Asian Journal of Chemistry; Vol. 38, No. 11 (2026), 3080-3088
ASIAN JOURNAL OF CHEMISTRY
https://doi.org/10.14233/ajchem.2026.37089

LC-MS-Based Phytochemical Profiling, Antioxidant and Anti-Obesity Activities of *Sansevieria cylindrica* Leaves

ABHISHEK MARWARI[1], RIDEN SAXENA[2], JASMINE CHAUDHARY[1] and AKASH JAIN[1,*]

[1]M.M. College of Pharmacy, Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala-133207, India
[2]Department of Microbiology, School of Sciences, Vivek University, Bijnor-246701, India

*Corresponding author: E-mail: akash.jain@mmumullana.org

Received: 31 August 2026 *Accepted*: 24 October 2026 *Published online*: 13 November 2026 AJC-22539

Sansevieria cylindrica contains diverse secondary metabolites with potential pharmacological significance. This study compared the phytochemical profiles of aqueous and ethanolic extracts of *Sansevieria cylindrica* leaves using LC-MS/MS and assessed their antioxidant and anti-obesity activities. Fourteen phytoconstituents were identified, among them quercetin, kaempferol, luteolin, homopterocarpin, trifasciatine, delphinidin and herpestine, with variations in their abundance between the extracts. The ethanolic extract exhibited stronger DPPH radical-scavenging activity (IC_{50} = 45.53 µg/mL) than the aqueous extract (IC_{50} = 64.72 µg/mL), while ascorbic acid showed an IC_{50} of 12.64 µg/mL. In high-fat diet-induced obese male Wistar rats, both extracts at doses of 200 and 400 mg/kg reduced body-weight gain, adiposity, visceral fat accumulation and anthropometric alterations. Improvements were observed in lipid profile, blood glucose, adipokine levels, SGOT/SGPT activities and tissue glutathione status. Histopathological examination revealed reduced fat accumulation in tissues. The ethanolic extract at 400 mg/kg generally showed the strongest metabolic effects. These findings support further investigation of *S. cylindrica* as a potential source of phytochemicals for managing obesity-induced metabolic disturbances.

Keywords: Phytochemical profiling, *Sansevieria cylindrica*, Triglycerides, Leptin, Antioxidant activity, Anti-obesity activity.

INTRODUCTION

Medicinal plants represent an important source of structurally diverse secondary metabolites with potential applications in the management of metabolic disorders [1]. Bioactive constituents such as flavonoids, alkaloids, phenolic compounds, saponins and terpenoids have attracted considerable interest due to their reported biological activities [2,3]. Characterization of the phytochemical composition of botanical extracts is therefore important for establishing a chemical basis for their observed pharmacological effects. *Sansevieria cylindrica* Bojer ex Hook., belonging to the family Asparagaceae, is native to Angola and is widely cultivated in India [4]. The plant has been reported to possess antioxidant, anti-inflammatory, anticancer, antidiabetic, antihypertensive, anti-obesity and antiallergic properties, which have been associated with its diverse phytochemical constituents [4].

Previous phytochemical investigations of *S. cylindrica* have demonstrated the presence of potentially important bioactive constituents. In particular, compounds reported from its aerial parts include dihydrochalcone (+)-2′,4′-dihydroxy-3′-methoxy-3,4-methylenedioxy-8-hydroxymethyldihydrochalcone, also known as (+)-(8*S*)-trifasciatine as well as 3,7-dihydroxy-8-methoxy-3-(3′,4′-methylenedioxybenzyl)chroman-4-one. Dihydrochalcone and steroidal saponins have also been reported from this species [5]. Such chemical diversity highlights the importance of analytical profiling of *S. cylindrica* extracts. LC-MS/MS-based analysis can facilitate characterization of complex botanical extracts and enable comparison of phytochemical profiles obtained using different extraction solvents [6]. However, detailed analytical conditions and supporting references for this aspect require further documentation in the present manuscript.

The phytochemical composition of medicinal-plant extracts is also relevant to their antioxidant and metabolic effects [7]. The manuscript identifies flavonoids and phenolic constituents as potentially important components and relates antioxidant status to metabolic disturbances associated with obesity. High-fat diet (HFD) consumption promotes excessive adiposity and is associated with hyperglycaemia, dyslipidaemia,

This is an open access journal, and articles are distributed under the terms of the Attribution 4.0 International (CC BY 4.0) License. This license lets others distribute, remix, tweak, and build upon your work, even commercially, as long as they credit the author for the original creation. You must give appropriate credit, provide a link to the license, and indicate if changes were made.

oxidative stress and alterations in adipose-tissue homeostasis [8]. HFD-fed rodents therefore provide a useful experimental model for evaluating the biological activity of phytochemically characterized extracts [9]. In the present study, obesity related responses were assessed through body weight, BMI, waist–hip ratio, visceral fat accumulation, serum lipid profile, glucose, leptin, adiponectin, reduced glutathione and histopathological alterations.

Although *S. cylindrica* has been investigated for its biological activities and phytochemical constituents, comparative profiling of aqueous and ethanolic leaf extracts, alongside antioxidant and *in vivo* anti-obesity assessments, remains insufficiently explored. The present study aimed to characterize and compare the phytochemical composition of both extracts using LC-MS/MS, assess their antioxidant activity and investigate their effects on anthropometric, metabolic, biochemical, oxidative stress-induced and histopathological changes in high-fat diet (HFD)-induced obese Wistar rats.

EXPERIMENTAL

The leaves of the selected plant, *Sansevieria cylindrica*, chosen for this study, were freshly collected from a Local garden in Bijnor city and identified and authenticated by the Central Ayurveda Research Institute, Bengaluru, Ministry of Ayush, Government of India, *via* Ref. No. Authentication/ SMPU/CARI/BNG/2021-22/1130 (Ref. RRCBI mus-314). The collected leaves were washed and shade-dried. The dried leaves were then ground into a coarse powder. Orlistat was acquired from Sun Pharmaceutical Industries Ltd, India and all other chemicals used were of analytical grade.

Preparation of extracts: A 100 g powdered sample of *S. cylindrica* leaves was subjected to Soxhlet extraction. The sample was first defatted using petroleum ether and then air-dried. It was then extracted using ethanol and water separately. After the completion of the extraction process, both extracts were filtered through Whatman filter paper (No.1) and then concentrated using a rotary evaporator. The dried extracts were then weighed to find the extraction yield and then subjected to phytochemical screening and other studies. The dried extracts were stored at 4 ºC [10].

Phytochemical characterization

Determination of total phenolic content: Total phenolic content (TPC) of the aqueous and ethanolic extracts was determined using the Folin-Ciocalteu colorimetric method [11]. An appropriately diluted aliquot of each extract was mixed with Folin-Ciocalteu reagent followed by the addition of sodium carbonate solution to provide alkaline reaction conditions. The reaction mixture was incubated for colour development and absorbance was measured at 765 nm using a UV-visible spectrophotometer. Gallic acid was used as the reference standard. The TPC of each extract was calculated from the corresponding calibration curve and expressed as milligrams of gallic acid equivalents per gram of dried extract (mg GAE/g extract).

Determination of total flavonoid content: Total flavonoid content (TFC) of the aqueous and ethanolic extracts was determined using a standard aluminium chloride colorimetric assay [12]. An appropriate aliquot of each extract was reacted with aluminium chloride under the specified assay conditions to produce a flavonoid-aluminium complex. Following incubation for colour development, the absorbance was measured spectrophotometrically. A suitable flavonoid reference standard was used to prepare the calibration curve and the flavonoid content of the extracts was calculated from the corresponding regression equation. The results were expressed as equivalent amounts of the selected reference flavonoid per gram of dried extract.

LC-MS phytochemical profiling: The aqueous and ethanolic leaf extracts of *S. cylindrica* were subjected to liquid chromatography-tandem mass spectrometry (LC-MS/MS). LC-MS analysis was performed using an Agilent 6470 LC/TQ system equipped with a Poroshell EC-C18 column (2.7 μm, 3.0 × 150 mm). The mobile phase consisted of 5 mM ammonium formate containing 0.1% formic acid in water (A) and 100% methanol (B). A gradient program was applied from 95% A/5% B initially to 5% A/95% B at 15-16 min followed by re-equilibration to the initial conditions by 20 min. The injection volume was 5 μL and the column temperature was maintained at 55 ºC. Mass spectrometric conditions included a gas temperature of 225 ºC, gas flow of 6 L/min, nebulizer pressure of 50 psi, sheath gas temperature of 300 ºC, sheath gas flow of 12 mL/min, capillary voltage of 2000 V and nozzle voltage of 500 V. The analytical method used multiple reaction monitoring (MRM) and analyte retention times were required to agree within 5% of those of the corresponding standards. The method reported a limit of detection of 5.0 ng/mL, a limit of quantification of 10.0 ng/mL, a working range of 5-250 ng/mL and an acceptable recovery range of 70-120% [13]. The resulting chromatographic and mass-spectral data were evaluated for the detection and profiling of phytochemical constituents

In vitro studies

Antioxidant activity assay: A common chemical technique was used to determine the levels of reduced glutathione (GSH) [14]. The GSH content was directly correlated with the generated chromogen's absorbance, which was evaluated at 405 nm. Tissue samples were homogenized in an appropriate ice-cold buffer and an aliquot of the homogenate was treated with 10% trichloroacetic acid (TCA) to precipitate proteins. The mixture was centrifuged at 3000-5000 rpm for 10-15 min, then clear supernatant was collected and mixed with a suitable chromogenic reagent. The absorbance of the resulting coloured solution was measured at 405 nm using a UV-visible spectrophotometer against a reagent blank. The GSH concentration was determined from a calibration curve prepared using known GSH standards. The results were expressed relative to tissue weight or protein content [15].

Animals study: Healthy Wistar male rats weighing between 150 and 200 g were taken from the animal house of Vivek College of Technical Education, Bijnor, India. The animals were kept in polypropylene cages and acclimatized to environmental conditions, *i.e.* a 12 h light/dark cycle, temperature of 23 ± 2 ºC and 65 ± 5% humidity, unrestricted access to water and a normal rat chow pellet. The protocol was approved by the Institutional Animal Ethics Committee

with protocol no. VCTE/IAEC/22-23/001. All the research was carried out in accordance with the CCSEA ethical guidelines.

In vivo studies

Obesity induction: The weighed Wistar male rats were given a high-fat diet (HFD) to induce obesity. The HFD includes powdered NPD (375 g), lard (290 g), casein (265 g), corn oil (10 g), cholesterol (10 g), vitamins and minerals mix (60 g), DI-methionine (3 g), yeast powder (1.0 g) and sodium chloride (1.0 g). Individual rats (Groups B-F), except Group A, were given the prepared high-fat diet for 84 days. For 12 weeks, each cage's daily food intake was tracked at regular intervals and the average consumption was calculated [16].

Animal grouping: Male Wistar rats were allocated into seven groups (n = 6 animals per group). The first group, Group A (normal control), received a normal regular rat diet; Group B (obese control) received HFD for 84 days; Group C, fed with HFD, was kept on the standard drug orlistat (30 mg/kg/BW), administered orally once daily for 84 days. However, Group D (ASCE 200 mg/Kg/BW), Group E (ASCE 400 mg/Kg/BW), Group F (ESCE 200 mg/Kg/BW) and Group G (ESCE 400 mg/Kg/BW) fed on HFD for 84 days were administered the specified extract orally once a day. The weight gain in rats was measured using each rat's initial and final body weights [17]. Food consumption was recorded at cage level. Consequently, cage-level food-intake measurements were distinguished from individual-animal outcomes such as body weight and biochemical measurements.

Collection of blood and samples: On the last day of the study (*i.e.*, after 84-days of trial), the blood was withdrawn in 3 different test tubes for biochemical and hematological assessments. For hematological parameters, the first blood sample was drawn in EDTA salt [18]. The second blood sample was collected in a simple tube, which was then centrifuged to separate the serum. The serum was stored at -20 ºC in aliquots until needed for evaluating the lipid profiles, along with leptin, adiponectin and other biochemical parameters. The third blood sample was placed in a sodium fluoride tube for estimating glucose [19].

All the rats were then sacrificed at the end of the protocol and adipose tissues, *i.e.* retroperitoneal (RET), epididymal (EPI) and mesenteric (MES), were promptly removed, washed with phosphate-buffered saline, weighed and then preserved in 10% formalin. The fat pads, kidney, liver and testicles were also removed, weighed and prepared for histopathological studies [20].

Assessment of anthropometric parameters: The body weights were determined once a week. Body mass index (BMI), waist-hip ratio, adiposity index and obesity index were also calculated using the following formulae [21]:

$$\text{BMI} = \frac{\text{Body weight (g)}}{\text{Length}^2\ (\text{cm}^2)}$$

$$\text{Waist-Hip ratio (WHR)} = \frac{\text{Waist circumference (cm)}}{\text{Hip circumference (cm)}}$$

$$\text{Adipose index} = \frac{\text{Perirenal WAT} + \text{Retroperitoneal WAT} + \text{Epididymal WAT}}{\text{Body weight}} \times 100$$

$$\text{Obesity index} = \frac{\text{Body weight of rat}}{\text{Naso anal length}} \times 10^4$$

Assessment of biochemical parameters: Total serum glucose was estimated by the glucose-peroxidase method. Total cholesterol and HDL cholesterol levels in serum were determined using Bayer Diagnostic kit (Bayer Diagnostic India Ltd.) and Triglyceride levels using a kit from Erba Diagnostics in Mannheim, Germany. VLDL and LDL levels were determined using the following formulae:

$$\text{Serum VLDL levels (mg/dL)} = \frac{\text{Triglycerides}}{5}$$

$$\text{LDL levels (mg/dL)} = \text{Total cholesterol} - (\text{HDL level} + \text{VLDL level})$$

Hormones like leptin and adiponectin were also assessed [22].

Histopathological analysis: The fatty tissue extracted and preserved in 10% neutral buffered formalin was fixed in paraffin for histological analysis. After cutting standard sections of 5 μm thickness, they were stained with haematoxylin and eosin and observed under a light microscope [23].

Statistical analysis: One-way analysis of variance (ANOVA) followed by an appropriate post-hoc multiple comparison test was used to statistically evaluate the analytical data using GraphPad Prism software. Data are expressed as mean ± standard error (SE). The biochemical data for random blood glucose, lipid profile and fat pad weights, along with the impact of ethanolic extract of *S. cylindrica* leaves on feed intake, body weight, BMI and obesity index, were statistically analyzed using ANOVA and the multiple comparison test $p < 0.05$. A p-value of less than 0.05 was considered statistically significant.

RESULTS AND DISCUSSION

LC-MS phytochemical profiling: LC-MS/MS analysis of the aqueous and ethanolic leaf extracts of *S. cylindrica* revealed chromatographic signals provisionally assigned to 14 phytochemical constituents or constituent classes, such as quercetin, kaempferol, luteolin, anthraquinones, pterocarpan, homopterocarpin, lanceolatin, isoflavonone, dihydrochalcone, quinolone, trifasciatine, delphinidin, herpestine and cambodianol. The manuscript reports a limit of detection (LOD) of 5 ng/mL and a limit of quantification (LOQ) of 10 ng/mL.

The aqueous extract showed reported concentrations ranging from 17.2220 ng/mL for quinolone to 211.4484 ng/mL for trifasciatine (Table-1). Other constituents reported at relatively high concentrations were homopterocarpin (177.0043 ng/mL), delphinidin (167.4365 ng/mL), anthraquinones (161.2911 ng/mL) and kaempferol (117.6840 ng/mL) (Fig. 1a). The ethanolic extract, analyzed in negative-ionization mode, showed a different concentration profile. Trifasciatine remained the most abundant reported analyte (281.6537 ng/mL) followed by homopterocarpin (223.8837 ng/mL) and delphinidin (206.5733 ng/mL). Other relatively abundant analytes were isoflavonone (137.6407 ng/mL), anthraquinones (129.1253 ng/mL), herpestine (124.2080 ng/mL) and kaempferol (103.2891 ng/mL) (Fig. 1b). These differences may

TABLE-1
LIST OF LC-MS/MS-IDENTIFIED PHYTOCHEMICAL CONSTITUENTS IN AQUEOUS AND ETHANOLIC EXTRACTS OF *S. cylindrica* LEAVES WITH THEIR RETENTION TIMES AND CONCENTRATIONS

Compound	Aqueous extract of *S. cylindrica* leaves			Ethanolic extract of *S. cylindrica* leaves		
	Positive mode			Negative mode		
	RT	Response	Conc. (ng/mL)	RT	Response	Conc. (ng/mL)
Quercetin	2.993	72992	40.1848	2.966	58435	32.1708
Kaempferol	6.386	612653	117.684	6.373	537714	103.2891
Luteolin	6.532	62009	25.8331	6.517	56908	23.7081
Anthraquinones	7.761	2439217	161.2911	7.761	1952771	129.1253
Pterocarpan	11.728	531611	27.7466	11.714	672408	35.0953
Homopterocarpin	12.153	1061366	177.0043	12.151	1342467	223.8837
Lanceolatin	13.354	1056371	75.4048	13.341	1303288	93.03
Cambodianol	15.46	104867	66.9746	15.46	120489	76.9516
Isoflavonone	15.593	881007	103.3323	15.519	1173519	137.6407
Dihydrochalcone	17.653	264806	44.0119	17.653	352727	58.6248
Quinolone	19.837	2018002	17.222	19.813	2401111	20.4916
Trifasciatine	28.838	222865	211.4484	28.069	296861	281.6537
Delphinidin	29.076	315274	167.4365	37.717	388966	206.5733
Herpestine	37.74	71536	93.2478	37.756	95288	124.208

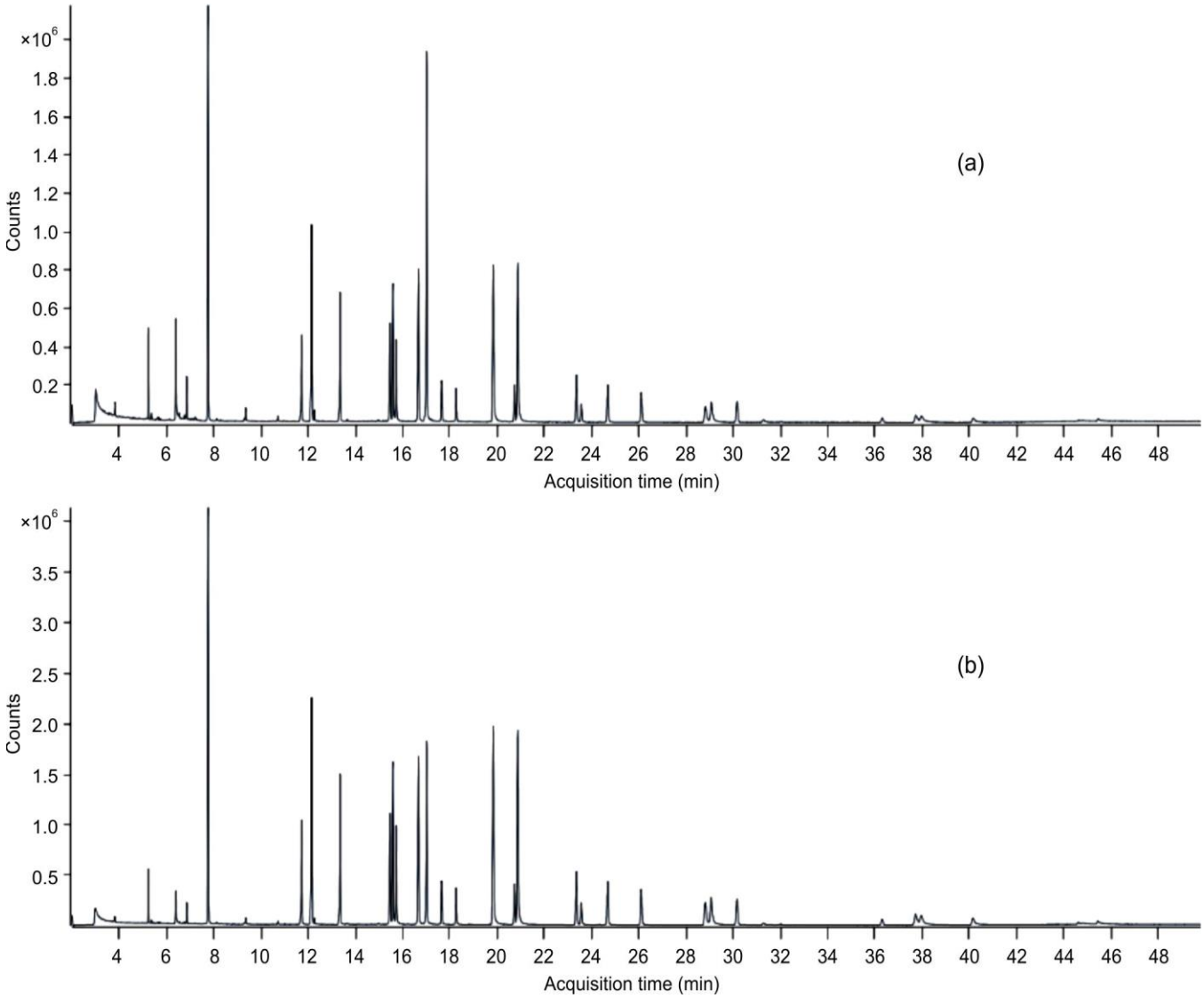


Fig. 1 LC-MS chromatographic profile of the (a) aqueous and (b) ethanolic extracts of *S. cylindrica* leaves in positive ionization mode analyzed in negative ionization mode

reflect solvent-dependent extraction and the use of different ionization modes. Direct quantitative comparison between the extracts requires caution, as ionization efficiency and matrix effects may influence the measured signals.

Previous investigations support the presence of diverse secondary metabolites in *S. cylindrica*. Raslan *et al.* [24] isolated a new dihydrochalcone, along with new and known steroidal saponins, from the aerial parts of the plant. Ibrahim *et al.* [5] examined methanolic leaf and rhizome extracts using GC-MS and reported a diverse chemical profile with fatty acids and their esters prominent in the extracts and steroidal saponins detected in both plant parts. These studies establish a broader phytochemical basis for investigating *S. cylindrica*, although their findings do not independently confirm the identities of all compounds tentatively assigned in the present LC-MS/MS analysis.

Comparative LC-MS profiles: Several similar analyte assignments were reported in both extracts, although the aqueous extract was analyzed in positive electrospray ionization mode and the ethanolic extract in negative electrospray ionization mode. Quercetin, kaempferol, luteolin and anthraquinones were reported at higher concentrations in the aqueous extract, whereas pterocarpan, homopterocarpin, lanceolatin, cambodianol, isoflavonone, dihydrochalcone, quinolone, trifasciatine, delphinidin and herpestine showed higher reported concentrations in the ethanolic extract. The differences were notable for trifasciatine (211.4484 *vs.* 281.6537 ng/mL), homopterocarpin (177.0043 *vs.* 223.8837 ng/mL) and delphinidin (167.4365 *vs.* 206.5733 ng/mL) in the aqueous and ethanolic extracts, respectively. These variations may be associated with solvent-dependent extraction and differences in ionization efficiency. The tentative assignment of a dihydrochalcone-type constituent is important, as Raslan *et al.* [24] isolated and structurally characterized a dihydrochalcone from the aerial parts of *S. cylindrica*.

DPPH radical-scavenging activity: Both aqueous and ethanolic extracts exhibited concentration-dependent DPPH radical scavenging activity (Fig. 2). At 12.5 µg/mL, the aqueous and ethanolic extracts showed 20.59% and 36.92% scavenging activity, respectively. At 150 µg/mL, the corresponding values increased to 62.24% and 81.27%, whereas ascorbic acid produced 90.75% scavenging. The calculated IC_{50} values were 64.72 µg/mL for the aqueous extract, 45.53 µg/mL for the ethanolic extract and 12.64 µg/mL for ascorbic acid. Thus, the ethanolic extract exhibited higher DPPH radical

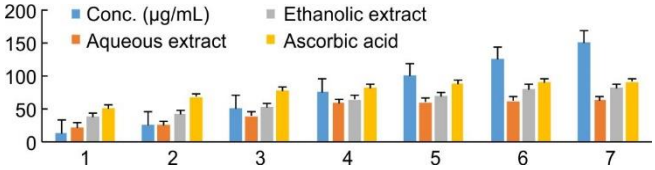


Fig. 2. Concentration-dependent DPPH radical-scavenging activity of aqueous and ethanolic extracts of *S. cylindrica* leaves compared with ascorbic acid

scavenging activity than the aqueous extract, although both were less active than ascorbic acid. In an HFD model, Ibukun & Omoregie [25] reported that methanolic leaf extracts rich in flavonoids such as kaempferol, quercetin and luteolin protected Wistar rats against dyslipidaemia and oxidative stress.

Body weight and anthropometric parameters: HFD feeding produced a marked increase in body weight. The HFD control group increased from 176.17 ± 3.851 g to 380.84 ± 4.397 g, corresponding to a 116.17% increase, whereas the normal control group showed a 62.57% increase. Treatment with orlistat, ASCE and ESCE significantly attenuated HFD-induced weight gain ($p < 0.05$) (Table-2; Fig. 3). ESCE at 400 mg/kg produced a final body weight of 255.39 ± 2.381 g and weight gain of 51.76%, compared with 67.64% for ASCE at 400 mg/kg and 50.64% for orlistat.

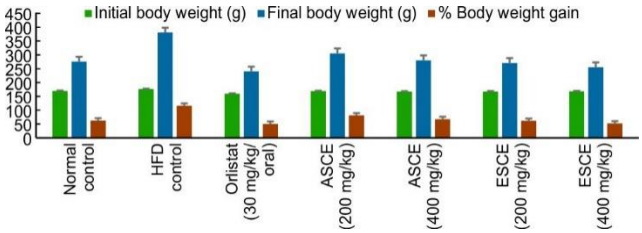


Fig. 3. Effect of aqueous and ethanolic extracts of *S. cylindrica* leaves on body-weight gain in HFD-fed Wistar rats

The anthropometric findings showed a similar pattern. At week 12, WHR and BMI in the HFD control reached 1.05 and 0.65 g/cm^2, respectively, compared with 0.90 and 0.55 g/cm^2 in normal controls. ESCE at 400 mg/kg produced corresponding values of 0.92 and 0.58 g/cm^2 (Table-3; Fig. 4). These results are consistent with several recent HFD models employing botanical interventions.

Visceral fat accumulation, adiposity and obesity index: Treatment with ASCE and ESCE at 200 and 400 mg/kg significantly attenuated these alterations compared with the HFD

TABLE-2
EFFECT OF AQUEOUS AND ETHANOLIC *S. cylindrica* LEAVES EXTRACTS ON BODY-WEIGHT CHANGES IN HFD-FED WISTAR RATS

Groups	Body weight (%)		
	Initial body weight (g)	Final body weight (g)	Body weight gain (%)
Normal control	169.33 ± 2.011	275.71 ± 1.362	62.57
HFD control	176.17 ± 3.851[a]	380.84 ± 4.397[a]	116.17[a]
Orlistat (30 mg/kg/oral)	159.35 ± 1.945[b]	240.06 ± 2.002[b]	50.64[b]
ASCE (200 mg/kg)	168.83 ± 1.815[b]	305.67 ± 1.790[b]	81.05[b]
ASCE (400 mg/kg)	167.32 ± 2.052[b]	280.49 ± 2.381[b]	67.64[b]
ESCE (200 mg/kg)	167.83 ± 1.815[b]	270.62 ± 1.790[b]	61.25[b]
ESCE (400 mg/kg)	168.29 ± 2.044[b]	255.39 ± 2.381[b]	51.76[b]

Data are expressed as Mean ± S.E.M. (n = 6). Where [b]$p < 0.05$ *vs.* HFD control and [a]$p < 0.05$ *vs.* normal control.

TABLE-3
EFFECT OF AQUEOUS AND ETHANOLIC *S. cylindrica* LEAVES EXTRACTS ON WAIST-HIP RATIO AND BODY MASS INDEX DURING HFD-INDUCED OBESITY

Groups	WH Ratio			BMI (g/cm^2)		
	Week 4	Week 8	Week 12	Week 4	Week 8	Week 12
Normal control	0.87	0.89	0.9	0.52	0.54	0.55
HFD control	0.93^a	0.98^a	1.05^a	0.55^a	0.64^a	0.65^a
Orlistat (30 mg/kg)	0.9^b	0.95^b	0.91^b	0.53^b	0.58^b	0.56^b
ASCE (200 mg/kg)	0.92^b	0.99^b	0.97^b	0.54^b	0.63^b	0.61^b
ASCE (400 mg/kg)	0.91^b	0.97^b	0.95^b	0.53^b	0.62^b	0.60^b
ESCE (200 mg/kg)	0.92^b	0.98^b	0.94^b	0.53^b	0.61^b	0.59^b
ESCE (400 mg/kg)	0.91^b	0.99^b	0.92^b	0.54^b	0.60^b	0.58^b

Data are expressed as Mean ± S.E.M. (n = 6). Where $^b p < 0.05$ *vs.* HFD control and $^a p < 0.05$ *vs.* normal control

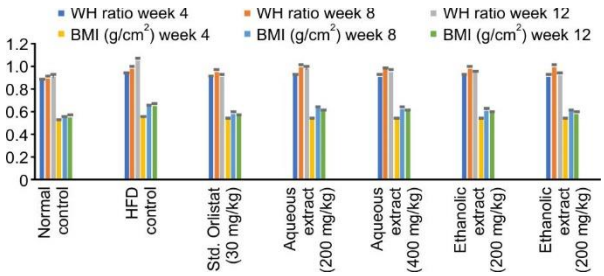


Fig. 4. Effect of aqueous and ethanolic *S. cylindrica* leaves extracts on waist-hip ratio and body mass index in HFD-fed rats

control ($p < 0.05$) (Table-4). The reduction in adipose-tissue mass occurred concurrently with reduced body-weight gain, which indicate that attenuation of body-weight gain was accompanied by decreased accumulation of visceral fat.

Blood glucose, leptin and adiponectin: HFD feeding increased random blood glucose from 84.65 to 131.72 mg/dL and leptin levels from 2.58 to 8.76 ng/mL, while adiponectin decreased from 9.47 to 6.89 µg/mL. These changes are consistent with impaired glucose regulation and adipokine imbalance associated with diet-induced obesity. The *S. cylindrica* extracts improved glucose, leptin and adiponectin levels, with ESCE at 400 mg/kg showing the strongest response (98.68 mg/dL, 3.87 ng/mL and 7.84 µg/mL, respectively), which suggest the partial restoration of adipose tissue endocrine function (Table-5). The present results support the potential of *S. cylindrica*, particularly the ethanolic extract at 400 mg/kg, to improve obesity related metabolic disturbances in this animal model.

Serum lipid profile: The HFD feeding produced marked dyslipidaemia (Fig. 5). Compared with normal controls, HFD animals showed increases in TC (98.64 ± 3.02 to 224.32 ± 2.83 mg/dL), TG (86.69 ± 5.67 to 189.68 ± 2.70 mg/dL), LDL (35.03 ± 2.86 to 156.69 ± 3.49 mg/dL) and VLDL (17.34 ± 3.56 to 37.94 ± 3.46 mg/dL), accompanied by a decrease in HDL

TABLE-4
EFFECT OF AQUEOUS AND ETHANOLIC *S. cylindrica* LEAVES EXTRACTS ON VISCERAL FAT-PAD WEIGHTS, TOTAL FAT, ADIPOSITY INDEX AND OBESITY INDEX IN HFD-FED WISTAR RATS

Groups	Fat pad weights			Total fat (g)	Adiposity index (%)	Obesity index
	Epididymal fat (g)	Retro-peritoneal fat (g)	Mesenteric fat (g)			
Normal control	2.96 ± 0.51	1.56 ± 0.45	2.97 ± 0.35	7.49 ± 0.49	2.65 ± 0.09	420.07 ± 8.90
HFD control	7.68 ± 0.73^a	4.36 ± 0.73^a	8.2 ± 0.45^a	20.24 ± 2.11^a	5.64 ± 0.45^a	511.17 ± 7.02^a
Orlistat (30 mg/kg)	3.15 ± 0.67^b	1.98 ± 0.65^b	3.65 ± 0.76^b	8.78 ± 1.54^b	4.90 ± 0.25^b	311.25 ± 3.37^b
ASCE (200 mg/kg)	5.41 ± 0.93^b	2.29 ± 0.47^b	5.56 ± 0.92^b	13.26 ± 1.98^b	5.42 ± 0.32^b	382.89 ± 9.73^b
ASCE (400 mg/kg)	3.82 ± 0.69^b	2.11 ± 0.54^b	4.56 ± 0.68^b	10.49 ± 0.57^b	5.18 ± 0.09^b	342.62 ± 7.94^b
ESCE (200 mg/kg)	4.59 ± 0.96^b	2.14 ± 0.67^b	5.1 ± 0.64^b	11.83 ± 1.76^b	5.31 ± 0.11^b	357.22 ± 8.54^b
ESCE (400 mg/kg)	3.68 ± 0.62^b	2.09 ± 0.28^b	4.22 ± 0.29^b	9.99 ± 0.89^b	5.03 ± 0.35^b	335.70 ± 11.45^b

The mean ± S.E.M. of n = 6/group is used to represent all values. where $^b p < 0.05$ *vs.* HFD control and $^a p < 0.05$ *vs.* normal control.

TABLE-5
EFFECT OF AQUEOUS AND ETHANOLIC *S. cylindrica* LEAVES EXTRACTS ON RANDOM BLOOD GLUCOSE, SERUM LEPTIN AND SERUM ADIPONECTIN IN HFD-FED WISTAR RATS

Groups	Serum leptin (ng/mL)	Random blood glucose (mg/dL)	Adiponectin (µg/mL)
Normal control	2.58 ± 0.39	84.65 ± 5.53	9.47 ± 2.34
HFD control	8.76 ± 0.58^a	131.72 ± 1.62^a	6.89 ± 1.25^a
Orlistat (30 mg/kg)	3.65 ± 0.27^b	93.27 ± 3.38^b	8.39 ± 3.15^b
ASCE (200 mg/kg)	6.48 ± 0.35^b	127.36 ± 5.41^b	7.06 ± 2.25^b
ASCE (400 mg/kg)	4.69 ± 0.32^b	118.76 ± 2.87^b	7.21 ± 1.41^b
ESCE (200 mg/kg)	5.59 ± 0.33^b	113.24 ± 4.52^b	7.49 ± 4.36^b
ESCE (400 mg/kg)	3.87 ± 0.24^b	98.68 ± 3.03^b	7.84 ± 3.39^b

The mean ± S.E.M. of n = 6/group is used to represent all values. where $^b p < 0.05$ *vs.* HFD control and $^a p < 0.05$ *vs.* normal control.

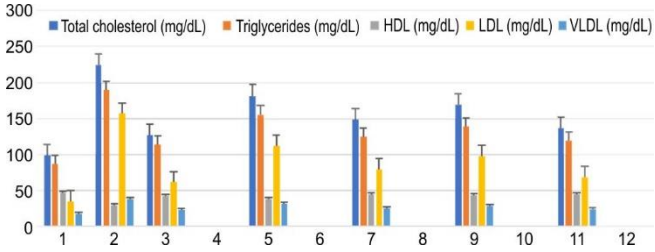


Fig. 5. Effect of aqueous and ethanolic *S. cylindrica* leaves extracts on the serum lipid profile of HFD-fed Wistar rats

from 46.27 ± 4.83 to 29.69 ± 3.70 mg/dL. ESCE at 400 mg/kg reduced TC, TG, LDL and VLDL to 136.62 ± 4.83, 118.86 ± 1.61, 68 ± 2.44 and 23.80 ± 3.54 mg/dL, respectively, while HDL increased to 44.92 ± 3.89 mg/dL (Table-6). These lipid-lowering pattern agrees with the recent reported experimental studies of phytochemical-rich extracts [25-27].

SGPT, SGOT and organ weights: The HFD control group exhibited elevated SGPT and SGOT activities (68.31 ± 2.37 and 74.23 ± 1.13 U/L, respectively) compared with normal controls (36.18 ± 0.37 and 21.31 ± 0.54 U/L). These changes are consistent with the hepatic dysfunction associated with HFD feeding. Treatment with aqueous (ASCE) and ethanolic (ESCE) extracts reduced both enzyme activities, with ESCE at 400 mg/kg showing values of 52.39 ± 0.86 U/L for SGPT and 56.43 ± 1.18 U/L for SGOT (Fig. 6). HFD feeding was accompanied by increased liver, kidney and testis weights. Liver weight rose from 10.90 ± 0.04 g in normal controls to 22.13 ± 0.04 g in the HFD control, while ESCE at 400 mg/kg reduced it to 13.68 ± 0.04 g. Similar changes were observed in kidney and testis weights (Fig. 7). These findings point to a possible protective effect of ESCE against HFD-induced hepatic and organ-weight alterations.

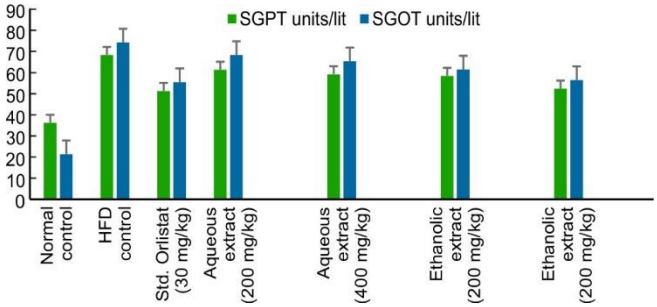


Fig. 6. Effect of aqueous and ethanolic *S. cylindrica* leaves extracts on serum SGPT and SGOT levels in HFD-fed Wistar rats

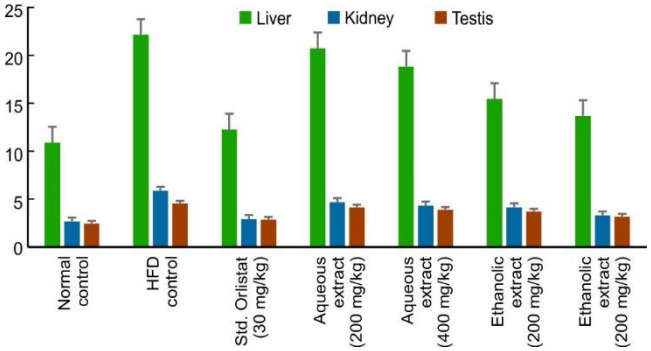


Fig. 7. Effect of aqueous and ethanolic *S. cylindrica* leaves extracts on organ tissue weights in HFD-fed Wistar rats

Comparable findings have been reported for other plant-derived interventions. Zhang *et al*. [27] reported that walnut-shell extract reduced ALT and AST activities and improved lipid metabolism in HFD-fed animals. Nimbolide treatment in HFD-fed Wistar rats also improved the hepatic and anti-oxidant parameters and reduced body-weight gain [28]. The present findings are consistent with these reports and warrant further investigation of *S. cylindrica*, particularly ESCE at 400 mg/kg, for its potential effects on obesity-induced hepatic and metabolic disturbances.

Changes in GSH-induced absorbance: The HFD-control group showed lower GSH-induced assay absorbance (0.385 ± 0.01) than the normal-control group (0.769 ± 0.02). Extract-treated groups had higher absorbance values than the HFD control, with ESCE at 400 mg/kg reaching 0.578 ± 0.046 (Table-7). These results show differences in the GSH-induced assay response among the experimental groups. The findings

TABLE-7
EFFECT OF AQUEOUS AND ETHANOLIC *S. cylindrica* LEAVES EXTRACTS ON TISSUE REDUCED GLUTATHIONE IN HFD-FED WISTAR RATS

Groups	Absorbance
Normal control	0.769 ± 0.02
HFD control	0.385 ± 0.01[a]
Orlistat (30 mg/kg)	0.612 ± 0.21[b]
ASCE (200 mg/kg)	0.479 ± 0.04[b]
ASCE (400 mg/kg)	0.516 ± 0.03[b]
ESCE (200 mg/kg)	0.536 ± 0.039[b]
ESCE (400 mg/kg)	0.578 ± 0.046[b]

The mean ± S.E.M. of n = 6/group is used to represent all values. Where [b]$p < 0.05$ *vs.* HFD control and [a]$p < 0.05$ *vs.* normal control.

TABLE-6
EFFECT OF AQUEOUS AND ETHANOLIC *S. cylindrica* LEAVES EXTRACTS ON SERUM TOTAL CHOLESTEROL, TRIGLYCERIDES, HDL-C, LDL-C AND VLDL-C IN HFD-FED WISTAR RATS

Groups	Total cholesterol (mg/dL)	Triglycerides (mg/dL)	HDL (mg/dL)	LDL (mg/dL)	VLDL (mg/dL)
Normal control	98.64 ± 3.02	86.69 ± 5.67	46.27 ± 4.83	35.03 ± 1.26	17.34 ± 3.65
HFD control	224.32 ± 2.83[a]	189.68 ± 2.7[a]	29.69 ± 3.7[a]	156.69 ± 3.29[a]	37.94 ± 2.25[a]
Orlistat (30 mg/kg)	126.72 ± 4.29[b]	113.35 ± 1.32[b]	42.68 ± 3.85[b]	61.37 ± 2.67[b]	22.67 ± 3.43[b]
ASCE (200 mg/kg)	181.54 ± 5.02[b]	155.41 ± 4.97[b]	38.49 ± 1.64[b]	112 ± 2.64[b]	31.10 ± 4.92[b]
ASCE (400 mg/kg)	148.35 ± 3.77[b]	124.25 ± 3.65[b]	44.35 ± 2.65[b]	79 ± 3.69[b]	24.90 ± 2.91[b]
ESCE (200 mg/kg)	168.93 ± 1.52[b]	138.32 ± 2.56[b]	43.69 ± 5.62[b]	98 ± 5.76[b]	27.70 ± 5.63[b]
ESCE (400 mg/kg)	136.62 ± 4.83[b]	118.86 ± 1.61[b]	44.92 ± 3.89[b]	68 ± 2.44[b]	23.80 ± 3.54[b]

The mean ± S.E.M. of n = 6/group is used to represent all values. Where [b]$p < 0.05$ *vs.* HFD control and [a]$p < 0.05$ *vs.* normal control.

match the *in vitro* DPPH results, with the higher absorbance in extract-treated groups pointing to a possible improvement in HFD antioxidant status.

Histopathological findings: The histopathological examination of liver sections revealed normal tissue architecture in the normal-control group, whereas the HFD-control group exhibited marked vacuolar changes and hepatic fat accumulation. Treatment with orlistat, ASCE and ESCE reduced the extent of these alterations, with the extract-treated groups showing fewer prominent vacuolar spaces than the HFD control (Fig. 8). These findings support the biochemical results and suggest that *S. cylindrica* leaves extracts may help reduce hepatic steatosis induced by a high-fat diet.

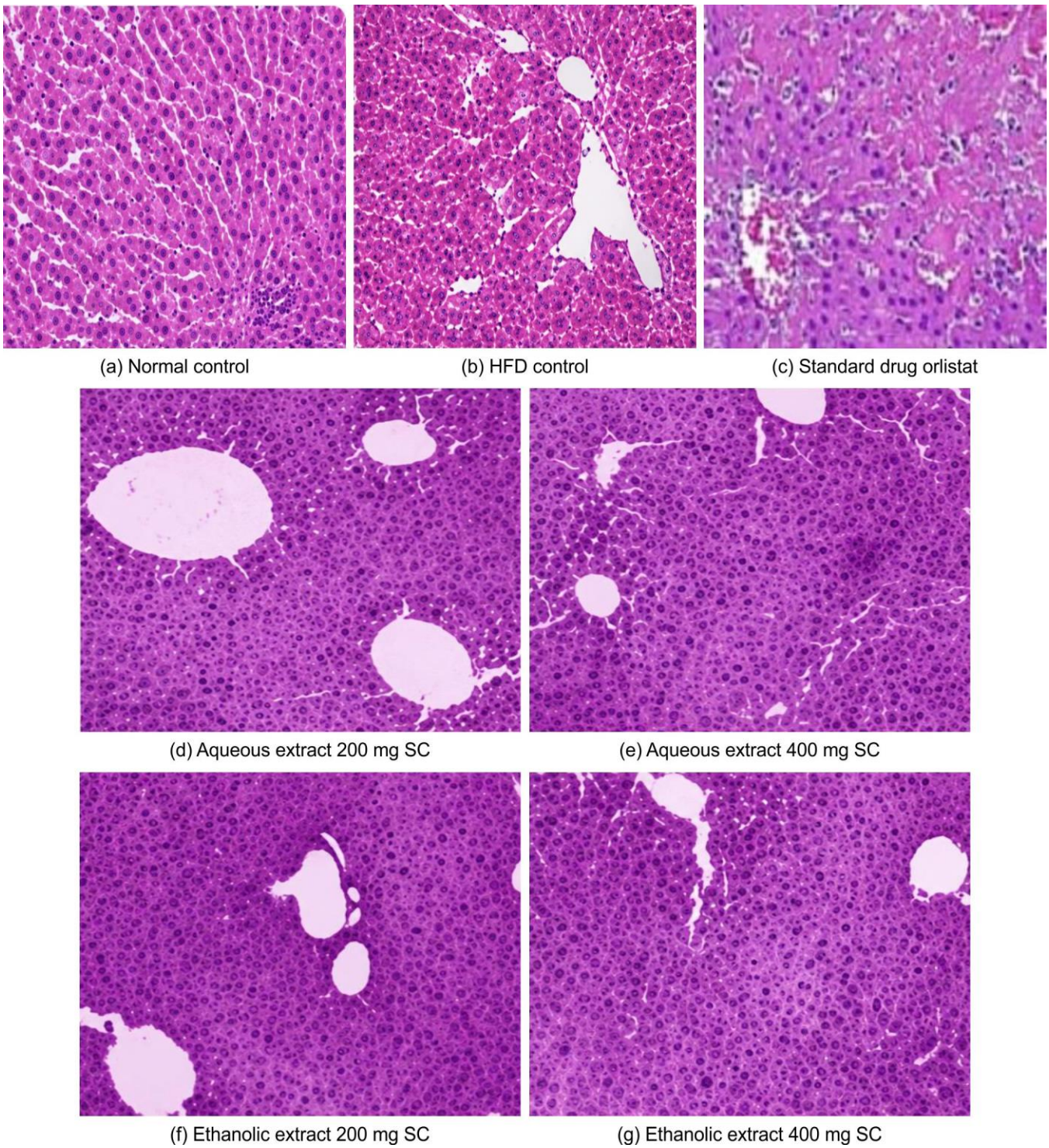


Fig. 8. Histopathological images following administration of aqueous and ethanolic *S. cylindrica* leaf extracts to HFD-fed Wistar rats (40×): (a) normal control; (b) HFD control; (c) orlistat 30 mg/kg; (d) ASCE 200 mg/kg; (e) ASCE 400 mg/kg; (f) ESCE 200 mg/kg; and (g) ESCE 400 mg/kg

Conclusion

In conclusion, both aqueous and ethanolic extracts of *Sansevieria cylindrica* leaves reduced several obesity-induced changes in male Wistar rats during 84 days of high-fat diet (HFD) feeding. Both extracts reduced body-weight gain and visceral fat accumulation and improved selected lipid-profile parameters, blood glucose, adipokine levels and histopathological changes compared with the HFD-control group. Among the treated groups, the ethanolic extract at 400 mg/kg generally showed the strongest effects. The LC-MS/MS analysis identified several possible phytochemical constituents in the extracts. Since treatment began during HFD exposure, the findings support a reduction in diet-induced metabolic changes rather than treatment of established obesity.

ACKNOWLEDGEMENTS

The author is thankful to the Faculty of Pharmaceutical Sciences, Maharishi Markandeshwar, Mullana, for providing the necessary research facilities.

CONFLICT OF INTEREST

The authors declare that there is no conflicts of interest regarding the publication of this article.

DECLARATION OF AI-ASSISTED TECHNOLOGIES

During the preparation of this manuscript, the authors used an AI-assisted tool(s) to improve the language and no data, results or scientific conclusions were generated by AI. All analyses, interpretations and conclusions are the authors' own. The authors reviewed and edited the content and take full responsibility for the published work.

REFERENCES

1. V.K. Gauttam, K. Munjal, H. Chopra, A. Ahmad, M.K. Rana and M.A. Kamal, *Curr. Pharm. Des.*, **30**, 10 (2024); https://doi.org/10.2174/0113816128274446231220113957
2. B. Hilal, M.M. Khan and Q. Fariduddin, *Plant Physiol. Biochem.*, **211**, 108674 (2024); https://doi.org/10.1016/j.plaphy.2024.108674
3. K. Shrinet, R.K. Singh, R. Saxena, A.K. Chaurasia and A. Kumar, *Pharm. Sci. Adv.*, **1**, 100011 (2023); https://doi.org/10.1016/j.pscia.2023.100011
4. S. Shewale, V. Undale, A.V. Addapalli, V. Bhatia, V. Desai, S. Wawale, V. Shelar, M. Pawade, S. Satone, S. Lembhe, S. Parikh and P. Pujari, *Toxicol. Int.*, **30**, 555 (2023); https://doi.org/10.18311/ti/2023/v30i4/31062
5. O.H.M. Ibrahim, A.A.H. Issa, W.M. Al-Otaibi, H.M. Al-Yasi, L.M. Al Masoudi, O.H. Tawfik, A.I. Alqubaie, F. Althobaiti and E.F. Ali, *Ind. Crops Prod.*, **223**, 120169 (2025); https://doi.org/10.1016/j.indcrop.2024.120169
6. S.A. Abdulla, F.A. Elshaari, M. Alshintari and L. Zourgui, *Open Vet. J.*, **15**, 2478 (2025); https://doi.org/10.5455/OVJ.2025.v15.i6.20
7. R. Latif and T. Nawaz, *Phytochem. Rev.*, **25**, 2299 (2026); https://doi.org/10.1007/s11101-025-10194-7
8. Z. Wang, X. Liu, L. Sheng, Y. Xie, W. Feng and L. Yu, *Obest. Res. Clin. Pract.*, **19**, 54 (2025); https://doi.org/10.1016/j.orcp.2025.02.001
9. M. Cuchillo-Hilario, D.L. Ramírez-Ramírez, M.I. Fournier-Ramírez, M. Díaz-Martínez, G. Flores-Coello, I. Torre-Villalvazo, C. Delgadillo-Puga and L. G. Noriega-López, *Int. Dairy J.*, **181**, 106727 (2026); https://doi.org/10.1016/j.idairyj.2026.106727
10. S. Sun, Y. Yu, Y. Jo, J.H. Han, Y. Xue, M. Cho, S.-J. Bae, D. Ryu, W. Park, K.-T. Ha and S. Zhuang, *Front. Pharmacol.*, **16**, 1615338 (2025); https://doi.org/10.3389/fphar.2025.1615338
11. P. Mori, M. Chauhan, V. Kumar, K. Kapadiya, H. Masih and S. Goswami, *The Microbe*, **8**, 100420 (2025); https://doi.org/10.1016/j.microb.2025.100420
12. D. Mammen and M. Daniel, *Food Chem.*, **135**, 1365 (2012); https://doi.org/10.1016/j.foodchem.2012.05.109
13. J. La Nasa, F. Modugno and I. Degano, *Mass Spectrom. Rev.*, **40**, 381 (2021); https://doi.org/10.1002/mas.21644
14. G. Salbitani, C. Bottone and S. Carfagna, *Bio-protocol*, **7**, e2372 (2017); https://doi.org/10.21769/BioProtoc.2372
15. L. Gnatyshyna, V. Khom, V. Martinyuk, T. Matskiv, V. Pedrini-Martha, M. Niederwanger, O. Stoliar and R. Dallinger, *Comp. Biochem. Physiol. C Toxicol. Pharmacol.*, **263**, 109490 (2023); https://doi.org/10.1016/j.cbpc.2022.109490
16. A. Garg and R. Singh, *Int. J. Pharm. Pharm. Sci.*, **7**, 237 (2015); https://doi.org/10.22159/ijpps.2015v7i4.4275
17. B. Dutta, A.P. Raghavendra, A. Tripathy, D.N. Manel, S. Umakanth and S.U. Kamath, *J. Appl. Pharm. Sci.*, **15**, 67 (2025); https://doi.org/10.7324/JAPS.2025.219097
18. A. Sharma, M. R. Chorawala, R. M. Rawal and N. Shrivastava, *Sci. Rep.*, **14**, 2363 (2024); https://doi.org/10.1038/s41598-024-52915-6
19. G. Bréger, A. André, C. Cottet, A. Hammaid, A. Amérand, C. Favre, L. Martignat and M.Y. Mallem, *Biology*, **13**, 999 (2024); https://doi.org/10.3390/biology13120999
20. H.-R. Yu, Y.-L. Tain, M.-M. Tiao, C.-C. Chen, J.-M. Sheen, I.-C. Lin, S.-W. Li, C.-C. Tsai, Y.-J. Lin, K.-S. Hsieh and L.-T. Huang, *Lipids Health Dis.*, **17**, 50 (2018); https://doi.org/10.1186/s12944-018-0701-0
21. A.S. Chitre, O. Polesskaya, K. Holl, J. Gao, R. Cheng, H. Bimschleger, A. Garcia-Martinez, T. George, A.F. Gileta, A. Horvath, A. Hughson, W. Han, K. Ishiwari, C.P. King, A. Lamparelli, C.L. Versaggi, C. Martin, C.L. St. Pierre, J.A. Tripi, T. Wang, H. Chen, S.B. Flagel, P. Meyer, J. Richards, T.E. Robinson, A.A. Palmer and L.C. Solberg Woods, *Obesity*, **28**, 1964 (2020); https://doi.org/10.1002/oby.22927
22. D. Barham and P. Trinder, *Analyst*, **97**, 142 (1972); https://doi.org/10.1039/an9729700142
23. S. D. Parlee, S. I. Lentz, H. Mori and O.A. MacDougald, Quantifying Size and Number of Adipocytes in Adipose Tissue, In: Methods in Enzymology, Elsevier, vol. 537, Chap. 6, pp. 93-122 (2014).
24. M.A. Raslan, F.R. Melek, A.A. Said, A.I. Elshamy, A. Umeyama and M.M. Mounier, *Phytochem. Lett.*, **22**, 39 (2017); https://doi.org/10.1016/j.phytol.2017.08.004
25. O. Ibukun and E.S. Omoregie, *Bull. Natl. Res. Cent.*, **46**, 204 (2022); https://doi.org/10.1186/s42269-022-00883-0
26. N.W. Bogoriani, G.A.P.E. Pratiwi, I.G.A.G. Bawa, K.T.N. Dewi and A. Fudholi, *Int. J. Des. Nat. Ecodyn.*, **20**, 1533 (2025); https://doi.org/10.18280/ijdne.200710
27. X. Zhang, Y. Luo, L. Qin, Y. Ma, D. Chen and S. Zhao, *J. Funct. Foods*, **122**, 106558 (2024); https://doi.org/10.1016/j.jff.2024.106558
28. L. Zhang, Y. Li, D. Sun and F. Bai, *J. Oleo Sci.*, **71**, 709 (2022); https://doi.org/10.5650/jos.ess21389