Anti-diabetic Effect of Ethanolic Extracts of Cissus Quadrangularis linn Fruits and Michelia Champaea Leaves in Alloxan Induced Hyperglycaemic Rats and in 3T3L1 Cell Lines

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ABSTRACT

Background: Diabetes is a metabolic disorder that results in increased blood sugar. This study came up with a search for alternative medicines with no or fewer side effects for antidiabetic therapy.

Materials and methods: The plants are extracted and screened for phytochemical study of crude extracts. Anti-diabetic activity in alloxan induced hyperglycaemic rats, in single dose study, multiple dose treatment was investigated. In vitro cellular assay using 3T3L1 cell line was performed to check the cell viability with increasing plant extract treatment.

Results: Phytochemical investigation reveals the presence of alkaloids, flavonoids, saponins, tannins, steroids, triterpenoids, carbohydrates, and glycosides in both plant extractions. In acute toxicity studies, no mortality was observed with either of the extracts even at a dosage of the level of 5000 mg per kg of body weight. The ethanolic extracts showed a noteworthy decline in blood glucose level in alloxan induced rats in both single and multiple dosage methods. Significant changes were observed in the serum glucose and body weight from day 0 to day 14. The cell viability of the extracts was also comparable with the standard.

Conclusion: Our results report that CQ fruits and MC leaves have potent antidiabetic action and on further studies, can be a credible resource in antidiabetic therapy.

Key Words: Cissus Quadrangularis Linn Fruits, Michelia Champaea Leaves, Anti-diabetic activity, 3T3L1 cell line, Cyototoxicity, Wistar rats.

INTRODUCTION

Diabetes mellitus (DM) is a syndrome characterized by chronic hyperglycemia and disturbances of carbohydrate, fat, and protein metabolism associated with absolute or relative deficiencies in insulin secretion and/or insulin action¹. It is a metabolic disorder comprising of micro and macro vascular complications that result from insignificant morbidity and mortality. It is a major cause of death worldwide ². There are an estimated 143 million people worldwide diagnosed with DM and this number will probably double by the year 2030 ³.

Despite significant advancement in the treatment of DM using oral hypoglycemic agents, exploration for newer drugs continue due to several limitations of synthetic drugs. In recent times, there has been a renewed interest in plant remedies ⁴⁻⁵. The medicinal properties of CQ were known since the distant past. Cissus was also used in ayurvedic medicines for treating injured bones, ligaments, and tendons. In Siddha medicine CQ finds its application as an analgesic, and in treating broken bones. The Magnoliaceae belong to the fossil plant family dated back to 95 million years. These are characterized by large, cup-shaped flowers with no distinct petals. Some species, including the champak (Michelia champaca) and Michelia doltsopa are grown for their flowers, both on the tree and as cut flowers. Champak flowers are also used to produce essential oil for perfume. A few species have been introduced to gardens or as street trees outside of the Indomalaya region, including Michelia figo, M. doltsopa, and M. champaca⁶⁻⁸.

The current paper deals with screening of Cissus quadrangularis linn fruits and Michelia champaea leaf extracts for...
anti-diabetic activity in alloxan induced hyperglycaemic rats.

**MATERIALS AND METHODS**

**Materials**

**Experimental Animals**

Adult Wistar albino rats (150-200 g), housed in the institutional animal house and used for the study. Animals caged in polypropylene cages in a controlled environmental condition (22±3°C, 55 ± 5% humidity, and a 12 h light/ dark cycle). The animals were provided with a regular rodent diet and water ad libitum. The animals were allowed to adapt to these conditions for a week.

**Methods**

**Plant collection and authentication**

The CQ fruits and MC leaves were obtained from the local places of Tirupati, AP. The CQ fruit was authenticated by Dr. K. Madhava Chetty, M.Sc., M.Ed., M.Phil., Ph.D., PG DPD., Assistant Professor, Department of Botany, Sri Venkateswara University, Tirupati, Andhra Pradesh.

**Extraction by maceration**

Fresh leaves of *MC and fruits of CQ* were washed with water to get rid of contaminants like dirt and other impurities and were shade-dried. These dried leaves and fruits were ground and sieved to get a uniform, coarse powder. Powdered plant material was weighed (1Kg) and immersed in 95% ethanol and kept for maceration for 7 days with occasional stirring. On the 8th day, the solvent was filtered by pressing with a muslin cloth and was evaporated in a rotary evaporator at 40°C. The resultant extract was put in a desiccator to remove any ethanol left in it. The dried ethanolic extract of *Cissus Quadrangularis* (EEMC) and ethanolic extract of *Michelia Champaea* (EECQ) were packed in an air-tight bottle and put in a dry place for further studies.

**Qualitative evaluation of phytoconstituents**

The EECQ were screened for the presence of various phytoconstituents like carbohydrates, flavonoids, polyphenolic compounds, saponins, tannins, triterpenoids, etc.

**Cell culture**

3T3L1 cell line was procured from the National Centre for Cell Science, Pune. Cells were cultured in Dulbecco’s Modified Eagle Medium (DMEM) (high glucose) with 10% FBS (Invitrogen, Canada), 10,000 U Penicillin G, 10,000 μg/mL streptomycin sulfate (Invitrogen), and 10 mM 4-(2-hydroxyethyl)-1-piperazineethanesulfonic acid. Cultures were maintained at 37°C in 5% CO2 in a humidified incubator.

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**Evaluation of anti diabetic activity**

For the study of anti-diabetic activity of various extracts of EEMC and EECQ, the study was divided into two phases

(I) Activity in normoglycaemic animals

(II) Activity in alloxan induced hyperglycaemic rats

(a) Single-dose study

(b) Multiple-dose study (14 days treatment)

**Activity in normoglycaemic animals**

**Method of oral administration of extracts**

An 18-gauge needle was suitably covered with flexible polythene tubing, where the edge was made blunt. The needle was fixed to a 1ml tuberculin syringe. The rat was held firmly in the left hand. The tubing was moistened with glycerin and inserted right into the oesophagus and gently pressing plunger for drug administration, and this was followed by 0.2ml of distilled water to ensure administration of the correct dose of the drug.

**Experimental design**

Twenty-four animals were categorized into four equal groups. Animals (Wister rats) were fasted for 18 h but were allowed free access to water before and throughout the experiment. The study was approved by the institutional animal ethical committee with No: 1447/PO/Re/S/11/CPCSEA/15/A.

**Group-I**: Administered with vehicle (distilled water) & served as Normal control.

**Group-II**: Administered with standard drug Glipizide (5mg/kg).

**Group III**: Administered EECQ (100mg/kg).
Group IV: Administered EECQ (200mg/kg).
Group V: Administered EEMC (200mg/kg).
Group VI: Administered EEMC (400mg/kg).

Blood samples were withdrawn from the retro-orbital venous plexus with capillary tubes under ether anesthesia and with Sodium citrate as an anticoagulant. Serum was separated by centrifugation. The glucose level in blood was measured after 0, 1, 2, 4, 8, 12, and 24 h of administration of the single dose of test samples.

Estimation of serum glucose by GOD/POD method
This method utilizes two enzymes Glucose Oxidase (GOD) and Peroxidase (POD) along with chromogen-4-amino anti-pyrine, phenol and is intended for in vitro quantitative determination of glucose in serum, plasma, and cerebrospinal fluid. There was no interference due to the creatinine, fructose, galactose, reduced glutathione, ascorbic acid, and xylose. Hemoglobin or bilirubin up to 10 mg does not affect the test.

Single Dose Study
Induction of diabetes
The animals were allowed to fast for 24 h and rendered diabetic by injecting a single dose of alloxan at 150 mg/kg body weight administered as a 5% w/v in distilled water by i.p. route. It produces diabetes by selected necrosis of β - cells of islets of Langerhans of the pancreas.

After 48 h of injecting alloxan, diabetes was confirmed by testing blood sugar with Erba CHEM 5 Plus Auto analyzer.

The animals with a sugar level of more than 250 mg/dl were selected. Animals were maintained for four days in diabetic conditions for good establishment of diabetes.

Standard: Glipizide at the dose of (5mg/kg) was used as a standard drug.

Experimental Design: Animals were categorized into 5 different groups of six animals each. The animals (Wister rats) were fasted for 18 h but were allowed free access to water before and throughout the experiment.

Blood samples were collected from the retro-orbital venous plexus with capillary tubes under ether anesthesia and with sodium citrate as an anticoagulant. Serum was separated by centrifugation.

Multiple-dose treatment (14 days treatment)
The animals used for this study are the same animals used for the single-dose study, had free access to feed and water during this period.

The chronic study involved repeated administration of extracts of EEMC, EECQ, and Glipizide for 14 days(once a day) to the groups used for single-dose study at a prefixed time and the glucose levels in blood estimated in samples withdrawn after 2 h on day 0, 7th and 14th day.

Statistical analysis
The result analysis was carried out by the one-way ANOVA method followed by Dunnett’s multiple comparison tests.

RESULTS

Preliminary phytochemical screening
Results of phytochemical screening were elucidated in Table 1.

The preliminary phytochemical screening indicated the presence of various phytoconstituents like flavonoids, phenolic compounds, triterpenoids, tannins, saponins, amino acids, proteins, and carbohydrates in EECQ. The preliminary phytochemical screening showed the presence of various phytoconstituents like flavonoids, phenolic compounds, triterpenoids, tannins, saponins, amino acids, proteins, and carbohydrates in EEMC.

Cytotoxicity assay on 3T3 L1 cell line
3T3-L1 cells were treated with different concentrations (25 μg–400 μg/mL) of EECQ and EEMC were assayed for their cytotoxic effect. The extract displayed no cytotoxic effect on cells. The concentrations of the extract used and the respective percent cell viability were tabulated and plotted [Table 2 and Figures 1].

Body weight
The changes in body weight of the different groups of animals during the period of study was given in Table 3 and represented in Figure 2 which shows an increase in the mean body weight (± SEM) of normal rats from 230.33 ± 1.47 g on day 0 to 240.00 ± 1.06 g on day 7, 249.2 ± 0.94 g on day 14. This shows that the group of normal rats gained body weight during the treatment period of 14 days.

Effect on normoglycaemic rats
The fasting serum glucose of the different groups of animals during the single-dose treatment period of study is given in Table 4 and presented in figure 3, which shows that the mean (±SEM) fasting serum glucose values of the normal group of rats was 95.16 ± 1.81, 95.16 ± 1.078, 95.83 ± 1.49, 96 ± 1.00, 97.33 ± 1.60, 96 ± 0.85 and 95.83±0.60 mg/dl, on 0, 1, 2, 4, 8, 12 and 24 h respectively.

Effect on alloxan induced hyperglycaemic rats
The fasting serum glucose of the different groups of animals during the single-dose treatment period of study is given in Table 5, and presented in figure 4, which shows that the
During the period of the EECQ (100 mg/kg) treated group of 15-17th day respectively, which was found to be significantly (p≤0.01) higher when compared with the normal rats.

In the multiple dose study the mean fasting serum glucose (±SEM) in the diabetic control group of rats was found to be 269.64±2.89, 337.73±9.899 and 386.5±17.92 mg/dl on 0th, 7th and 14th day respectively, which was found to be significantly (p≤0.01) higher when compared with the normal rats. These elevated fasting serum glucose levels were found to have been maintained throughout the 14 days of the treatment period indicating that the rats are rendered diabetic.

The glipizide (5 mg/kg) treated diabetic rats show a mean (±SEM) fasting serum glucose was reduced from day 0 to day 7 and then to day 14, a similar reduction was also observed with multiple doses treated groups.

**DISCUSSION**

In cytotoxicity assay on 3T3 L1 cell line, the lowest concentration of EECQ and EEMC (25 µg/mL) showed 98.6% and 99.7% viability respectively, and the highest concentration (400 µg/mL) showed 89.45% and 88.9% of viability respectively after 24 h of exposure. These results indicated that EECQ and EEMC are not toxic to mammalian cells even at higher concentrations and could be used to analyze other parameters of antidiabetic studies. Metformin (100 µM) treatment – positive control – also had a percent viability of 97.4% post 24-h exposure. During the period of treatment, the diabetic group of rats has shown a change in body weight from a mean (± SEM) value of 190.5 ± 1.2 g on day 0, 160. ± 1.28 g. On day 7 and which decreased further to 132.8 ±1.07g on day 14. The glipizide (5 mg/kg) treated group body weight was found to have been increased. The body weight gain in this group of rats from day 0 through day 7 to day 14 was relatively less when compared with the normal group. The EECQ (100 mg/kg) treated group of diabetic rats was found to have a mean body weight (±SEM) of 174.3±2.30 g on day 0, 178.00±1.4 g on day 7, 202.3±0.9 g on day 14 . The EECQ (200 mg/kg) treated group of diabetic rats shows mean (±SEM) body weight of 164±1.25 g on day 0, 172.80 ± 1.9 g on day 7, 195.80 ± 1.13 g. on day 14. The EEMC (200 mg/kg) treated group of diabetic rats shows mean (±SEM) body weight of 161±1.12g on day 0, 169±2.21g on day 7, 194±2.11g on day 14. The EECQ (400 mg/kg) treated group of diabetic rats shows mean (±SEM) body weight of 158±1.23g on day 0, 165±1.43g on day 7, 192±1.44, on day 14.

Effect on normoglycaemic rats was studied by measuring glipizide (5 mg/kg) treated normal rats show a mean (±SEM) fasting serum glucose of 96.83 ± 0.60, 94 ± 1.29, 79.16 ± 0.94, 74 ± 1.03, 69.66 ± 0.33 and 92.16 ± 0.83 mg/dl on 0, 1, 2, 4, 8, 12 and 24 h respectively. The EECQ and EEMC treated normal rats showed mean fasting serum glucose of reduced levels respectively with doses. These changes in fasting serum glucose values illustrate that the normoglycaemic rats treated with EECQ and EEMC show a progressive and significant reduction.

**CONCLUSION**

Phytochemical evaluation of EECQ and EEMC showed the presence of carbohydrates, flavonoids, tannins, terpenoids, saponins, proteins, amino acids, and phenolic compounds. According to the literature, EECQ and EEMC were found to be safe in the dose used and there was no mortality up to 5000 mg/kg dose.

The results indicate that the EECQ fruits and EEMC leaves have good anti-diabetic activity. The ethanolic extracts of CQ fruits and MC leaves displayed noteworthy anti-hyperglycaemic activity in alloxan-induced hyperglycaemic rats without any major variation in body weight; they also enhanced the condition of DM that was indicated by body weight, serum creatinine, serum urea, and serum alkaline phosphatase. The study also displayed damage of the pancreas in alloxan-treated diabetic control rats and leads to regeneration of cells by glipizide and extract treatment group.

**ACKNOWLEDGEMENT**

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Conflict of Interest

No conflict of interest

Funding Information

Self financed

Authors’ Contribution

Jasti Deepthi developed the theoretical formalism, performed the analytic calculations and numerical simulations. Both Jasti Deepthi and D V R N Bhikshapathi contributed to the final version of the manuscript.

REFERENCES


Table 1: Results of phytochemical screening of EECQ

<table>
<thead>
<tr>
<th>S. No</th>
<th>Name of the phytochemical</th>
<th>EECQ</th>
<th>EEMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Carbohydrates</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>2.</td>
<td>Amino acids</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>3.</td>
<td>Proteins</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>4.</td>
<td>Alkaloids</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>5.</td>
<td>Cardiac glycosides</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>6.</td>
<td>Triterpenoids</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>7.</td>
<td>Saponins</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>8.</td>
<td>Flavonoids</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>9.</td>
<td>Phenolic compounds</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>10.</td>
<td>Tannins</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>11.</td>
<td>Steroids</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>12.</td>
<td>Gums</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Where, + means positive and - means negative.
Table 2: Percentage viability on various concentrations of EECQ and EEMC

<table>
<thead>
<tr>
<th>Treatment groups</th>
<th>EECQ Percentage of viability</th>
<th>EEMC Treatment groups</th>
<th>Percentage of viability</th>
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<tbody>
<tr>
<td>Control</td>
<td>100</td>
<td>Control</td>
<td>100</td>
</tr>
<tr>
<td>Metformin</td>
<td>97.4</td>
<td>Metformin</td>
<td>97.4</td>
</tr>
<tr>
<td>100 µg/ml</td>
<td></td>
<td>100 µg/ml</td>
<td></td>
</tr>
<tr>
<td>25 µg/ml</td>
<td>98.6</td>
<td>25 µg/ml</td>
<td>99.7</td>
</tr>
<tr>
<td>50 µg/ml</td>
<td>98.0</td>
<td>50 µg/ml</td>
<td>97.1</td>
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<tr>
<td>100 µg/ml</td>
<td>95.6</td>
<td>100 µg/ml</td>
<td>96.5</td>
</tr>
<tr>
<td>200 µg/ml</td>
<td>93.6</td>
<td>200 µg/ml</td>
<td>94.3</td>
</tr>
<tr>
<td>400 µg/ml</td>
<td>90.45</td>
<td>400 µg/ml</td>
<td>91.9</td>
</tr>
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</table>

Table 3: Effect of EECQ and EEMC on body weight of rats

<table>
<thead>
<tr>
<th>Groups</th>
<th>Dose Administered</th>
<th>Body Weight (Mean ± S.E.M) in ‘gm’</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0 Day</td>
</tr>
<tr>
<td>Group-I</td>
<td>Distilled water</td>
<td>230.3±1.47</td>
</tr>
<tr>
<td>Group-II</td>
<td>Allaxon, 150mg/kg</td>
<td>190.5±1.2*</td>
</tr>
<tr>
<td>Group-III</td>
<td>Glipizide 5mg/kg</td>
<td>189.7±2.4*</td>
</tr>
<tr>
<td>Group-IV</td>
<td>EECQ 100mg/kg</td>
<td>174.3±2.3*</td>
</tr>
<tr>
<td>Group-V</td>
<td>EECQ 200 mg/kg</td>
<td>164±1.25*</td>
</tr>
<tr>
<td>Group-VI</td>
<td>EEMC 200mg/kg</td>
<td>161±1.12*</td>
</tr>
<tr>
<td>Group-VII</td>
<td>EEMC 400mg/kg</td>
<td>158±1.23*</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± SEM; n=6
* p<0.01 Diabetes control Vs G-I
* p<0.05, Glipizide/MEBR/MECA/MEMP/PHME Vs Diabetic Control.

Table 4: Effect of EECQ and EEMC on serum glucose levels in normoglycaemic rats

<table>
<thead>
<tr>
<th>Groups</th>
<th>Dose (mg/kg)</th>
<th>Serum glucose levels in mg/dl (Mean ± S.E.M)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0 h</td>
</tr>
<tr>
<td>Group-I</td>
<td>Distilled water</td>
<td>95.16±1.81</td>
</tr>
<tr>
<td>Group-II</td>
<td>Glipizide 5mg/kg</td>
<td>96.83±0.60</td>
</tr>
<tr>
<td>Group-III</td>
<td>EECQ 100mg/kg</td>
<td>96.16±1.22</td>
</tr>
<tr>
<td>Group-IV</td>
<td>EECQ 200 mg/kg</td>
<td>96.16±0.7</td>
</tr>
<tr>
<td>Group-V</td>
<td>EEMC 200mg/kg</td>
<td>96.12±1.12</td>
</tr>
<tr>
<td>Group-VI</td>
<td>EEMC 400mg/kg</td>
<td>96.32±1.32</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± SEM; n=6. *P<0.05, **P<0.01, compared to G-I
Table 5: Effect of EECQ and EEMC on serum glucose levels in alloxan induced diabetes rats (Single dose study)

<table>
<thead>
<tr>
<th>Group</th>
<th>Dose (mg/kg)</th>
<th>0 hr</th>
<th>1 h</th>
<th>2 h</th>
<th>4 h</th>
<th>8 h</th>
<th>12 h</th>
<th>24 h</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Water</td>
<td>95.76±3.24</td>
<td>96.2±3.21</td>
<td>96.86±3.47</td>
<td>97.3±3.26</td>
<td>97.96±3.29</td>
<td>98.65±3.15</td>
<td>97.68±3.44</td>
</tr>
<tr>
<td>II</td>
<td>alloxan-150mg/kg</td>
<td>262.16±7.96 b</td>
<td>266.5±7.39 b</td>
<td>275.5±7.2 b</td>
<td>285±7.42 b</td>
<td>296.16±6.84 b</td>
<td>316.5±4.61 b</td>
<td>326.16±4.76 b</td>
</tr>
<tr>
<td>III</td>
<td>Glipizide 5mg/kg</td>
<td>253±3.36</td>
<td>237.8±5.36** a</td>
<td>168.16±2.79** a</td>
<td>83±4.09** a</td>
<td>87.52±3.48** a</td>
<td>95.00±2.06** a</td>
<td>98.35±1.75** a</td>
</tr>
<tr>
<td>IV</td>
<td>EECQ 100mg/kg</td>
<td>265.83±5.19</td>
<td>238.83±3.67** a</td>
<td>195.33±2.29** a</td>
<td>138.33±1.92** a</td>
<td>98.16±1.85** a</td>
<td>123.91±2.25* a</td>
<td>140.65±1.80** a</td>
</tr>
<tr>
<td>V</td>
<td>EECQ 200mg/kg</td>
<td>268.36±6.75</td>
<td>249.8±5.14</td>
<td>207.25±3.0** a</td>
<td>156.58±6.56** a</td>
<td>112.6±3.76** a</td>
<td>131.05±3.47** a</td>
<td>177.51±7.35** a</td>
</tr>
<tr>
<td>VI</td>
<td>EEMC 200mg/kg</td>
<td>258.11±2.33</td>
<td>242.21±1.32</td>
<td>174.23±2.21</td>
<td>88.22±2.32</td>
<td>95.11±2.16** a</td>
<td>101.21±2.22 a</td>
<td>106.13±2.32** a</td>
</tr>
<tr>
<td>VII</td>
<td>EEMC 400mg/kg</td>
<td>255.11±1.45</td>
<td>239.21±1.61</td>
<td>171.21±1.23</td>
<td>86.31±1.14</td>
<td>89.11±1.32** a</td>
<td>97.23±2.34</td>
<td>101.11±1.33** a</td>
</tr>
</tbody>
</table>

Values are expressed as mean±SEM; n=6 *P<0.05, **P<0.01, 'a' indicates comparison of G-III, IV and G-V with Diabetic control **P<0.01, 'b' indicates comparison of G-II with G-I.

Table 6: Effect of EECQ and EEMC on serum glucose levels of rats after multiple dose treatment

<table>
<thead>
<tr>
<th>Groups</th>
<th>Dose (mg/kg)</th>
<th>0 Day</th>
<th>7 Day</th>
<th>14 Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Distilled water</td>
<td>94.63±3.54</td>
<td>96.27±3.60</td>
<td>97.29±3.09</td>
</tr>
<tr>
<td>II</td>
<td>Alloxan 150mg/kg</td>
<td>269.64±2.89a</td>
<td>337.73±9.89a</td>
<td>386.5±17.92a</td>
</tr>
<tr>
<td>III</td>
<td>Glipizide 5mg/kg</td>
<td>251.83±3.07*</td>
<td>158.30±0.55*</td>
<td>106.6±0.98**</td>
</tr>
<tr>
<td>IV</td>
<td>EECQ 100mg/kg</td>
<td>271.26±3.68</td>
<td>185.11±6.63**</td>
<td>123.19±2.25**</td>
</tr>
<tr>
<td>V</td>
<td>EECQ 200mg/kg</td>
<td>274.11±2.48*</td>
<td>189.48±5.56**</td>
<td>130.31±1.79**</td>
</tr>
<tr>
<td>VI</td>
<td>EEMC 200mg/kg</td>
<td>254.45±2.34</td>
<td>163.11±2.44**</td>
<td>109.32±1.34**</td>
</tr>
<tr>
<td>VII</td>
<td>EEMC 400mg/kg</td>
<td>253.11±3.41</td>
<td>161.43±3.55**</td>
<td>107.45±4.52**</td>
</tr>
</tbody>
</table>

Values are expressed as mean±SEM; n=6 *P≤0.05 Diabetes control Vs Normal control. **P≤0.01, Vs Diabetic Control.

<table>
<thead>
<tr>
<th>Metformin 100 µg/ml</th>
<th>EECQ 400 µg/ml</th>
<th>EEMC 400 µg/ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metformin 100 µg/ml</td>
<td>EECQ 400 µg/ml</td>
<td>EEMC 400 µg/ml</td>
</tr>
</tbody>
</table>

Figure 1: Photos representing various concentrations of EECQ and EEMC on 3T3 L1 cell line.
Deepthi et al: Anti-diabetic effect of ethanolic extracts of cissus quadrangularis linn fruits and michelia champaea leaves

Figure 2: Effect of EECQ and EEMC on body weight in rats.

Figure 3: Effect of EECQ and EEMC on serum glucose levels in normoglycaemic rats

Figure 4: Effect of EECQ and EEMC on serum glucose levels in alloxan induced diabetes rats (Single dose study)

Figure 5: Effect of EECQ and EEMC on serum glucose levels of rats after multiple dose treatment.