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Protective Effects of Methanolic Extract of *Michelia champaca* Leaves Against Dexamethasone-induced Dyslipidemia and Hyperglycemia in Albino Wistar Rats

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Abstract

Background: Long-term use of dexamethasone is associated with metabolic complications such as hyperglycemia, dyslipidemia, and hepatic dysfunction. Natural plant-derived compounds have gained attention as complementary approaches for managing metabolic disorders. Leaves of *Michelia champaca* contain several bioactive phytochemicals with reported antidiabetic and antioxidant activities. **Aim:** This study evaluated the protective effects of the methanolic extract of *M. champaca* leaves (MEMC) against dexamethasone-induced metabolic alterations in albino Wistar rats. **Methods:** Rats were divided into five groups (n = 6): normal control, dexamethasone control, standard drug, MEMC 200 mg/kg, and MEMC 400 mg/kg. Dexamethasone (1 mg/kg) was administered for 21 days to induce metabolic disturbances. Body weight, fasting blood glucose, serum lipid profile (total cholesterol, triglycerides, HDL, LDL, and VLDL), and liver function markers (AST, ALT, and ALP) were assessed. **Results:** Dexamethasone significantly increased fasting blood glucose, total cholesterol, triglycerides, LDL, and VLDL levels, while reducing HDL levels and liver enzyme levels. MEMC treatment resulted in dose-dependent improvements in these parameters. The higher dose (400 mg/kg) showed greater reduction in hyperglycemia and dyslipidemia and partially restored liver enzyme levels. **Conclusion:** MEMC demonstrated significant antihyperglycemic, antidyslipidemic, and hepatoprotective effects, suggesting its potential as a complementary therapeutic agent against glucocorticoid-induced metabolic disturbances.

Major Finding: MEMC at 400 mg/kg effectively reduced hyperglycemia and dyslipidemia while improving liver function, highlighting its protective role against dexamethasone-induced metabolic complications.

Keywords: Antihyperglycemic Activity, Dexamethasone-induced Diabetes, Dyslipidemia, Medicinal Plants, *Michelia champaca*, Wistar Rats

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1. Introduction

1.1 Background and Context

Diabetes mellitus is a growing global health burden, with hundreds of millions affected worldwide and projections of continued rise in prevalence[1]. Conventional anti-diabetic drugs can be effective but often have limitations or side effects, driving interest in plant-derived therapies for diabetes prevention and management[1]. Meanwhile, glucocorticoids (e.g. dexamethasone)

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are widely used anti-inflammatory drugs, but their long-term use is "severely hampered by undesirable metabolic complications, including the development of type 2 diabetes mellitus"[2]. Glucocorticoid receptor activation in liver and peripheral tissues leads to increased gluconeogenesis (raising blood glucose) and reduced glucose uptake, promoting insulin resistance[2]. In clinical and experimental settings, dexamethasone administration consistently induces hyperglycemia, insulin resistance and atherosclerotic dyslipidemia (elevated triglycerides, LDL-cholesterol and reduced HDL-cholesterol)[2,3]. Oxidative stress appears to mediate much of this glucocorticoid-induced metabolic dysfunction[3]. Together, these changes constitute a metabolic syndrome-like state that greatly increases cardiovascular risk.

Also, the metabolic side effects of glucocorticoid therapy, including steroid-induced hyperglycemia and dyslipidemia, remain a significant clinical problem. Standard interventions often require polypharmacy and can introduce further risks. Thus, there is an urgent need for safe complementary strategies to prevent or attenuate glucocorticoid-induced metabolic derangements. Plant-based compounds are promising in this regard because they often exert multi-target effects; indeed, recent systematic reviews show that various medicinal plant extracts can reverse dexamethasone-induced metabolic changes in animals[4].

Medicinal plants have long been screened for antidiabetic properties, yielding several lead compounds and extracts. The tropical tree *Michelia champaca* (*Magnoliaceae*) is used in traditional medicine for conditions such as fever, inflammation and diabetes[5,6]. Phytochemical investigations of *M. champaca* (especially flowers and leaves) have identified diverse bioactives such as alkaloids, flavonoids, phenolic glycosides, tannins, triterpenoids, etc[7]. Many of which have antioxidant and metabolic regulatory effects. Consistent with this, *M. champaca* extracts have demonstrated antidiabetic and lipid-lowering activities in experimental diabetes models. For example, ethanolic extracts of *M. champaca* flower buds produced dose-dependent glucose-lowering and restoration of altered biochemical parameters in alloxan-diabetic rats. More recently, ethanolic *M. champaca* leaf extract (500 mg/kg) significantly lowered fasting glucose and normalised serum cholesterol, triglycerides, HDL and LDL in STZ/NA-induced diabetic rats[8]. Likewise, isolated phenylethanoid glycosides from *M. champaca* leaves and reported that the leaf extract exhibited potent antioxidant as well as hypoglycemic and hypolipidemic effects *in vitro*[7]. Together, these studies validate the traditional anti-diabetic use of *M. champaca* and suggest multiple mechanisms of action (e.g. insulin sensitisation, enzyme modulation, free-radical scavenging) attributable to its complex phytochemistry.

If we see this from an ethnopharmacological perspective, multi-component herbal extracts can address complex metabolic diseases via poly pharmacology. The hypothesis is that *M. champaca* leaf extract's rich phytoconstituent mixture may simultaneously modulate glucose and lipid metabolic pathways, oxidative stress, and insulin signalling. For example, flavonoids in the extract could inhibit intestinal carbohydrate enzymes and enhance insulin sensitivity, while alkaloids or other compounds could regulate hepatic gluconeogenic enzymes and improve β-cell function[7]. In network pharmacology terms, such a multi-target approach may yield complementary benefits that single-target drugs (e.g. sitagliptin) do not fully capture. Thus, testing *M. champaca* in a glucocorticoid-induced diabetes model is conceptually grounded in the idea of harnessing traditional medicinal knowledge with modern pharmacological insights.

Despite evidence for antidiabetic effects of *M. champaca*, no published study has examined its effects against steroid-induced metabolic syndrome. Prior work has focused on alloxan or streptozotocin (chemical) diabetes models[8]. The unique pathogenesis of glucocorticoid-induced dysmetabolism (glucocorticoid receptor–mediated gene regulation, oxidative injury, etc.) means that *M. champaca*'s efficacy in this context remains unknown. Addressing this gap could uncover a new protective use for the plant in a clinically relevant setting.

The primary objective of the present study is to evaluate whether a methanolic extract of *M. champaca* leaves (MEMC) can prevent or ameliorate dexamethasone-induced hyperglycemia and dyslipidemia in albino Wistar rats. Secondary objectives include assessing effects on liver function enzymes and exploring potential mechanisms (e.g. antioxidant activity) underlying the protection. We hypothesise that MEMC will dose-dependently attenuate

dexamethasone-induced elevations in fasting glucose, total cholesterol, triglycerides, LDL/VLDL, and restore HDL and liver enzyme levels toward normal. The multiple bioactive constituents of MEMC are expected to act synergistically to improve glucose utilisation and lipid metabolism, consistent with prior reports of *M. champaca*'s metabolic benefits[8].

Demonstrating that *M. champaca* leaf extract protects against steroid-induced metabolic abnormalities would provide strong scientific validation for its traditional use and suggest a novel complementary therapy for patients on long-term glucocorticoids. Unlike single-target pharmaceuticals, MEMC's multi-pronged actions (antioxidant, anti-inflammatory, insulin-sensitizing) may offer broad metabolic protection with fewer side effects. These findings could inform future development of *M. champaca* derived nutraceuticals or phyto-therapeutics for preventing glucocorticoid-induced diabetes and dyslipidemia, ultimately improving patient outcomes.

2. Literature Review

2.1 Global Diabetes Burden and Steroid Diabetes

Diabetes mellitus is a major global health issue, with over 537 million adults affected and numbers rising. Long-term therapy is costly and often causes side effects, motivating interest in complementary treatments. Glucocorticoids like dexamethasone (Dex) are effective anti-inflammatories, but their chronic use frequently induces metabolic complications ("steroid diabetes"), including insulin resistance, hyperglycemia, dyslipidemia and fatty liver[9]. Glucocorticoid receptors in liver, muscle, and adipose tissue mediate these effects: Dex upregulates hepatic gluconeogenic enzymes (PEPCK, G6Pase) while impairing peripheral insulin signalling (IRS-1/PI3K/Akt), reducing glucose uptake. It also promotes hepatic lipogenesis (via SREBP-1c/FAS), increases VLDL secretion, and alters lipoprotein lipase, causing elevated triglycerides and LDL plus decreased HDL[9]. Oxidative stress compounds these effects, since Dex raises reactive oxygen species and lipid peroxidation, depleting antioxidant defenses. Clinically, steroid-induced dysmetabolism heightens cardiovascular risk and complicates disease management. Recent reviews stress that although glucocorticoids are ubiquitous in therapy, there is no consensus on preventing their diabetogenic side effects[9]. This gap calls for novel interventions.

2.2 Plant-derived Antidiabetic Agents

Ethnopharmacological research has identified many antidiabetic plant compounds. Natural products (e.g. berberine, catechins, curcumin) exhibit diverse antidiabetic actions, such as enzyme inhibition, insulin sensitisation, and antioxidant effects. These multi-target properties could counter the multi-factorial nature of steroid diabetes. For example, berberine activates AMPK and improves insulin resistance, and quercetin attenuates inflammation in metabolic tissues. A systematic review highlights numerous herbs that mitigate glucocorticoid-induced metabolic syndrome, though clinical validation is lacking. Notably, several studies show non- *M. champaca* extracts protect against Dex-induced dysmetabolism. An aqueous extract of *Baillonella toxisperma* (African rain tree) bark significantly reversed Dex-induced hyperglycemia, dyslipidemia and elevated transaminases in rats[9]. Similarly, *Cissus polyantha* extracts lowered Dex-induced glucose and lipid elevations and boosted antioxidant enzymes. These findings suggest that plant polyphenols and sterols can offset the metabolic disturbances of steroid therapy.

2.3 *Michelia champaca*: Ethnomedicine and Phytochemistry

Michelia champaca (*champak*) is an evergreen tree in *Magnoliaceae*, used in *Ayurveda*, *Unani* and Chinese medicine. All parts (flowers, leaves, bark) are traditionally employed for fever, inflammation, skin ailments, and metabolic disorders. Phytochemical analyses reveal that *M. champaca* is rich in alkaloids (e.g. micheline), flavonoids (quercetin, kaempferol, rutin), phenolic acids, tannins, saponins, steroids and triterpenoids. Specifically identified numerous bioactive constituents in the leaves, including phenylethanoid glycosides, confirming high antioxidant potential. In vitro assays and molecular docking support free-radical scavenging and enzyme inhibitory activities of these compounds.

2.4 Antidiabetic/Antidyslipidemic Studies of *M. champaca*

Prior pharmacological studies have shown that *M. champaca* extracts can lower blood glucose and

improve lipids in diabetic animal models. Ethanolic extract of *M. champaca* flower buds (200–400 mg/kg) produced dose-dependent antihyperglycemic effects in alloxan-induced (type 1) diabetic rats. Treated rats exhibited significantly reduced fasting glucose and partial normalisation of cholesterol and triglyceride levels, confirming the extract's efficacy. The study was well-designed with control and dose groups, but was limited by focusing only on flower buds and not analysing mechanisms beyond biochemical endpoints. Deepthi and Bhikshapathi (2022) reported similar glucose-lowering effects using ethanolic leaf extract in alloxan-diabetic rats and in 3T3-L1 adipocytes, suggesting improved insulin signalling (though as an unpublished report). A more clinically relevant type-2 model (STZ + nicotinamide) and observed that 500 mg/kg *M. champaca* leaf extract significantly decreased fasting glucose, TC and TG, while raising HDL. This was accompanied by improved antioxidant markers (catalase, GSH), indicating reduced oxidative stress. Both Jarald and Nanda concluded that *M. champaca* phytochemicals (flavonoids, alkaloids) mediate the antidiabetic effect. However, Nanda's study was limited by its brief duration and lack of insulin or inflammatory assays. Notably, none of these studies addressed a glucocorticoid-induced model.

2.5 Patterns, Contradictions and Gaps

Overall, the literature consistently indicates that *M. champaca* extracts exert multi-faceted antidiabetic actions, likely due to synergistic phytochemicals. Jarald's and Nanda's findings align: both saw significant glucose reductions and lipid improvements with extract treatment[5,8]. The effect magnitudes are comparable (30–40% glucose lowering) despite different models and doses, suggesting robust efficacy. A possible contradiction is that Jarald used flower buds while Nanda used leaves; both showed activity, implying that bioactives are present throughout the plant. A remaining gap is the lack of mechanistic clarity: the studies did not directly measure insulin levels, β-cell function, or inflammatory cytokines, leaving the precise pathways speculative. Moreover, extracts and doses varied widely, and solvent (ethanol *vs.* methanol) differences complicate direct comparisons. Crucially, no study has evaluated *M. champaca* against steroid-induced metabolic dysfunction. This is a significant gap, since glucocorticoid diabetes involves different pathways (insulin resistance in peripheral tissues rather than autoimmune β-cell loss)[9]. The present study directly addresses this gap: by using a Dex model, we test whether *M. champaca*'s known antidiabetic effects extend to glucocorticoid-induced diabetes.

Michelia champaca contains numerous bioactive compounds and has demonstrated antidiabetic and antidyslipidemic effects in various rat models. The pathophysiological basis of Dex-induced diabetes is well-characterised[9], and other plants have shown protective effects in this context[9]. The literature thus supports the rationale for testing *M. champaca* extract against Dex metabolic toxicity. Our study's objectives – to evaluate MEMC in Dex-treated rats – are directly aligned with addressing the identified knowledge gap of plant intervention in glucocorticoid-induced dysmetabolism[10].

3. Materials and Methods

All procedures were performed in accordance with CPCSEA guidelines and approved by Shri Guru Ram Rai University IAEC (Approval No. SGRRU/IAEC/2021/08, dated 15.08.2021). The study used an experimental design with five groups (n=6 rats/group). Male albino Wistar rats (200–250 g) were sourced from the university's Central Animal House. Animals were housed in polypropylene cages (6 per cage) under standard conditions (25±2°C, 55±5% RH, 12-h light/dark) with free access to standard pellet diet and water. They were acclimatised for 7 days before treatment.

3.1 Plant Collection and Extract Preparation

Fresh *M. champaca* leaves were collected near Dehradun, Uttarakhand, India (August 2021) and authenticated by Dr Aarti Sati (voucher SGRRU/SPS/MC/2021/01). Leaves were washed, shade-dried (25–30°C, 15 days), and pulverised. 500 g of powder was macerated in 2.5 L analytical-grade methanol (Buchi R-210) at room temperature for 72 h with occasional shaking. The extract was filtered (Whatman No.1) and the residue re-extracted twice. Combined filtrates were concentrated by rotary evaporation at 40°C and dried under vacuum to yield a semi-solid MEMC (yield ~12.4% w/w). The extract was stored in amber bottles

at 4°C. Preliminary phytochemical screening of MEMC (standard tests) confirmed the presence of alkaloids, flavonoids, phenolics, tannins, saponins, steroids and triterpenoids.

3.2 Acute Toxicity

A limit test (OECD 423) was conducted in female Wistar rats (n=6). MEMC (2000 mg/kg, p.o.) was administered once. Rats were observed continuously for 4 h and then daily for 14 days for signs of toxicity (behavioural changes, autonomic symptoms, mortality). Body weights were recorded on days 0, 7, and 14. At the study end, rats were sacrificed, and organs (liver, kidney, heart, spleen, lungs) were examined grossly. No mortality or abnormalities were noted, indicating MEMC's safety (LD_{50} >2000 mg/kg).

3.3 Experimental Treatment Groups

After acclimation, rats were randomised into five groups (n=6):

Group I (Normal Control): received 0.5% carboxymethylcellulose (CMC) vehicle, p.o., 10 mL/kg daily for 21 days. Group II (Dex Control): received dexamethasone sodium phosphate (Dexona®, Zydus Cadila) 1 mg/kg, subcutaneously (s.c.), once daily for 21 days. Group III (Standard Drug): received Dex 1 mg/kg s.c. + sitagliptin phosphate (Januvia®, MSD) 10 mg/kg, p.o., once daily for 21 days. Group IV (MEMC 200): received Dex 1 mg/kg s.c. + MEMC 200 mg/kg, p.o., once daily for 21 days. Group V (MEMC 400): received Dex 1 mg/kg s.c. + MEMC 400 mg/kg, p.o., once daily for 21 days.

Dex was given between 9 and 10 AM each day. Sitagliptin and MEMC were suspended in 0.5% CMC and administered via oral gavage (10 mL/kg). All groups were fasted overnight (12 h) before terminal blood collection.

3.4 Measurements

Body weights were measured on days 0 (baseline), 7, 14, and 21 using a digital balance. The percentage change in body weight was calculated by given formula:

$$\%d = \frac{Day\ 21\ weight - Day\ 0\ weight}{Day\ 0\ weight} \times 100$$

Fasting blood glucose (FBG) was measured on days 0, 7, 14, and 21. After a 12-h fast, tail vein blood was collected, and glucose was measured using an Accu-Chek Active glucometer (Roche Diagnostics, Germany) via the glucose oxidase–peroxidase method. On day 22 (after final fasting), rats were anaesthetised with diethyl ether. Blood was collected by cardiac puncture into plain tubes. After clotting (30 min, room temperature), samples were centrifuged (3000 rpm, 15 min) to obtain serum.

3.5 Biochemical Assays

Serum was assayed using Erba Mannheim diagnostic kits on a semi-automated analyser (Erba Chem-7, Transasia Bio-Medicals). Lipid profile analyses included: Total Cholesterol (TC) via CHOD-PAP method, Triglycerides (TG) via GPO-PAP, HDL-C via direct HDL assay (after precipitation of other lipoproteins), LDL-C calculated by Friedewald's formula (LDL = TC – [HDL + TG/5]), and VLDL-C as TG/5. Liver function tests were: SGOT (AST) and SGPT (ALT) by kinetic UV assay, and Alkaline Phosphatase (ALP) by kinetic p-nitrophenyl phosphate method (commercial reagents, Erba Mannheim).

3.6 Statistical Analysis

Data (mean ± SEM, n=6) were analysed using GraphPad Prism 8.0. Body weight and FBG over time were evaluated by two-way repeated measures ANOVA with Tukey's post hoc test. Lipid and enzyme data (day 21) were analysed by one-way ANOVA with Tukey's multiple comparisons. Assumptions of normality (Shapiro–Wilk) and variance homogeneity (Levene's test) were confirmed. A p-value <0.05 was considered significant. Differences were reported as: *vs.* Dex control ($p<0.05$, $p<0.01$, $p<0.001$) and *vs.* normal control (#$p<0.05$, ##$p<0.01$, ###$p<0.001$). The statistical output included F-values, degrees of freedom, and effect sizes (η^2), which should be reported in the results.

4. Results

4.1 Effect of MEMC on Body Weight

Changes in body weight are summarised in Table 1. Normal control animals showed a gradual increase in body weight during the study period. In contrast, dexamethasone treatment caused a progressive decline in body weight. Administration of the

standard drug prevented this reduction. MEMC treatment attenuated dexamethasone-induced weight loss, with the higher dose (400 mg/kg) showing a greater protective effect.

4.2 Effect on Fasting Blood Glucose

Fasting blood glucose levels are presented in Table 2. Dexamethasone administration produced a marked elevation in glucose levels compared with the normal control group. Treatment with the standard drug significantly reduced hyperglycemia. MEMC also decreased fasting glucose levels in a dose-dependent manner, with the higher dose producing a stronger antihyperglycemic effect.

4.3 Effect on Serum Lipid Profile

Serum lipid profile parameters are shown in Table 3. Dexamethasone treatment resulted in significant dyslipidemia, characterised by increased total cholesterol, triglycerides, LDL-cholesterol, and VLDL-cholesterol, along with a decrease in HDL-cholesterol. Treatment with the standard drug significantly improved these parameters. MEMC administration produced dose-dependent improvements in lipid levels, with the higher dose demonstrating greater efficacy.

4.4 Effect on Liver Function Markers

Changes in liver enzyme activities are presented in Table 4. Dexamethasone administration significantly

Table 1. Effect of MEMC on body weight in dexamethasone-induced rats

Group	Day 0 (g)	Day 7 (g)	Day 14 (g)	Day 21 (g)	% Change
Normal Control	215.3 ± 4.2	228.6 ± 4.5	241.8 ± 4.8	254.2 ± 5.1	+18.1%
Dexamethasone Control	218.4 ± 4.6	210.2 ± 4.3###	203.5 ± 4.1###	196.8 ± 3.9###	-9.9%
Standard Drug	216.8 ± 4.4	218.5 ± 4.5*	220.3 ± 4.6**	222.6 ± 4.7***	+2.7%
MEMC 200 mg/kg	217.2 ± 4.3	214.6 ± 4.2	212.4 ± 4.1*	210.8 ± 4.0*	-2.9%
MEMC 400 mg/kg	219.1 ± 4.5	217.8 ± 4.4*	216.5 ± 4.3**	215.4 ± 4.2**	-1.7%

Values are expressed as mean ± SEM (n=6). ###p<0.001 *vs.* Normal Control; p<0.05, p<0.01, p<0.001 *vs.* Dexamethasone Control. One-way ANOVA followed by Tukey's post hoc test.

Table 2. Effect of MEMC on fasting blood glucose levels (mg/dL)

Group	Day 0	Day 7	Day 14	Day 21
Normal Control	86.2 ± 2.1	88.5 ± 2.3	90.3 ± 2.4	91.8 ± 2.5
Dexamethasone Control	87.4 ± 2.3	132.6 ± 3.8###	164.2 ± 4.5###	186.5 ± 4.8###
Standard Drug	85.8 ± 2.2	98.4 ± 2.8***	103.6 ± 3.1***	108.3 ± 3.2***
MEMC 200 mg/kg	88.1 ± 2.4	118.5 ± 3.5**	138.4 ± 3.9**	152.6 ± 4.1**
MEMC 400 mg/kg	86.9 ± 2.3	105.2 ± 3.0***	113.8 ± 3.4***	121.4 ± 3.6***

Values are expressed as mean ± SEM (n=6). ###p<0.001 *vs.* Normal Control**p < 0.01, ***p < 0.001 *vs.* dexamethasone control. One-way ANOVA followed by Tukey's post hoc test.

Table 3. Effect of MEMC on serum lipid profile (mg/dL)

Group	TC	TG	HDL-C	LDL-C	VLDL-C
Normal Control	78.4 ± 2.1	82.6 ± 2.3	42.8 ± 1.5	19.1 ± 0.8	16.5 ± 0.5
Dexamethasone Control	142.8 ± 3.6###	168.5 ± 4.2###	28.4 ± 1.2###	80.7 ± 2.4###	33.7 ± 0.8###
Standard Drug	86.5 ± 2.4***	92.3 ± 2.6***	38.6 ± 1.4***	29.4 ± 1.1***	18.5 ± 0.5***
MEMC 200 mg/kg	118.6 ± 3.2**	138.4 ± 3.8**	31.8 ± 1.3*	59.1 ± 2.0**	27.7 ± 0.7**
MEMC 400 mg/kg	95.2 ± 2.8***	108.6 ± 3.1***	35.2 ± 1.3***	38.3 ± 1.5***	21.7 ± 0.6***

Values are expressed as mean ± SEM (n=6). TC: Total Cholesterol; TG: Triglycerides; HDL-C: High-Density Lipoprotein Cholesterol; LDL-C: Low-Density Lipoprotein Cholesterol; VLDL-C: Very Low-Density Lipoprotein Cholesterol. ###p<0.001 *vs.* Normal Control; p<0.05, p<0.01, p<0.001 *vs.* Dexamethasone Control. One-way ANOVA followed by Tukey's post hoc test.

Table 4. Effect of MEMC on liver function markers (U/L)

Group	SGOT (AST)	SGPT (ALT)	ALP
Normal Control	42.3 ± 1.6	38.6 ± 1.4	98.2 ± 2.8
Dexamethasone Control	128.6 ± 3.8###	142.5 ± 4.2###	186.4 ± 5.1###
Standard Drug	58.4 ± 2.1***	52.3 ± 1.9***	112.6 ± 3.2***
MEMC 200 mg/kg	96.5 ± 3.2**	102.4 ± 3.5**	158.3 ± 4.5**
MEMC 400 mg/kg	68.2 ± 2.5***	64.8 ± 2.3***	128.5 ± 3.7***

Values are expressed as mean ± SEM (n=6). SGOT: Serum Glutamic Oxaloacetic Transaminase; SGPT: Serum Glutamic Pyruvic Transaminase; ALP: Alkaline Phosphatase. ###p<0.001 *vs.* Normal Control; p<0.01, *p<0.001 *vs.* Dexamethasone Control. One-way ANOVA followed by Tukey's post hoc test.

increased SGOT, SGPT, and ALP levels compared with the normal control group. Treatment with the standard drug markedly reduced these elevations. MEMC treatment also decreased liver enzyme levels, with the higher dose producing a stronger hepatoprotective effect.

5. Discussion

The results demonstrate that MEMC significantly counteracts Dex-induced metabolic dysfunction in rats. Chronic Dex (1 mg/kg for 21 days) produced marked hyperglycemia, dyslipidemia, and hepatotoxicity, consistent with the known insulin-resistant state of glucocorticoid excess[2,9]. The MEMC-treated groups, particularly at 400 mg/kg, showed substantial improvements: fasting glucose was reduced by ~35% compared to Dex controls, and lipid and liver enzyme levels were markedly normalised. These effects are in line with prior reports on *M. champaca* observed that ethanolic flower extracts dose-dependently reduced glucose and partially corrected lipid parameters in alloxan-diabetic rats[5], while similar effects of leaf extract in an STZ model[8]. Our findings extend these results to a steroid-induced diabetes model. The comparability of MEMC 400 mg/kg to sitagliptin (a DPP-4 inhibitor) underscores its potency.

The protective mechanisms likely involve MEMC's rich phytochemistry. Flavonoids and phenolic glycosides in *M. champaca* can scavenge reactive oxygen species and upregulate endogenous antioxidants, mitigating Dex-induced oxidative stress[3,7]. Alkaloids and saponins may enhance insulin secretion and sensitivity; for instance, many plant alkaloids open ATP-sensitive K^+ channels or activate AMPK, improving β-cell function and glucose uptake[1,3]. The observed HDL increase with MEMC (23.9%) suggests stimulation of reverse cholesterol transport, possibly via upregulation of liver LDL receptors or paraoxonase-1 activity[9]. Notably, MEMC reduced SGPT/SGOT levels, indicating hepatoprotection—this may reflect anti-inflammatory action (inhibiting NF-κB) and membrane stabilisation by flavonoids[1].

Compared to other studies, MEMC's efficacy is impressive. The 34.9% glucose-lowering mirrors Jarald's flower extract results[5], and the lipid improvements are on par with known antihyperlipidemic agents in plants[3]. Unlike alloxan or STZ models (which destroy β-cells), Dex-induced diabetes is predominantly insulin resistance, so the fact that MEMC still significantly lowered glucose implies enhancement of peripheral insulin action or inhibition of hepatic gluconeogenesis[2]. This broader applicability underscores the plant's versatile mechanism.

6. Limitations

This study has some constraints. We did not measure serum insulin, so we cannot specify whether MEMC acted by increasing insulin secretion or sensitivity. Histopathological examination of the pancreas or liver would have strengthened mechanistic insight. The 21-day Dex exposure is subacute; chronic studies would clarify long-term efficacy and safety. We also used healthy rats; testing in an inflammatory disease model (e.g. arthritis) receiving Dex could better simulate clinical contexts. Lastly, MEMC is a crude extract; identifying and quantifying its active constituents is needed for standardisation and quality control.

7. Conclusion

This study provides strong preclinical evidence that the methanolic extract of *M. champaca* leaves effectively prevents dexamethasone-induced hyperglycemia and dyslipidemia. MEMC dose-dependently restored glucose and lipid homeostasis and protected liver function, with the 400 mg/kg dose nearly matching standard therapy. These effects likely result from MEMC's antioxidant flavonoids and other bioactives acting on multiple metabolic pathways. Our findings validate the traditional use of *M. champaca* in metabolic disorders and suggest that it could serve as a complementary therapy for patients on long-term glucocorticoids. Future work should isolate the key phytocompounds, test chronic administration, and explore clinical applicability to harness this plant's therapeutic potential.

8. Ethical Approval

The study protocol was approved by the Institutional Animal Ethics Committee (IAEC) of SGRR University.

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Author Contribution

S.S. conducted the experimental work, collected and analysed the data, and prepared the initial draft of the manuscript. A.S. supervised the study, contributed to data interpretation, critically revised the manuscript, and approved the final version for publication. S.D proof read the study. A.J proof read the study. All authors have read and agreed to the published version of the manuscript.