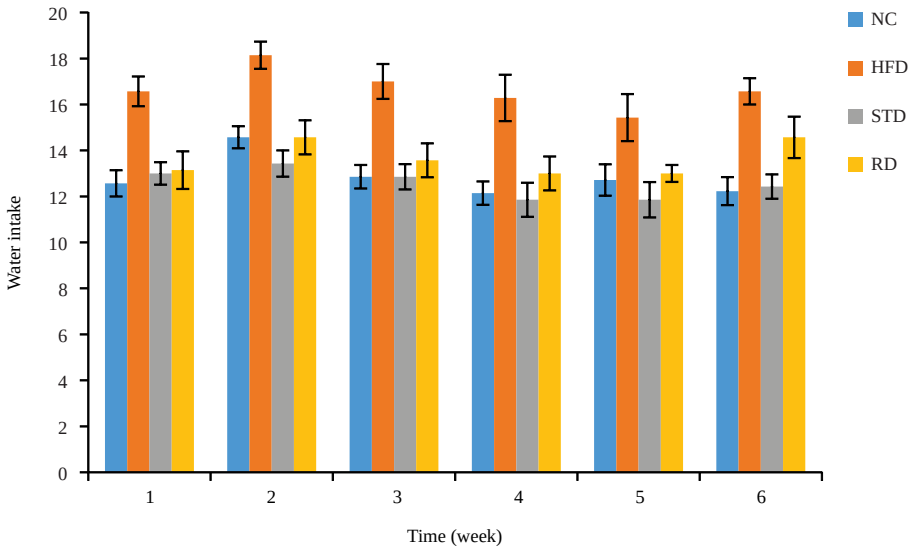

Fig. 2: Effects of treatment on water intake
NC: Normal control, HFD: High fat diet, STD: Orlistat, RD: *Rosa damascena*

Table 4: Effects of treatment on food intake

Weeks	NC	HFD	STD	RD
1	13.33±0.76	21.00±1.155	20.32±0.282	17.94±0.856
2	12.273±0.32	20.265±1.75	18.37±0.112	19.37±1.3
3	12.667±0.66	19.76±0.77	18.54±0.856	18.84±2.654
4	14.833±1.47	18.47±0.79	17.94±0.447	17.39±0.84
5	15.833±1.195	18.49±0.477	16.19±0.6	19.75±0.609
6	17.835±0.945	18.41±0.73	16.84±0.365	18.37±0.5

NC: Normal control, HFD: High fat diet, STD: Orlistat, RD: *Rosa damascena*

group, the result is following that of Latha *et al.*[35]. All the treatment groups showed a significant ($p<0.001$) reduction in body weight compared to the HFD group. The treatment groups, STD and RD showed significant reduction ($p<0.001$) in body weight gain, 53.22±0.75 and 22.43±1.34%, respectively compared to the HFD group.

Food intake: Consumption of the HFD led to obesity because it initiates the development of a positive energy balance leading to an increase in fat deposition. In the current study, rats of the HFD group consumed significantly more food than the control rats throughout the experiment. So, their caloric intake was increased and they showed a large increase in perirenal visceral adipose tissue mass, suggesting that the excess energy led to the buildup of adiposity. This is the source of the increase in body weight[48]. There was a significant ($p<0.001$) increase in food intake(18.41±0.73-21±1.155) in HFD fed group compared to the normal control(12.273±0.32-17.835±0.945)while all the treatment groups showed non-significantly ($p>0.05$) lower food intake except STD ($p<0.01$) compared to HFD. The results of the experiment showed that HFD fed animals took more food during the experiment while treatment groups took slightly lower food intake with fluctuations of lower and higher intake in subsequent weeks as compared to the HFD group in Table 4.

Water intake: There was no significant change of water intake observed in HFD fed rats as well as in treatment groups. Fluctuations in water intake were observed in HFD and treatment groups throughout the experiment. The results of the experiment showed that the treatments with standard and RD have no effect on the behaviour of animals for water intake in Fig. 2.

Organs weight analysis: The HFD fed animals showed significant ($p<0.001$) increase in weight of heart (0.8286±0.017 g), liver (10.636±0.45 g), spleen (0.7198±0.024 g) and kidney (1.826±0.051 g) in comparison to normal control animals. Treatment with RD resulted in a significant decrease in weight of heart, liver, spleen and kidney (0.7847±0.028, 8.171±0.20, 0.6527±0.007 and 1.645±0.096 g, respectively) as compared to HFD fed animals. The details of the results are given in Table 5.

Table 5: Organs weight analysis

Groups	Heart (g)	Liver (g)	Spleen (g)	Kidneys (g)
NC	0.7393±0.015	7.504±0.113	0.6075±0.014	1.381±0.011
HFD	0.8286±0.017***a	10.636±0.45***a	0.7198±0.024***a	1.826±0.051***a
STD+HFD	0.765±0.045***b	7.74±0.34***b	0.628±0.003***b	1.487±0.042*b
RD+HFD	0.7847±0.028***b	8.171±0.20**b	0.6527±0.007**b	1.645±0.096*b

All values are given as Mean±SEM, n = 6, [a]Compared with Normal Control group, [b]Compared with HFD group, ns: p>0.05, *p<0.05, **p<0.01, ***p<0.001, NC: Normal control, HFD: High fat diet, STD: Orlistat, RD: *Rosa damascena*

Table 6: Fat pad analysis

Groups	Mesenteric	Perirenal	Uterine
NC	0.634±0.03	0.648±0.04	0.664±0.028
HFD	1.2345±0.11***a	1.145±0.08***a	1.264±0.145***a
STD+HFD	0.724±0.08***b	0.68±0.02***b	0.713±0.031***b
RD+HFD	0.873±0.08**b	0.832±0.035**b	0.946±0.154*b

All values are given as Mean±SEM, n = 6, [a]Compared with Normal Control group, [b]Compared with HFD group, ns: p>0.05, *p<0.05, **p<0.01, ***p<0.001, NC: Normal control, HFD: High fat diet, STD: Orlistat, RD: *Rosa damascena*

Table 7: Effects of treatment on total cholesterol

Groups	TC (mg dL^{-1})	HDL (mg dL^{-1})	LDL (mg dL^{-1})	VLDL (mg dL^{-1})	Atherogenic index	Triglycerides (mg dL^{-1})
NC	64.34±1.16	25.375±0.36	21.514±0.62	17.446±0.488	1.535±0.2	87.23±1.53
HFD	162.48±2.45***a	9.03±0.51***a	109.72±0.81*a	43.73±2.39*a	16.993±2.34*a	218.65±1.69***a
STD+HFD	69.87±1.87***b	24.64±56***b	26.446±0.65*b	18.784±0.36*b	1.835±0.12*b	93.92±1.24ns
RD+HFD	116.37±2.01***b	14.33±0.17**b	69.448±5.47*b	32.592±1.76*b	7.121±1.34*b	162.96±1.71***a

All values are given as Mean±SEM, n = 6, [a]Compared with normal control group, [b]Compared with HFD group, [c]Compared with SMM, ns: p>0.05, *p<0.05, **p<0.01, ***p<0.001, NC: Normal control, HFD: High fat diet, STD: Orlistat, RD: *Rosa damascena*. TC: Total cholesterol, LDL: Low-density lipoproteins, HDL: High-density lipoprotein, VLDL: Very-low-density lipoproteins

Table 8: Effects of treatment on serum glucose level

Groups	Glucose (mg dL^{-1})	Reduction of glucose vs. HFD (%)
NC	88.74±1.49	
HFD	192.79±1.05***a	100
STD+HFD	96.51±1.14***b	49.95±0.55***b
RD+HFD	154.30±2.61***b	19.96±1.05***b

All values are given as Mean±SEM, n = 6, [a]Compared with normal control group, [b]Compared with HFD group, [c]Compared with SMM, ns: p>0.05, *p<0.05, **p<0.01, ***p<0.001, NC: Normal control, HFD: High fat diet, STD: Orlistat, RD: *Rosa damascena*

Fat pad analysis: As shown in Table 6, administration of HFD produced a highly significant (p<0.001) increase in weight of mesenteric, perirenal and uterine fat pads (1.2345±0.11, 1.145±0.08 and 1.264±0.145 g, respectively) when compared to normal control. Treatment with standard and RD exhibited a decrease in mesenteric, perirenal and uterine fat pads (0.873±0.08, 0.832±0.035 and 0.946±0.154 g, respectively) compared to HFD fed group.

Biochemical parameters

Total cholesterol: Increased fat consumption has been associated with the risk of hyperlipidaemia via alteration of Total Cholesterol (TC) and Triglycerides (TG) levels in plasma and tissues[49]. On the other hand, elevated levels of plasma Low-Density Lipoproteins (LDL-C) and TG, accompanied by reduced High-Density Lipoproteins (HDL-C) levels are associated with an increased risk of Cardiovascular Diseases (CVDs). Consumption of a high-fat diet accelerates the development of obesity and heart problems[35,50].

Consumption of HFD led to a significant increase (p<0.001) in total cholesterol (TC, 162.48±2.45 mg dL^{-1}), triglycerides (TGs, 218.65±1.69 mg dL^{-1}), low-density lipoproteins (LDL, 109.72±0.81 mg dL^{-1}), VLDL (43.73±2.39 mg dL^{-1}) and decrease in high-density lipoprotein (HDL, 9.03±0.51 mg dL^{-1}) cholesterol compared to normal diet group. Treatment with standard and RD showed a significant decrease in TC (116.37±2.01 mg dL^{-1}), TGs (162.96±1.71 mg dL^{-1}), LDL (69.448±5.47 mg dL^{-1}), VLDL (32.592±1.76 mg dL^{-1}) and an increase in HDL cholesterol level compared to animals of HFD fed group given in Table 7. These results suggested that RD has anti-hyperlipidemic effects and are in agreement with previous reports[17-34].

Blood glucose: Intake of high-fat diet significantly increased (p<0.001) the level of serum glucose in the HFD group (192.79±1.05 mg dL^{-1}) compared to the normal control group(88.74±1.49 mg dL^{-1}). Current findings showed that the treatment with RD significantly decreased (p<0.001) the level of serum glucose compared to the HFD group. As shown in Table 8 treatment with standard and RD significantly (p<0.001) reduced the level of glucose (154.30±2.61 mg dL^{-1}). The percentage reduction was, 49.95±0.55% for standard

Table 9: Effects of treatment on SGPT and SGOT

Groups	SGPT (IU L^{-1})	Reduction of SGPT compared to HFD (%)	SGOT (IU L^{-1})	Reduction of SGOT compared to HFD (%)
NC	55.35±1.55		91.47±2.27	
HFD	129.97±6.49***a	100	189.5±2.28***a	100
STD+HFD	60.33±1.73***b	53.58±2.49***b	103.8±1.79***b	45.20±1.62***b
RD+HFD	95.48±2.86***b	26.53±3.65***b	148.6±3.21***b	21.54±1.99***b

All values are given as Mean±SEM, n = 6, [a]Compared with normal control group, [b]Compared with HFD group, ns: p>0.05, *p<0.05, **p<0.01, ***p<0.001, NC: Normal control, HFD: High fat diet, STD: Orlistat, RD: *Rosa damascena*

Table 10: Effect of treatment on serum uric acid

Groups	Uric acid (μg mL^{-1})	Reduction of uric acid compared to HFD (%)
NC	2.42±0.067	
HFD	3.6765±0.11***a	100
STD+HFD	2.7057±0.09	26.41±4.15***b
RD+HFD	3.2892±0.18	10.54±4.01ns

All values are given as Mean±SEM, n = 6, [a]Compared with normal control group, [b]Compared with HFD group, NC: Normal control, HFD: High-fat diet, STD: Orlistat, RD: *Rosa damascena*

Table 11: Effect of treatment on serum creatinine level

Groups	Creatinine (mg dL^{-1})	Reduction of creatinine compared to HFD (%)
NC	0.692±0.04	
HFD	1.3945±0.053***a	100
STD+HFD	0.9945±0.057ns	40.22±2.31***b
RD+HFD	1.219±0.055*b	14.397±2.78*b

All values are given as Mean±SEM, n = 6, [a]Compared with normal control group, [b]Compared with HFD group, *p<0.001, NC: Normal control, HFD: High-fat diet, STD: Orlistat, RD: *Rosa damascena*

(Orlistat) and 19.96±1.05% for RD (p<0.001) respectively compared to the HFD group. The above findings showed that RD has the potential to reduce the elevated level of serum glucose due to obesity and its related disorders. These results are in line with the previous reports[20-21].

SGPT and SGOT: Obesity is the major risk factor for complex and chronic liver disorders[51]. These liver disorders begin as steatosis and cause steatohepatitis, cirrhosis, liver failure and hepatocellular carcinoma[52-54]. In obesity, the liver is bombarded by the Free Fatty Acids (FFA) that pour out of the adipose tissue into the portal blood. This can directly cause inflammation within the liver cells, which then release further pro-inflammatory cytokines, leading to more hepatocytes injury and affecting the integrity of liver cells[55]. As shown in Table 9, there was a significant increase (p<0.001) in the activity of SGPT (129.97±6.49 IU L^{-1}) and SGOT (189.5±2.28 IU L^{-1}) in HDF fed group compared to the normal control group (55.35±1.55, 91.47±2.27 IU L^{-1}, respectively). Administration of standard and RD produced significant lowering effects on the activity of SGPT (95.48±2.86 IU L^{-1}) and SGOT (148.6±3.21 IU L^{-1}) compared to HFD fed animals.

Treatment with standard and RD doses significantly (p<0.001) reduced the level of SGPT and SGOT. The percent reduction was 53.58±2.49 and 26.53±3.65% for SGPT and 45.20±1.62 and 21.54±1.99% for SGOT, respectively, as compared with HFD fed animals. Treatment with RD and OV also significantly (p<0.001) reduced the level of SGPT and SGOT. The above findings showed that the RD has protective effects on liver injuries caused by obesity and obesity-related disorders. The results of the experiment are complying with the previous reports[26-27].

Determination of serum uric acid: As shown in Table 10, the HFD fed rats showed a highly significant (p<0.001) increase in the concentration of serum uric acid (3.6765±0.11 μg mL^{-1}), compared to the normal control group (2.42±0.067 μg mL^{-1}) which agrees with the results of Cindik *et al.*[56]. A high-fat diet induces alteration of renal lipid metabolism by an imbalance between lipogenesis and lipolysis in the kidney, as well as systemic metabolic abnormalities and subsequent renal lipid accumulation leading to renal injury[55,57]. Treatment with standard orlistat (STD) significantly (p<0.001) reduced (26.41±4.15%) while treatment with RD (10.54±4.01%) non-significantly (p>0.05) reduced the level of serum uric acid compared to the HFD group.

Serum creatinine: As shown in Table 11, the HFD fed rats showed a highly significant (1.3945±0.053 mg dL^{-1}) increase in the concentration of serum creatinine, compared to the normal control group (0.692±0.04 mg dL^{-1}) which is in agreement with the results of Amin and Nagy[55] and Cindik *et al.*[56]. Treatment with standard orlistat (STD) and RD significantly reduced the level of serum creatinine (0.9945±0.057 and 1.219±0.055 mg dL^{-1}, respectively) compared to HFD (1.3945±0.053 mg dL^{-1}) fed animals.

CONCLUSION

In the present study, treatment with *R. damascena* significantly reduces the increased body weight, weight of heart, liver, spleen and kidney and fat pats, decreases cholesterol, triglycerides, glucose, SGOT, SGPT level and

creatinine level while increases HDL level. In conclusion, the results obtained from the present study signify the anti-obesity effect of *R. damascena,* which is comparable to that of orlistat. However, the exact mechanism(s) of this effect should be clarified in further studies.

SIGNIFICANCE STATEMENT

This study discovered the ameliorating effects of *Rosa damascena* in obesity and related disorders. This study will help the researchers to uncover the critical areas of diabetic disorders, hepatotoxicity and hypercholesterolemia that many researchers were not able to explore. Thus a new theory on overweight and obesity may be arrived at.

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