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EVALUATION OF ANTI DIABETIC ACTIVITY OF *MAERUA OBLONGIFOLIA* IN STREPTOZOTOCIN – NICOTINAMIDE INDUCED TYPE – II DIABETIC RATS

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ABSTRACT

The term diabetes mellitus describes a metabolic disorder of multiple etiology characterized by chronic hyperglycaemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action or bot.Freshly prepared *Maerua oblongifolia* extract was subjected to phytochemical screening tests for the detection of various constituents using conventional protocol. The effects of diabetes mellitus include long-term damage, dysfunction and failure of various organs. The extract treated groups showed greater persistence of the islets and less degree of necrotic changes when compared to the diabetic rats. Test extracts showed the anti-diabetic activity by acting as an insulin secretogogue. In present study we can conclude that aerial parts of *Maerua oblongifolia* at doses 200mg/kg and 400mg/kg showed significant reduction in glucose, lipid profile, liver enzymes, body weight .While in increasing insulin secretion and decreasing the levels of glycosylated haemoglobin, postprandial glucose a dose of 400 mg/kg shows good activity. *Maerua oblongifolia* at doses 400 mg/kg potentiated insulin secretion from surviving β- cells. Pancreas histopathology shows improvement in the histology of the islets of Langerhans upon treatment with extract.

KEYWORDS: Maerua oblongifolia, Extraction, Anti Diabetics.

1. INTRODUCTION

The term diabetes mellitus describes a metabolic disorder of multiple etiology characterized by chronic hyperglycemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action or both. The effects of diabetes mellitus include long-term damage, dysfunction and failure of various organs.

The disease is associated with reduced quality of life and increased risk factors for mortality and morbidity. The long-term hyperglycemia is an important factor in the development and progression of micro and macro vascular complications.

Hyperglycemia can lead to a reduced number of glucose transporters, down regulation in the number of insulin receptors as well as defects of tissue insulin signal transduction. Subsequent to these deteriorations, there is an absolute increase in hepatic glucose output, which exceeds an increase of glucose utilization, and fasting hyperglycemia occurs (Gerich., 2003). Finally, hyperglycemia itself manifests adverse effects on β-cell insulin secretion and on insulin resistance

This process leads to long-term damage, dysfunction and failure of various organs, especially the eyes, kidneys, nerves, heart and blood vessels and creates a huge economic burden related to the management of diabetic complications

Plant Profile

Plant: *MAERUA OBLONGIFOLIA.*

Botanical Classification

KINGDOM - Plantae
ORDER - Brassicales
FAMILY - Capparaceae
GENUS - *Maerua*
SPECIES - *Oblongifolia*

Plant description

Maerua Oblongifolia is a woody twinning straggler having elliptic-obtuse leaves with a mucro at the apex. The flowers are greenish yellow, in axillary and terminal corymbs and the fruit is a moniliform berry. It is distributed in the dry forests of south India. (Anonymous., 1985).

Chemical Constituents

The aerial parts of *Maerua Oblongifolia* contain lupane triterpenoids and whole plant contains dodecanoic acid, β sitosterol, ursolic acid, 4-hydroxy benzoic acid, methyl grevillate, glycerol 1,3, didodecanoate, 1-0-coumaroyl glycerol and β sitosterol-3-0-β-D-glucopyranoside. (Yousaf *et al*., 2008).

Medicinal Uses

Murva is an important ayurvedic drug used as one of the ingredients in many Ayurvedic preparations. *Maerua oblongifolia* (Forsk.) A. Rich. (Capparaceae) is one of the botanical sources of the Ayurvedic drug Murva. The accepted botanical source is *Marsdenia tenacissima* (Roxb.) Moon. Ethnomedical survey reveals that *Murva* is used to cure various diseases such as fever, stomach ache, skin infections, urinary calculi, diabetes mellitus, epilepsy, pruritis, rigidity in lower limbs, and abdominal colic.

In India, the ayurvedic systems of medicine has been existing for over three thousand years, Charaka and Sushruta, two of the earliest Indian scholars had sufficient knowledge of the properties of the Indian medicinal plants. The Vedas are the epic poems, which contain rich material on the herbal medicine of that time. (Kurian., 2001).

Murva is a controversial drug. Amongst the many synonyms of this plant, one is *'Dhanurgunopayogya'* meaning 'the plant whose bark is being used for the bow-strings'. These synonyms have also contributes to the existing confusion. The plant which has tough fibres is the *Murva*. There are many such fibre yielding plants are found in the vegetable kingdom. *Murva* is an important controversial drug used in diseases like

- Anemia (Pandu)
- Fever (Jwara)
- Diabetes (Prameha)
- Stomach disorders (Udara roga)
- Typhoid (Visama jwara)
- Urinary infection (Asmari) and
- Cough (Ksaya). (Alice *et al*., 2007)

Figure 4: Images showing aerial parts, leaves and fruits of *Maerua oblongifolia*.

LITERATURE REVIEW

Schuster *et al*., 2002 This process leads to long-term damage, dysfunction and failure of various organs, especially the eyes, kidneys, nerves, heart and blood vessels and creates a huge economic burden related to the management of diabetic complications.

Kecskemeti *et al*., 2002 Hyperglycemia can lead to a reduced number of glucose transporters, down regulation in the number of insulin receptors as well as defects of tissue insulin signal transduction. Subsequent to these deteriorations, there is an absolute increase in hepatic glucose output, which exceeds an increase of glucose utilization, and fasting hyperglycemia occurs (Gerich., 2003). Finally, hyperglycemia itself manifests adverse effects on β-cell insulin secretion and on insulin resistance.

Strojek.et al., 2003 the disease is associated with reduced quality of life and increased risk factors for mortality and morbidity. The long-term hyperglycemia is an important factor in the development and progression of micro and macro vascular complications.

Mc Cance *et al*., 1994 The term diabetes mellitus describes a metabolic disorder of multiple aetiology characterized by chronic hyperglycaemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action or both. The effects of diabetes mellitus include long-term damage, dysfunction and failure of various organs.

Need for investigation

Despite considerable progress in the treatment of diabetes by oral hypoglycemic agents, search for newer drugs continues because the existing synthetic drugs have several limitations. The herbal drugs with antidiabetic activity are yet to be commercially formulated as modern medicines, even though they have been acclaimed for their therapeutic properties in the traditional systems of medicine (Wadkar *et al*., 2008).

The plants provide a potential source of hypoglycemic drugs because many plants and plant derived compounds have been used in the treatment of diabetes. Many Indian plants have been investigated for their beneficial use in different types of diabetes and reports occur in numerous scientific journals. Ayurveda and other traditional medicinal system for the treatment of diabetes describe a number of plants used as herbal drugs. Hence, they play an important role as alternative medicine due to less side effects and low cost. The active principles present in medicinal plants have been reported to possess pancreatic beta cells re-generating, insulin releasing and fighting the problem of insulin resistance. (Welihinda *et al*., 1982).

Hyperglycemia is involved in the etiology of development of diabetic complications. Hypoglycemic herbs increase insulin secretion, enhance glucose uptake by adipose or muscletissues and inhibit glucose absorption from intestine and glucose production from liver (Hongxiang H *et al*., 2009).

Aims and objectives of present work

Aim

The study was aimed at investigating the Anti diabetic property of aerial parts of *Maerua oblongifolia.*

Objectives

- To carry out the extraction from the aerial parts of *Maerua oblongifolia* by soxhlation method.
- To carry out qualitative phytochemical tests of the obtained extract.
- To evaluate the Anti diabetic activity.

MATERIALS AND METHODS

Collection of plant material

The plant material *Maerua Oblongifolia* was collected from near Laknavaram lake, Warangal district during the month of April 2013 and authenticated by an expert taxonomist Dr. E. Narasimha murthy, with specimen accession number ENM-100122.

Animals

Healthy Wister albino rats of either sex aged between 2-3 months and weighing 150–200 g were used for the study which were procured from Teena Bio labs Pvt. Ltd. (Reg. no. 177/99 CPCSEA), Hyderabad, Andhrapradesh. Animals were housed at CPCSEA approved animal house of Vaagdevi College of Pharmacy, (1047/ac/07/CPCSEA) Warangal. Housed individually in polypropylene cages, maintained under standard conditions (12h light and 12h dark cycle, 25±30^{0}C, 35–60% relative humidity), the animals were fed with standard rat pellet diet and water ad libitum. The experiments planned after the approval of Institutional Animal Ethical Committee (IAEC), Vaagdevi college of Pharmacy, Warangal, A.P.

Chemicals

Glibenclamide was obtained as a gift sample from Suzikem Drugs private limited, Hyderabad. Streptozotocin was purchased from Hi-Media. Total cholesterol and HDL kit, Triglycerides kit and other chemicals were procured from SS pharma, Hanamkonda.

Preparation of extracts

The ethanolic extract was prepared by Soxhlet extraction by taking 100 grams of the shade dried powder in 500 ml of ethanol, followed by prior defattening with N-Hexane. The extract was filtered, concentrated, dried in vaccum (8%yield) and the residue stored in a refrigerator at 2–8^{o}C for use in subsequent experiments. (Arulselvan *et al*., 2006).

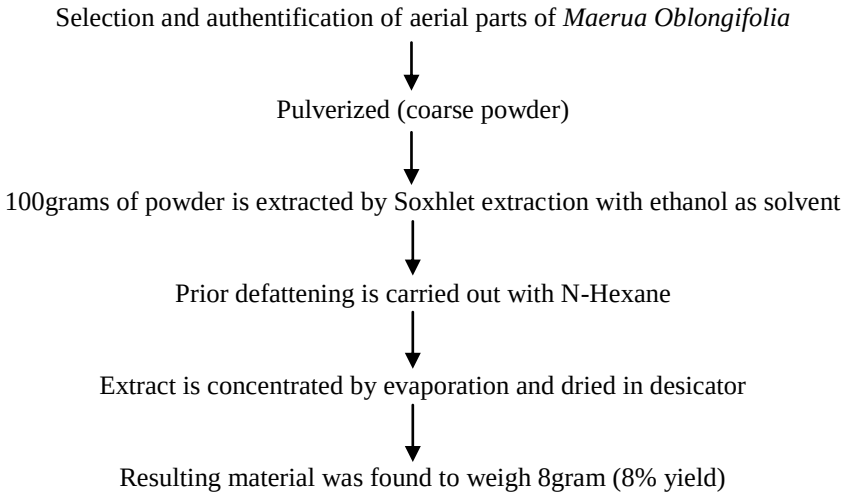


Figure 5: A schematic representation of extraction.

METHODS

Phytochemical Screening (Trease *et al*., 1989).

Freshly prepared *Maerua oblongifolia* extract was subjected to phytochemical screening tests for the detection of various constituents using conventional protocol.

Test for Reducing Sugars

1ml of filtrate was added to a mixture of 1ml each of Fehling's solution (A) and Fehling's solution (B) and allowed to boil for 1 minute and observed for formation of brick-red precipitate, indicates the presence of free reducing sugars.

Test for the presence of Anthraquinones

3ml of benzene was added to the filtrate and shaken, then 10% ammonia solution was added to the filtrate, the presence of a pink, red or violet colour in the ammonical (lower) phase indicated the presence of anthraquinones.

Test for Saponins

10 ml of distilled water was added to the filtrate and shaken vigorously for 5 min, appearance of stable foam indicates the presence of saponins.

Test for Flavonoids

2-3 drops of 10 % ferric chloride solution was added to the filtrate and observed, green or blue colour indicated the presence of phenolic nucleus.

Test for Steroids/ Terpenes

2 ml of acetic anhydride was added to the filtrate and then Sulphuric acid was added carefully along the sides of the test tube and observed for colour change from violet to blue to green indicated the presence of a steroidal nucleus.

Test for Tannins

2-3 drops of 10% ferric chloride was added to the filtrate and observed for a blue-black or blue-green precipitate would indicate the presence of tannins.

Test for Alkaloids

1ml of the filtrate was treated carefully with dilute hydrochloric acid then few drops of Mayer's reagent was added. Turbidity or precipitation with the reagent indicates the presence of alkaloids in the extracts.

Acute oral toxicity study (oecd., 2001)

The acute oral toxicity procedure was followed by using OECD 423 guidelines. The acute toxic class method is a stepwise procedure with 6 animals of a single sex per step Depending on the mortality and /or moribund status of the animals, on the average 2-4 steps may be necessary to allow judgment on the acute toxicity of the test substance. This procedure results in the use of a minimal number of animals while allowing for acceptable data based scientific conclusion.

The method uses defined doses (5, 50, 300, 2000 mg/kg body weight) and the results allow a substance to be ranked and classified according to the Globally Harmonized System (GHS) for the classification of chemicals which cause acute toxicity.

After the oral administration of test, animals were observed individually at least once during the first 30 minutes and periodically during the first 24 hours, with special attention given during the first 4 hours and daily Thereafter, for total of 14 days.

Body weight of the rats before and after treatment were noted and any changes in skin, fur, eyes, mucous membranes, salivation, nasal discharge, urination, behavioral (sedation, depression), neuromuscular (tremors, convulsions), cardiovascular, lethargy, sleep and coma were noted 14 days.

RESULTS

Phytochemical screening

Table 9: Showing Phytochemical screening.

Constituents	Observation
Reducing sugars	-
Alkaloids	-
Flavonoids	+
Saponins	-
Tannins	-
Sterols/terpene	+

(+) indicates presence of chemical constituents
(-) indicates absence of chemical constituents

Acute toxicity study

No toxic effects were observed at a dose of 2g/kg body weight. Hence there were no lethal effects in any of the group.

Effect of EEMO on fasting blood glucose

The effects of EEMO 200 mg/kg & 400 mg/kg in 0,7th, 14th and 21st days is shown in table 10. Glibenclamide 10 mg/kg and EEMO at 200 mg/kg and 400 mg/kg caused significant $p < 0.001$ reduction in blood glucose level by 60%, 39% and 51% against diabetic control groups on 21st day.

Effect of EEMO on OGTT

Table11 reveals the OGTT values. Blood glucose levels of experimental rats were increased at 30 min after glucose administration. Glibenclamide 10 mg/kg showed significant $p < 0.001$ reduction in blood glucose levels at 60 and 120 min. EEMO 200 mg/kg showed no effect in reduction of blood glucose at 60 and 120 min. while EEMO 400 mg/kg showed reduction in blood glucose at 60 & 120 min by $p < 0.01$ compared to normal control rats.

Effect of EEMO on Lipid profile

Total cholesterol, Triglycerides, HDL, LDL & VLDL levels of all 5 groups of rats are shown in table 12. Total cholesterol, triglycerides, LDL & VLDL levels were significantly higher in diabetic rats compared to normal rats, while the HDL levels were decreased in diabetic rats (12.1±1.10) compared to normal rats (23.05±2.65). Glibenclamide 10 mg/kg and EEMO 200 mg/kg, 400 mg/kg showed significant $p < 0.001$ reduction in Total cholesterol, Triglycerides, LDL, VLDL and an increase in HDL $p < 0.001$ was observed when compared to diabetic rats.

Effect on Liver enzymes

Table 13 explains the effect of EEMO on activities of serum SGOT and SGPT. The activities of SGOT & SGPT were higher in serum of diabetic rats when compared to control group of rats. While treatment with Glibenclamide 10 mg/kg and EEMO 200 mg/kg, 400 mg/kg decreased the activities of these enzymes significantly $p < 0.001$ compared to diabetic rats.

Effect of EEMO on Glycosylated haemoglobin (HbA_1C) & Insulin levels

HbA_1C and plasma insulin levels of control and treated rats are shown in Table 14. The HbA_1C levels of diabetic control rats is higher than that of the normal rats. Glibenclamide 10 mg/kg, EEMO 200 mg/kg & 400 mg/kg decreased the HbA_1C levels at $p < 0.001$, significance when compared to diabetic control rats. Similarly insulin levels are decreased in diabetic control rats while Glibenclamide 10 mg/kg showed significant $p < 0.001$ higher levels of insulin. EEMO 200 mg/kg is non significant. While EEMO 400 mg/kg showed significant $p < 0.01$ levels of insulin indicating effect of increase in insulin secretion at higher dose.

Effect on Body weight

The body weight of test groups increased significantly $p < 0.001$ on 21st day when compared to diabetic group in which the body weight is decreased. Table15.

Histology of pancreas

Normal control rats showed presence of normal pancreatic islet cells while upon observing diabetic control degranulated and dilated islet cells are observed. Glibenclamide treated group shows granulated absence of dilation cells with hyperplasticity while EEMO at doses 200 mg/kg and 400 mg/kg showed granulated cells showing protective effect of *Maerua oblongifolia* on pancreas in Figure 21.

Glucose levels

Table 10: Effect of Ethanolic extract of *Maerua oblongifolia* on fasting blood glucose levels.

Groups	Day 0	Day 7	Day 14	Day 21	% Reduction
Normal Control	76±4.24	79.66±3.55	85.5±2.66	92.16±2.63	
Diabetic control	241±9.31	254.5±14.85	257.5±7.91	261.66±8.06	
Glibenclamide (10 mg/kg)	231.16±6.11	184.83±28.92***	157±17.27***	113.16±9.64***	60%
EEMO(200mg/kg)	234.16±8.90	217.5±21.95**	192.66±11.77***	174±16.27***	39%
EEMO(400mg/kg)	229.83±12.27	203.83±14.51***	167.5±14.40***	138.5±9.81***	51%

Data represents mean ± S.D. (n=6). *p<0.5, **p< 0.01, ***p< 0.001, Significant compared to diabetic control analyzed by one-way ANOVA followed by Dunnett's test. Percent reduction was calculated as per the formula: 1 - (21st day treated value / 0 day treated value) / (21st day untreated control value / 0 day untreated control value) × 100.

Oral Glucose Tolerance Test

Table 11: Effect of Ethanolic extract of *Maerua oblongifolia* on glucose tolerance.

Blood glucose levels in mg/dl(Mean± S.D)				
Groups	**0min**	**30min**	**60min**	**120min**
Normal Control	89.5±8.78	117.33±8.21	105.83±8.70	96.33±7.39
Glibenclamide (10mg/kg)	81.83±6.64	95.83±10.16**	81.16±7.11***	76.16±7.41***
EEMO (200mg/kgbw)	79.16±7.44	105±10.50 ns	94.83±10.00 ns	86.83±9.53 ns
EEMO (400mg/kgbw)	75.5±13.80	96.83±13.04**	84.33±12.64**	79.16±7.41**

Data represents mean ± S.D. (n=6). *p<0.5, **p< 0.01, ***p< 0.001 Significant compared to control, analyzed by one-way ANOVA followed by Dunnett's test. Ns = non significant.

DISCUSSION

Diabetes is divided into two types, an insulin sensitive type (type 1), in which there is actual deficiency of insulin production, where β cells degeneration is dramatic and an insulin insensitive type (type 1) in which β cells degeneration is associated with slight insulin deficiency or it may result because of insulin resistance. This study was initiated with the objective of evaluating antidiabetic activity of ethanolic extract of *Maerua oblongifolia* in streptozotocin-nicotinamide induced diabetic rats.

Among the two doses of extract, 400mg/kg dose showed significant anti-hyperglycemic effect. As it is evident from the results that maximum reduction in the blood glucose levels were observed at 21stth day of treatment. The fasting blood glucose of the group treated with 400mg/kg body weight extract lowered the glucose level from 229.83mg/dl to 138.5mg/dl and glibenclamide from 231.16mg/dl to 113.16mg/dl representing 51% and 60% reductions respectively. The effect on the fasting blood glucose is dose dependent (Table 10).β cells regeneration is enhanced or cells are protected from destruction, by glucose load regulation as well as by enhancing insulin action and further effect β-cells to release insulin and activate the insulin receptors to absorb the blood sugar is the proposed mechanism of action of the extract. Regeneration of islet β-cells following destruction by streptozotocin may be the primary cause of the recovery. Controlling postprandial hyperglycemia is important in preventing diabetes complications. (Ratner., 2001). In the present study EEMO at a dose of 400 mg/kg showed significant $p < 0.01$ antihyperglycemic effect when compared to normal control rats in OGTT. (Table 11)

In this study, ethanolic extract significantly recovered the levels of serum lipid profile in treated diabetic rats when compared to untreated diabetic rats (Table 12). From this result, it may be stated that the ethanolic extract leads to regeneration of the β-cells of the pancreas and potentiation of insulin secretion from surviving β-cells.

Liver is the vital organ of metabolism, detoxification, storage and excretion of xenobiotics and their metabolites. (Rej., 1978). Liver was necrotized in STZ-induced diabetic rats.(Ohaeri., 2001). ALT and AST leakage occurs because of destruction of liver and hence their levels increases in plasma. (Navarro *et al*., 1993). Which gives an indication of the hepatotoxic effect of STZ. EEMO at doses 200mg/kg and 400 mg/kg after 21day treatment has been reported to reverse the increased AST and ALT activities towards near normalcy, which suggests prevention of cellular and tissue damages under diabetic conditions.

Less weight gain is observed in diabetic control when compared to normal and treated rats. Administration of ethanolic extracts of *Maerua oblongifolia* to diabetic (Group IV and V) rats resulted in an increase in body weight compared to diabetic rats (Group II). Results suggested that *Maerua oblongifolia* treatment has positive effect on maintaining body weights in diabetic rats. A gradual increase in body weights of Glibenclamide treated groups (Group III) was similar to that of normal control rats.

Diabetes causes increase in HbA_1C levels which is proportional to the blood glucose concentration. (Jackson *et al*., 1979). HbA_1C shows the glycemic levels during 2-3 months and is the more accurate and reliable biochemical measure than fasting blood glucose level. (Goldstein *et al*., 2004) Deficiency of insulin causes decrease in haemoglobin. (Kilpatrick., 2000). Hemoglobin levels are decresed because of formation of glycosylated haemoglobin. Oral administration of EEMO at a dose of 400 mg/kg showed decrease in HbA_1C levels which could be due to enhanced insulin secretion.(Jain *et al*., 2010). The increased levels of insulin in diabetic treated rats in this study indicate that Glibenclamide 10 mg/kg, EEMO at 400 mg/kg stimulates insulin secretion from the remnant β cells and/or regenerated β cells.

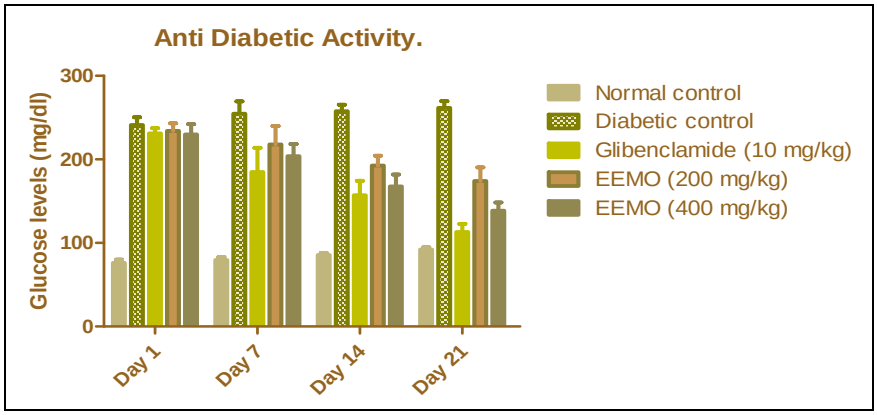


Figure 8: Blood glucose levels in normal and diabetic rats. Values are expressed in mean ± S.D. (n=6). *p<0.5, **p< 0.01, ***p< 0.001, Significant compared to diabetic control analyzed by one-way ANOVA followed by Dunnett's test.

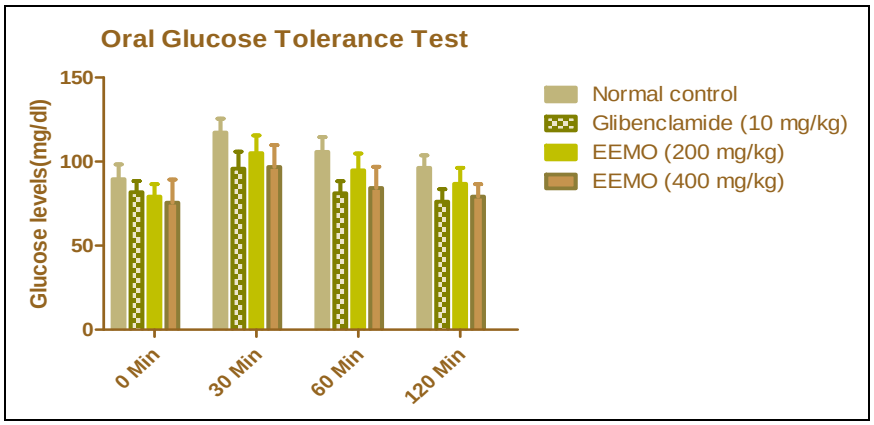


Figure 9: Blood glucose levels of Normal and treated rats in Oral glucose tolerance test. Values are expressed in mean ± S.D. (n=6). *p<0.5, **p< 0.01, ***p< 0.001 Significant compared to control, analyzed by one-way ANOVA followed by Dunnett's test. Ns = non significant.

LIPID LEVELS

Table 12: Effect of ethanolic extract of *Maerua oblongifolia* on serum lipid profile.

Groups	HDL (mg/dl)	LDL (mg/dl)	VLDL (mg/dl)	Total Cholesterol	Triglycerides (mg/dl)
Normal control	23.05±2.65	39.36±4.39	15.85±0.99	78.26±2.75	79.28.±4.98
Diabetic control	12.1 ±1.10	128.26± 6.53	36.05 ±0.60	176.25±7.14	180.25.±3.00
Glibenclamide (10 mg/kg)	29.98±2.63***	36.11±4.04***	17.41±0.59***	83.51±1.77***	87.08±2.98***
EEMO(200mg/kg)	20.85±2.79***	72.51±6.15***	21.67±0.77***	115.03±3.63***	108.36±3.87***
EEMO(400mg/kg)	23.75±6.01***	50.2± 7.24***	18.93±1.20***	92.88±1.98***	94.68±6.00***

Data represents mean ± S.D. (n=6). *p<0.5, **p< 0.01, ***p< 0.001, Significant compared to diabetic control analyzed by one-way ANOVA followed by Dunnett's test.

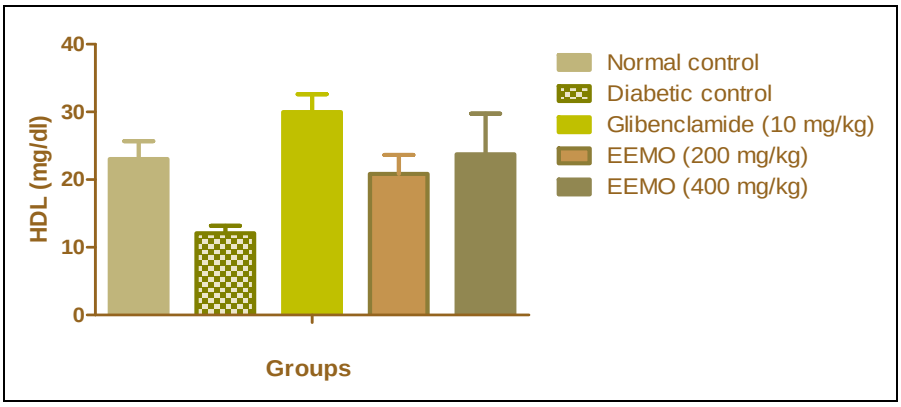


Figure 10: HDL levels in various groups.

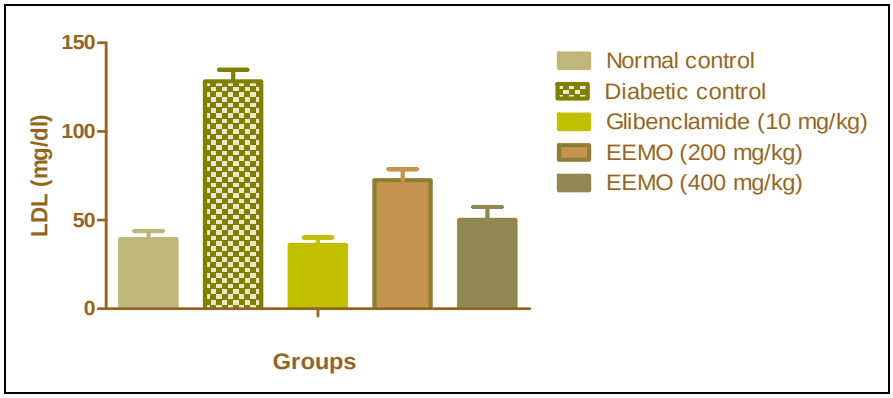


Figure 11: LDL levels in various groups.

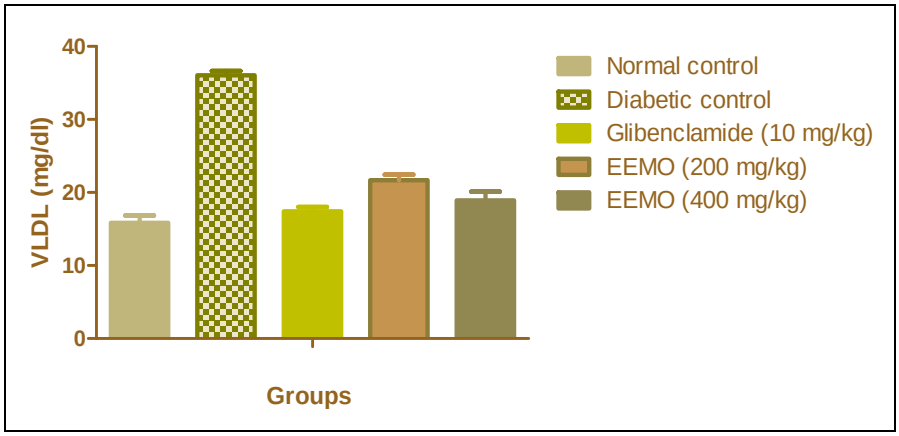


Figure 12: VLDL levels in various groups.

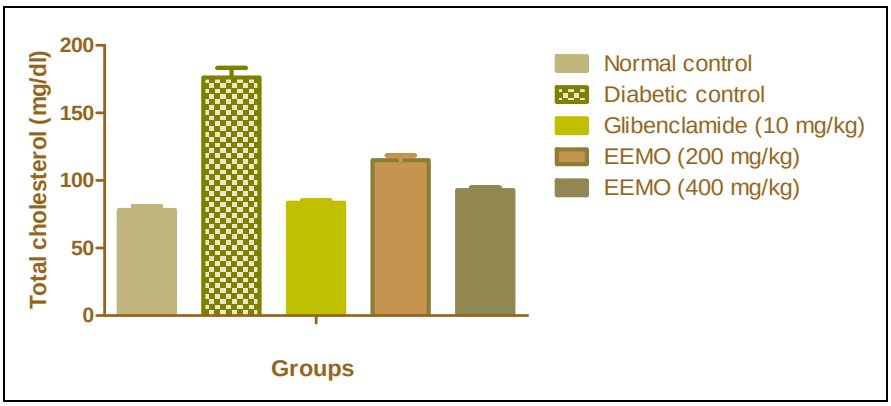


Figure 13: Total Cholesterol levels in various groups.

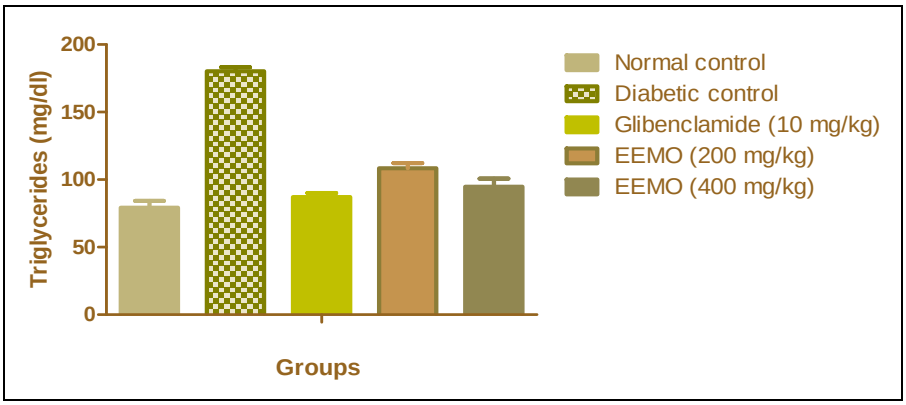


Figure 14: Triglycerides levels in various groups.

SGOT & SGPT LEVELS

Table 13: Effect of ethanolic extract of *Maerua oblongifolia* on liver enzyme levels.

Groups	SGOT(IU/ml)	SGPT(IU/ml)
Normal control	38.62±4.31	46.06±3.19
Diabetic control	89.20±5.00	98.54±5.41
Glibenclamide(10 mg/kg)	46.40±.4.39***	53.54±3.78***
EEMO(200mg/kg)	65.61±3.72***	87.22±4.72***
EEMO(400mg/kg)	54.18±3.85***	65.40±4.36***

Data represents mean ± S.D. (n=6). *p<0.5, **p< 0.01, ***p< 0.001, Significant compared to diabetic control analyzed by one-way ANOVA followed by Dunnett's test.

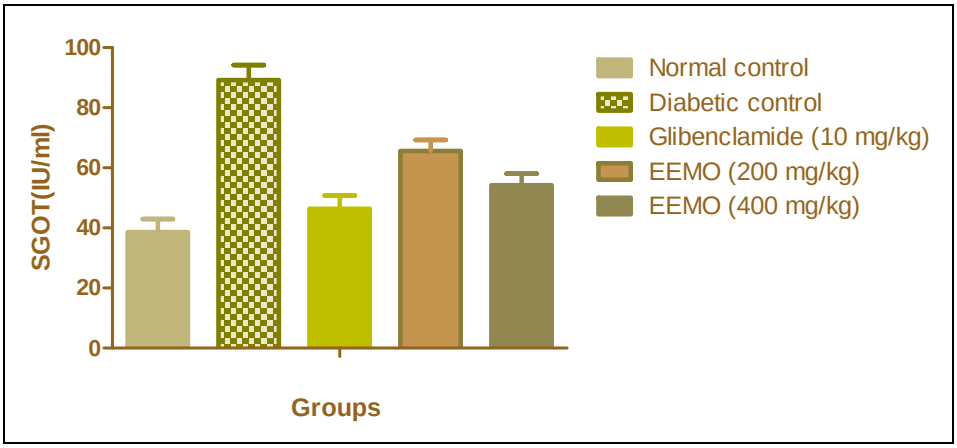


Figure 15: SGOT levels in various groups.

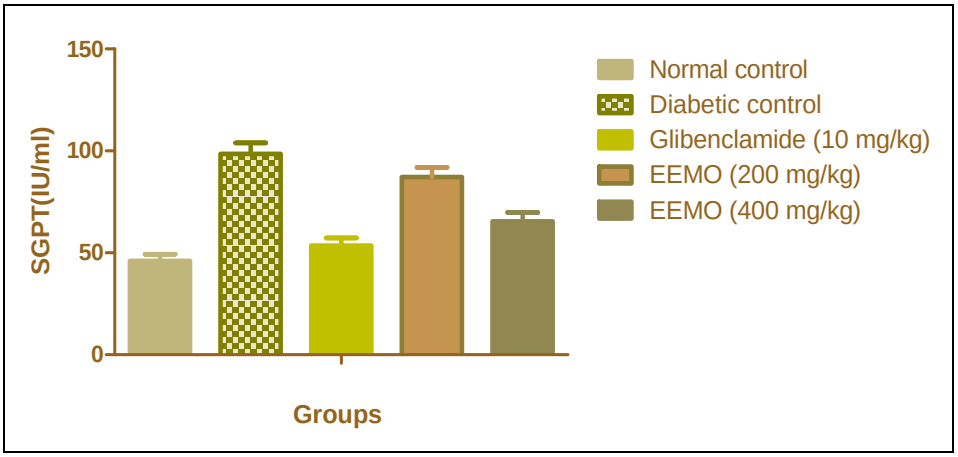


Figure 16: SGPT levels in various groups.

GLYCOSYLATED HAEMOGLOBIN & INSULIN

Table 14: Effect of Ethanolic Extract of *Maerua oblongifolia* on Glycosylated haemoglobin and Insulin levels

Groups	HbA_1C %	INSULIN µU/ml
Normal control	5.76±0.32	15.59±1.31
Diabetic control	11.93±0.75	6.48±0.80
Glibenclamide (10 mg/kg)	6.86±0.25***	13.83±1.05***
EEMO (200 mg/kg)	8.66±0.25***	8.40±0.77ns
EEMO (400 mg/kg)	7.5±0.26***	9.53±0.08**

Data represents mean ± S.D. (n=3). *p<0.5, **p<0.01, ***p< 0.001, Significant compared to diabetic control analyzed by one-way ANOVA followed by Dunnett's test. Ns = non significant.

BODY WEIGHTS

Table 15: Effect of Ethanolic Extract of *Maerua oblongifolia* on Body weights.

Group	Mean ± SD	
	Initial Weight	Final Weight
Normal Control	215.00 ± 20.00	234.16 ± 19.60
Diabetic Control	173.33 ± 3.61	145.83 ± 8.61
Glibenclamide (10 mg/kg)	177.50 ± 9.35	202.5 ± 6.12***
EEMO(200mg/kg)	170.00 ± 8.36	178.33 ± 10.32***
EEMO(400mg/kg)	173.33 ± 10.80	190 ± 8.94***

Data represents mean ± S.D. (n=6). *p<0.5, **p<0.01, ***p< 0.001, Significant compared to diabetic control analyzed by one-way ANOVA followed by Dunnett's test.

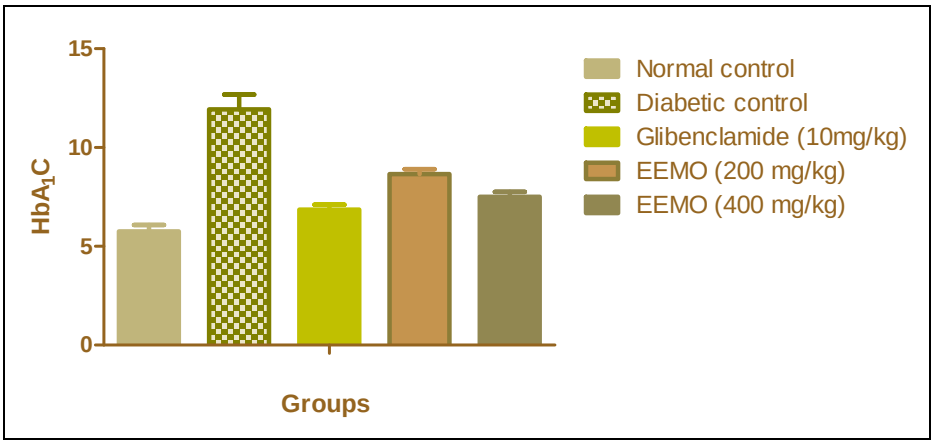


Figure 17: HbA_1C levels in various groups.

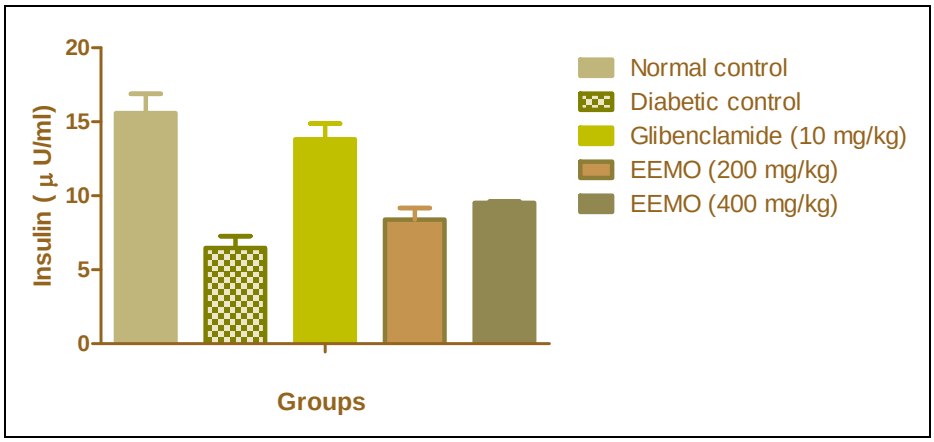


Figure 18: Insulin levels in various groups.

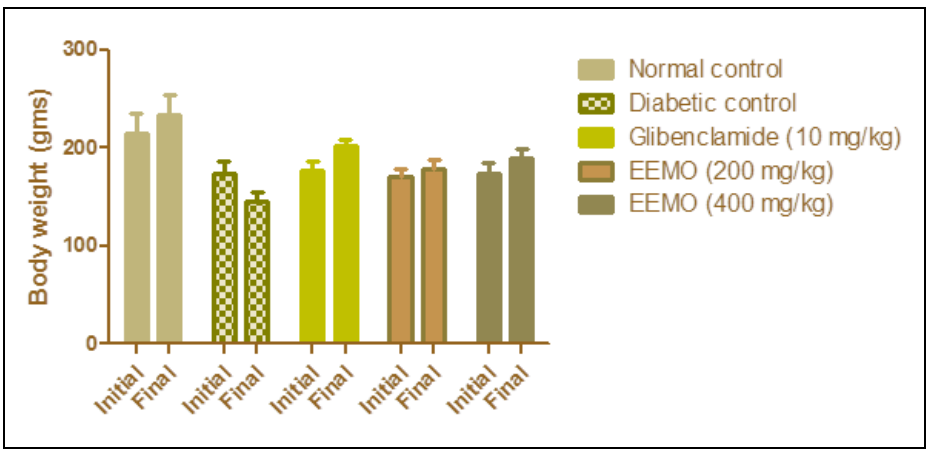
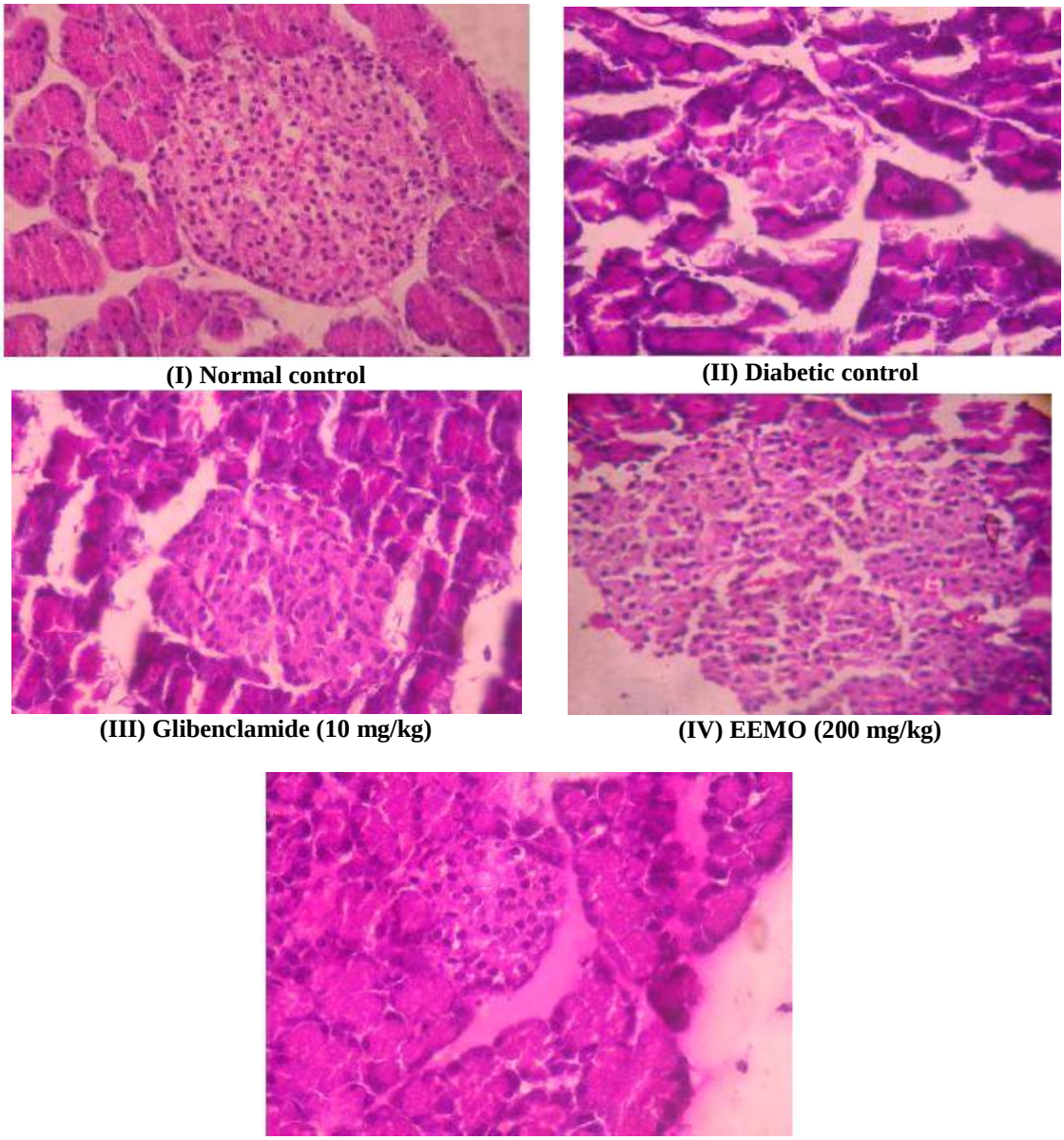


Figure 19: Body weights in various groups before and after treatment.

HISTOPATHOLOGICAL STUDIES OF PANCREAS OF VARIOUS TREATED GROUPS



(I) Normal control **(II) Diabetic control**

(III) Glibenclamide (10 mg/kg) **(IV) EEMO (200 mg/kg)**

(V) EEMO (400 mg/kg)

Figure 20: Histology of pancreas in experimental rats after 21 days of treatment with 0.1% C.M.C to Normal and Diabetic control rats, Glibenclamide 10 mg/kg, EEMO 200 mg/kg EEMO 400 mg/kg for diabetic treated rats.

(A) Normal control – Presence of normal pancreatic islet cells.
(B) Diabetic control – Degranulated and dilated islet cells.
(C) Diabetic + glibenclamide (10 mg/kg) – Granulated, absence of dilation and prominent hyperplasticity.
(D) and (E) Diabetic +tests (200 &400 mg/kg) – Granulated pancreatic islets, showing prominent hyperplasticity.

CONCLUSION

In present study we can conclude that aerial parts of *Maerua oblongifolia* at doses 200mg/kg and 400mg/kg showed significant reduction in glucose, lipid profile, liver enzymes, body weight .While in increasing insulin secretion and decreasing the levels of glycosylated haemoglobin, postprandial glucose a dose of 400 mg/kg shows good activity.

Maerua oblongifolia at doses 400 mg/kg potentiated insulin secretion from surviving β- cells. Pancreas histopathology shows improvement in the histology of the islets of Langerhans upon treatment with extract. The extract treated groups showed greater persistence of the islets and less degree of necrotic changes when compared to the diabetic rats. Test extracts showed the anti-diabetic activity by acting as an insulin secretogogue.

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