



Original Research Article

Volume 9, Issue 5 -2023

DOI: <http://dx.doi.org/10.22192/ijcrms.2023.09.05.004>

## Antidiabetic and Cytotoxic Effect of Aqueous and Methanolic Leaf Extract of *Portulaca oleracea*

Chindo Ishaya Ezekiel<sup>1</sup>, Solomon Matthias Gamde<sup>1</sup>, Debora Murna Jonathan<sup>2</sup>, \*Emmanuel Ifeanyi Obeagu<sup>3</sup>, Simon Peter Abriba<sup>1</sup>, Amos Dangana<sup>4</sup>

<sup>1</sup>Department of Medical Laboratory Science, Bingham University Karu, Nasarawa State, Nigeria.

<sup>2</sup>Department of Medical Laboratory Services, General Hospital Kachia, Kaduna State, Nigeria.

<sup>3</sup>Department of Medical Laboratory Science, Kampala International University, Uganda.

<sup>4</sup>Department of Haematology, University of Abuja Teaching Hospital, Gwagwalada, Nigeria.

### Abstract

*Portulaca oleracea* is one of the most used medicinal plants listed by the World Health Organization for diabetes. In the present study, the Antidiabetic and cytotoxic effect of the aqueous and methanolic leaf extract of *Portulaca oleracea* was evaluated. Forty-two animals were randomly assigned into seven groups consisting of six animals (n=6). Group I was normal control. Group II-III were normal animals administered with 500 and 1000 mg/kg extract. Group IV-VII were alloxan-induced type 2 diabetes animals. Group V-VI were treated with 500 and 1000 mg/kg extract while Group VII was treated with Glibenclamide. All treatments were administered once a day via oral gavage for 21 days. Blood sample was collected for biochemical assay and organs processed histologically using molten paraffin wax method. The acute toxicity values for methanol and aqueous extracts of *Portulaca oleracea* were greater than 5000 mg/kg. Aqueous extract showed the highest reduction in blood glucose level compared to the glibenclamide and methanolic extract. Isolated organs of the treated diabetic animals incontestably showed that *Portulaca oleracea* extract improved the kidney shrunken glomeruli and liver centrilobular necrosis. Besides, the acute toxicities of both methanol and aqueous extracts showed no treatment-related mortality at the tested doses. According to the result, *Portulaca oleracea* is a good source of antidiabetic drug. Both the aqueous and methanolic extracts improved the histology of the anatomic liver, kidney, and heart.

**Keywords:** *Portulaca oleracea*, biochemicals, centrilobular necrosis, histopathology.

### Introduction

Diabetes mellitus (DM) is a widespread metabolic disorder characterized by the lack of the body's ability to regulate blood glucose due to impaired insulin secretion, insulin action or even both<sup>1</sup>. In 2021, the global diabetes-related health

expenditures were estimated to be 966 billion USD and is projected to reach 1,054 billion USD by 2045<sup>2</sup>. Besides, this projection only considered demographic changes in populations relating to ageing and urbanization, and not changes in risk factor prevalence or survival, it is possible that the projection is underestimated. The rising

prevalence of diabetes is attributed principally to drug resistance and by this phenomenon, the number of people living with diabetes will continue to increase in the aging population<sup>3</sup>.

To obtain a distinct solution for diabetes-related health complications, an ethnopharmacological survey represents a major reference point in unveiling the treasure of natural resources<sup>4,5</sup>. *Portulaca oleraceae* (family Portulacaceae) is an herbaceous shrub found in India and other tropical countries Nigeria inclusive. The indigenous names for *Portulaca oleraceae* in Hausa and Igbo languages are pasa kasa and nti oke respectively<sup>2</sup>. *Portulaca oleraceae* provides a rich source of nutritional benefits when eaten raw as a green and cooked as a sauce in soup<sup>6</sup>. Besides, the nutritional composition includes carbohydrates, proteins, saponins, tannins, and essential amino acids (linoleic acid and oleic acid), and vitamins<sup>7,8</sup>.

Previous studies also reported the wound healing<sup>9</sup>, antifungal<sup>10</sup>, antifertility<sup>11</sup>, antiinflammatory<sup>12</sup>, and antidiabetic effects<sup>13</sup> of *Portulaca oleraceae*. However, diabetes affects several organs of the body with serious systemic involvements which are common problems<sup>14, 15</sup>. Therefore, the aim of the current study is to verify the antidiabetic and cytotoxic activities of the aqueous and methanolic leaf extracts of *Portulaca oleraceae* as a raw drug for diabetes especially after synthetic drugs resistance awareness.

## Materials and Methods

### Chemicals used

Alloxan monohydrate (Chemical Co. St. Louis, USA) and Radox reagent test kits (Radox Laboratories Limited, United Kingdom) for ALT, AST, AP, and E/U/Cr were purchased and used.

### Preparation of *Portulaca oleraceae* Aqueous and Methanol Extracts

Fresh *Portulaca oleraceae* was collected and identified in the Department of Botany, University of Nigeria, Enugu Campus, Nigeria,

where voucher specimen was deposited. The Aqueous and methanol extracts of the plant were prepared according to the method as described by Gamde *et al.*<sup>16</sup>. Five hundred grams (500 g) of dried *Portulaca oleraceae* was macerated in 1000 mL of distilled water for 24 hours and then filtered. The plant remains from the aqueous extract were resuspended in methanol. The filtrates were evaporated to dryness in an oven at 40°C to yield dark residues.

### PO Acute toxicity study

Acute toxicity study was carried out according to the guidelines of Organization of Economic Company and Development (OECD) 425 (OECD, 2001). The PO extracts were administered in a single dose using oral gastric tube. Animals were deprived of food 3 h prior to the extract dosing. After each extract was administered, physical observations were done at critical interval of 30 min for 4 hours and after 24 hours for behavioral change or death. The PO extract dosage 250, 500, 1000, 2000, 4000 mg/kg body weight were determined. The Up and Down method for oral acute toxicity study was carried out to determine the acute toxicity in Rabbits as described by Gamde *et al.*<sup>18</sup>. Briefly, animals were dosed one at a time and observed for survival or death. If a rabbit survives, the subsequent dose for the next rabbit was increased but if the rabbit die, the dose was reduced. Each rabbit was observed at least for 24 hours before dosing the next rabbit to arrive at the least dose lethal to the rabbits.

### Experimental Animals

The study was approved by the Animal Welfare and Ethics Committee of University of Nigeria, Enugu Campus, Nigeria. The male and female rabbits used in the study were obtained from the Animal House of the Department of Zoology, University of Nigeria, Enugu Campus, Nigeria. Animals were kept in metal cages and maintained under standard laboratory conditions. The animals were fed with chow and allowed free access to clean water *ad libitum*. All experimental procedures were in accordance to the United States National Institute of Health (NIH) Guide for Care and Use of Laboratory Animals.

## Induction of hyperglycemia

Hyperglycemia was induced by 150 mg/kg alloxan monohydrate after a 16 hours fast. The fasting blood sugar (FBS) was determined 72 hours after induction, a fasting blood glucose test confirmed hyperglycemia (14.0 mmol/L), after which *Portulaca oleracea* was orally administered and animals whose fasting blood sugar was and above were considered diabetic as described with little modification<sup>19</sup>.

## Induction of Diabetes Type II

Fresh 5% percent alloxan monohydrate was prepared in saline and it was used to induce diabetes using intraperitoneal injection of 150 mg/kg body weight of animals.

## Experimental Design

Forty-two animals were randomly assigned into seven groups consisting of six animals each.

Group I was normal animals control

Group II was animals administered with 500 mg/kg PO

Group III was animals administered with 1000 mg/kg PO

Group IV Diabetic induced animals without treatment

Group V Diabetic animals treated with 500 mg/kg PO

Group VI Diabetic animals treated with 1000 mg/kg PO

Group VII Diabetic animals treated with 2.5 mg/kg Glibenclamide

Glibenclamide and PO extract were administered via oral gavage to the animals once a day for 21 consecutive days. Animals were euthanized and blood samples were collected by cardiac puncture for biochemical assays. The liver, heart, and kidney were excised via abdominal incisions and processed using molten paraffin wax for histological examination.

## Biochemical assays

Serum triglyceride (TG) was determined by the method described by Fossati *et al.*<sup>17</sup>. Serum total

cholesterol (TC) was determined according to the method of Roeschlau *et al.*<sup>18</sup> while LDL-cholesterol was determined by the formula described by Friedewald *et al.*<sup>19</sup>

## Statistical Analysis

Results were analyzed using IBM SPSS (version 25) by one-way analysis of variance (ANOVA) and differences were considered statistically significant at  $p < 0.05$ .

## Results

### Toxicity of PO Extract

The acute toxicities of both methanol and aqueous PO extracts showed no death nor treatment-related mortality at the tested doses. The extracts seem to be safe up to a dose of 5000 mg/kg body weight. Therefore, the acute toxicity (LD<sub>50</sub>) value is considered to be greater than 5000 mg/kg.

### Effect of extract on blood glucose

The baseline blood glucose levels were determined at the beginning of the study ( $p > 0.05$ ). Following the induction of hyperglycemia, animals with blood glucose values  $\pm 200$  mg/dL ( $p > 0.05$ ) were considered diabetic. Active constituents of the aqueous PO extract showed the highest reduction in blood glucose levels compared with the glibenclamide and methanolic extract. Oral administration of the methanolic and aqueous extracts of *Portulaca oleracea* at 500, and 1000 mg/kg body weight showed significant reduction of the blood glucose levels compared to the control groups (Table 1 and 2).

### Effect of extract on liver and kidney functions

In this study, high blood glucose significantly ( $P < 0.05$ ) raised serum creatinine and hepatic enzymes (AST and ALT) levels for 21 days. However, active constituents of PO significantly reduced the raised hepatic enzymes and creatinine. PO extracted by methanol showed the highest reduction in a dose-related manner as compared with the aqueous extract and control (Table 3).

**Anti-hyperlipidemic effect of pericarp extract**

*PO* leaf extract on lipid profile on alloxan induced diabetes is presented in Table 4. There was a significant difference ( $p < 0.05$ ) in the LDL and total cholesterol contents of diabetic animals treated with 1000 mg/kg *PO* aqueous extract as compared with the aqueous extract and control.

**Histopathology**

Figure 3. Histopathology of diabetic animals illustrating shrunken glomeruli with decreased mesangium size while the liver exhibited centrilobular necrosis. However, animals treated with 1000 mg/kg *PO* revealed improved anatomic histology of the liver and kidney. No pathological changes was seen in the heart

**Table 1: Effect of Methanolic Extract on Blood Glucose (Mmol/L)**

Treatment groups	0 hr	10 days	21 days
Normal control	5.34±0.15 <sup>#</sup>	5.56±0.21 <sup>#</sup>	5.41±0.18 <sup>#</sup>
Normal + 500 mg/kg <i>PO</i>	5.37±0.03 <sup>#</sup>	5.96±0.21 <sup>#</sup>	5.32±0.14 <sup>#</sup>
Normal + 1000 mg/kg <i>PO</i>	5.57±0.16 <sup>#</sup>	5.63±0.25 <sup>#</sup>	5.30±0.38 <sup>#</sup>
DM control	15.24±0.15 <sup>*</sup>	14.98±0.14 <sup>*</sup>	14.99±0.28 <sup>*</sup>
DM + 500 mg/kg <i>PO</i>	14.92±0.50 <sup>*#</sup>	11.16±0.47 <sup>*#</sup>	9.29±0.33 <sup>*#</sup>
DM + 1000 mg/kg <i>PO</i>	15.20±0.16 <sup>*</sup>	10.09±0.07 <sup>*#</sup>	7.61±0.34 <sup>*#</sup>
DM + 2.5 mg/kg Glib.	15.14±0.09 <sup>*</sup>	10.45±0.18 <sup>*#</sup>	6.74±0.19 <sup>*#</sup>

Data are expressed as the mean ± standard deviation per group. \*Mean values were significantly different with respect to the Normal control at  $P = 0.05$ . #Mean values were significantly different compared to the diabetes group (Alloxan-induced DM only) at  $P = 0.05$ . N means normal, DM diabetes, Glib Glibenclamide and *PO* *Portulaca oleracae*

**Table 2: Effect of Aqueous Extract on Blood Glucose (Mmol/L) level**

Treatment groups	0 hr	10 days	21 days
Normal control	5.35±0.15 <sup>#</sup>	5.55±0.21 <sup>#</sup>	5.31±0.17 <sup>#</sup>
Normal + 500 mg/kg <i>PO</i>	5.36±0.03 <sup>#</sup>	5.94±0.21 <sup>#</sup>	5.33±0.14 <sup>#</sup>
Normal + 1000mg/kg <i>PO</i>	5.51±0.16 <sup>#</sup>	5.63±0.25 <sup>#</sup>	5.31±0.38 <sup>#</sup>
DM control	15.14±0.15 <sup>*</sup>	14.98±0.14 <sup>*</sup>	14.99±0.28
DM + 500 mg/kg <i>PO</i>	15.42±0.22 <sup>*</sup>	11.72±0.46 <sup>*#</sup>	9.35±0.28 <sup>*#</sup>
DM + 1000 mg/kg <i>PO</i>	15.05±0.23 <sup>*</sup>	7.87±0.31 <sup>*#</sup>	6.66±0.19 <sup>*#</sup>
DM + 2.5 mg/kg Glib.	15.14±0.09 <sup>*</sup>	10.45±0.18 <sup>*#</sup>	6.74±0.19 <sup>*#</sup>

Data are expressed as the mean ± standard deviation per group. \*Mean values were significantly different with respect to the Normal control at  $P = 0.05$ . #Mean values were significantly different compared to the diabetes group (Alloxan-induced DM only) at  $P = 0.05$ . DM means diabetes, Glib Glibenclamide, and *PO* means *Portulaca oleracae*.

**Table 3; Effect of Extract on Liver and Kidney Functions**

Group	U (Mmol/l)	Cr (Mmol/l)	AST (Mmol/l)	ALT(Mmol/l)	ASP (Mmol/l)	TB (Mmol/l)
Normal control	8.23±0.54 <sup>#</sup>	59.45±4.38 <sup>#</sup>	27.58±1.47 <sup>#</sup>	25.01±0.92 <sup>#</sup>	39.05±4.10	1.50±0.21
N+1000 mg aq PO	6.13±0.62*	55.25±10.19	36.00±4.30*	44.25±3.88*	58.25±7.16*	2.60±0.80
N+1000 mg/kg Met. PO	4.88±0.55*	71.00±7.99*	40.75±6.94*	48.25±9.67*	44.00±9.00*	1.80±0.00
DM control	5.88±.20*	77.75±4.19*	42,25±6.65*	46.00±8.63*	39.75±7.02	1.80±0.00
DM+2.5 mg/kg Glib.	2.95±0.22* <sup>#</sup>	58.25±5.68 <sup>#</sup>	31.25±5.54 <sup>#</sup>	48.00±3.11*	55.75±4.78* <sup>#</sup>	1.8±0.00
DM+500 mg/Kg MetPO	1.63±0.11* <sup>#</sup>	64.00±5.40* <sup>#</sup>	28.50±3.07 <sup>#</sup>	68.50±5.12* <sup>#</sup>	72.25±3.35* <sup>#</sup>	1.80±0.00
DM+500 mg/kg Aq PO	5.53±1.60*	53.50±9.13 <sup>#</sup>	41.50±1.04*	95.50±22.22* <sup>#</sup>	43.00±16.62*	1.80±0.00
DM+1000 mg/kg Met PO	3.23±0.77* <sup>#</sup>	49.25±4.44 <sup>#</sup>	26.0±04.49 <sup>#</sup>	59.50±10.90* <sup>#</sup>	50.50±8.42* <sup>#</sup>	1.80±0.00
DM+1000 mg/kg Aq PO	3.35±0.27* <sup>#</sup>	72.75±8.01*	44.00±8.65*	56.75±4.42* <sup>#</sup>	84.25±21.10* <sup>#</sup>	1.80±0.00

Data are expressed as the mean ± standard deviation per group. \*Mean values were significantly different with respect to the Normal control at  $P < 0.05$ . <sup>#</sup>Mean values were significantly different compared to the diabetes group (Alloxan-induced DM only) at  $P < 0.05$ . N means normal, Aq aqueous, Met methanol, DM diabetes and PO *Portulaca oleraceae*

**Table 4: Effect of Extract on Lipid Profile**

Group	LDL (Mmol/l)	TC (Mmol/l)	TG (Mmol/l)
Normal control	0.25±0.08 <sup>#</sup>	1.16±0.04 <sup>#</sup>	1.61±0.01
N+1000 mg/kg aq PO	0.06±0.01* <sup>#</sup>	2.47±0.17*	1.41±0.02*
N+1000 mg/kg Met. PO	0.70±0.00* <sup>#</sup>	2.27±0.11*	1.34±0.03*
DM control	0.26±0.01	3.31±0.01*	2.13±0.06*
DM +2.5 mg/kg Glib.	0.06±0.00* <sup>#</sup>	2.56±0.02 <sup>#</sup>	1.41±01 <sup>#</sup>
DM+500 mg/kg MetPO	0.16±0.01 <sup>#</sup>	3.11±0.02* <sup>#</sup>	1.65±0.02 <sup>#</sup>
DM+500 mg/kg Aq PO	0.12±0.01 <sup>#</sup>	3.13±0.01*	1.46±0.01 <sup>#</sup>
DM+1000 mg/kg MetPO	0.18±0.01 <sup>#</sup>	3.05±0.01*	1.49±0.01 <sup>#</sup>
DM+1000mg/kg Aq PO	0.09±0.00* <sup>#</sup>	2.76±0.00* <sup>#</sup>	1.41±0.01 <sup>#</sup>

Data are expressed as the mean ± standard deviation per group. \*Mean values were significantly different with respect to the Normal control at  $P < 0.05$ . <sup>#</sup>Mean values were significantly different compared to the diabetes group (Alloxan-induced DM only) at  $P < 0.05$ . N means normal, LDL low density lipoprotein, TC total cholesterol, TG triglyceride, Aq aqueous, Met methanol, DM diabetes and PO *Portulaca oleraceae*

## Histopathology result

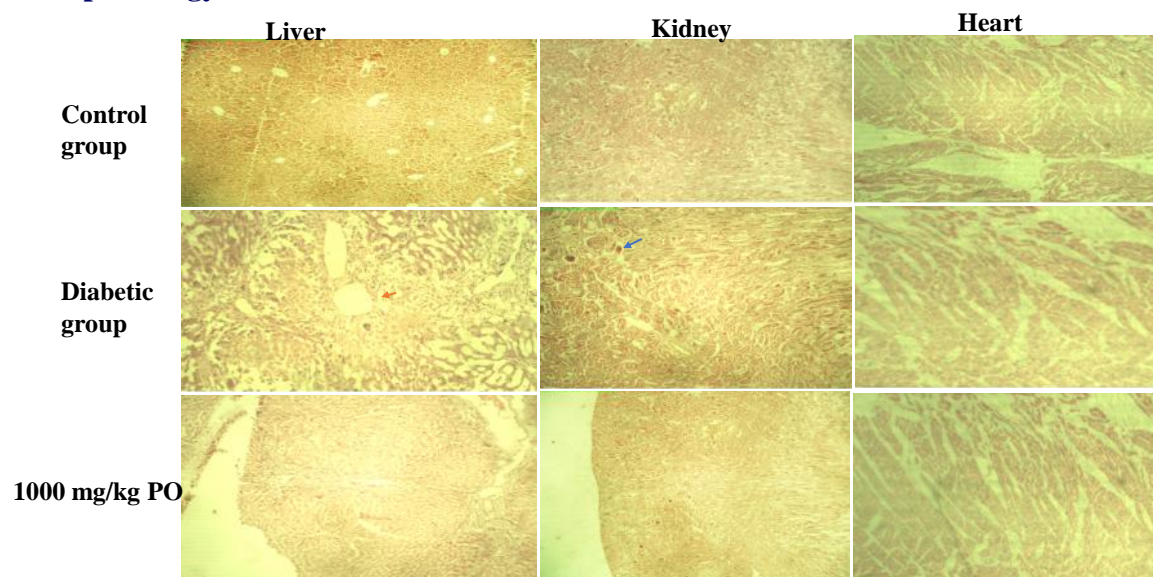


Fig. 1 Histopathological sections of the diabetic animals showed centrilobular necrosis (red arrow) and glomerular shrinkage (blue arrow). Animals treated with 1000 mg/kg PO revealed improved anatomic histologies of the liver and kidney. The regular cardiac muscles indicated no histopathological change when compared to the control (H &E stain. X 100).

## Discussion

In this study, the hypoglycemic effect of aqueous and methanolic leaf extract of *Portulaca oleracea* were observed in diabetic rabbits comparing to normal ones. Active constituents of the aqueous leaf extract demonstrated the highest reduction in blood glucose levels followed by glibenclamide and methanolic leaf extract comparing with the normal control. *P. oleracea* increases the stimulation of insulin secretion and glucose uptake, which can aid in the recovery process of diabetic patient<sup>1</sup>. A number of plants have also been reported to have hypoglycemic and insulin releasing stimulatory effects<sup>20,21</sup>. Flavonoids, tannins, and  $\text{Ca}^+$  were identified in *portulaca oleracea* to modulate calcium-mediated mechanism for insulin release<sup>7</sup>. In another study, *P. oleracea* reduces blood glucose and suppresses body weight gain. Although there were differences in diet calories, the present finding is consistent with Won *et al*<sup>22</sup> reports.

Documented evidence abounds that endocrine disorders such as lipids, carbohydrates, and protein metabolism are common in chronic diabetes<sup>23</sup>. In the present study, *Portulaca oleracea* shows antihyperlipidemic effect on the experimental model. The low serum LDL-

cholesterol and VLDL-cholesterol levels accompanying increase in HDL-cholesterol in the alloxan-induced animals treated with *Portulaca oleracea* extract suggest restraint of hyperlipidemia due to the phytochemicals identified<sup>24</sup>. Similar study has been reported by Wong *et al*<sup>22</sup> and Maqsood *et al*.<sup>23</sup>.

In addition, many in-vitro and in vivo studies have demonstrated that diabetes and its treatments is associated with various dysfunctions and organs failure<sup>25,26,27</sup>. Isolated organs of the treated diabetic animals incontestable showed that *Portulaca oleracea* extract improved the kidney shrunken glomeruli and liver centrilobular necrosis. Besides, the acute toxicities of both methanol and aqueous PO extracts showed no treatment-related mortality at the tested doses. Hence, investigating the diabetes-related cellular toxicities and developing new drug is essential.

## Conclusion

According to the result of this study, *Portulaca oleracea* is a good source of antidiabetic drug. Both the aqueous and methanolic leaf extracts of *Portulaca oleracea* improved the histology of the anatomic liver, kidney, and heart.

## References

- Hanie roozi, Masuod Mashhadi Akbar Boojar, Akram Eidi & Ramezanali Khavari-Nejad. The effect of portulaca oleracea alkaloids on antidiabetic properties through changes in ceramide metabolism, *Egyptian Journal of Basic and Applied Sciences*, 2021; 8:1, 156-166, DOI: 10.1080/2314808X.2021.1877889.
- Hong Sun, Pouya Saeedi, Suvi Karuranga, Moritz Pinkepank, Katherine Ogurtsova, Bruce B. Duncan, Caroline Stein, Abdul Basit, Juliana C.N Chan, Jean Claude Mbanya, Meda E. Pavkov, Ambady Ramachandaran, Sarah h. Wild, Steven James, William H. Herman, Ping Zhang, Christian Bommer, Shihchen Kuo, Edward J. Boyko, Dianna J. Magliano. IDF Diabetes Atlas: Global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. *Science direct. Diabetes research and clinical practice*, 2022; 183, 109119.
- Pupek-Musialik D, Kujawska-Łuczak M. Leczenie cukrzycy u osób w Podeszłym Wiek. DIABETOLOGIA online. 2020. [http://diabetologiaonline.pl/lekarz\\_diabeto\\_a\\_doż,info,85,0.html](http://diabetologiaonline.pl/lekarz_diabeto_a_doż,info,85,0.html). Accessed 17 Jul 2020.
- Solomon Matthias Gamde, Abubakar Sadiq, Ajayi Ayooye Samuel, Samuel Eugene Bwede, James O. Adisa. Histological Effects of Ethanolic Stem Bark Extract of *Anacardium Occidentale* on the Kidney of Rabbits. *International Journal of Innovative Research & Development*, 2019; 8(8):286- 291. DOI No.: 10.24940/ijird/2019/v8/i8/AUG19088.
- Solomon Matthias Gamde, Usman Wali, Aminu Garba, Daniel Dansy Agom, Haruna Mallah Ayuba. Histopathological And Biochemical Effects of Aqueous Fruit Extract of *Balanite Agyptiaca* on Selected Organs of Mice. *International Journal of Human and Health Sciences*.2023;7(3):54-59. DOI: <http://dx.doi.org/10.31344/ijhhs.v7i1.497>.
- Mohamed A. Dkhil1, Ahmed E. Abdel Moniem, Saleh Al-Quraishy1 and Reda Awadallah Saleh. Antioxidant effect of purslane (*Portulaca oleracea*) and its mechanism of action. *Journal of Medicinal Plants Research* , 2011; 5(9): 1589-1563.
- Mohamed A K, Angelika B, Stephan S, Hans T, Reinhard Z, Peter P. Nawroth. The role of oxidative stress and NF- B activation in late diabetic complications, *Bio Factors*, 1999; 10(2-3): 157–167.
- Sudhakar D, Krishna Kishore R, Parthasarathy PR. *Portulaca oleracea* L. extract ameliorates the cisplatin-induced toxicity in chick embryonic liver. *Indian J. Biochem. Biophys.*, 2010; 47: 185-189.
- Haus JM, Kashyap SR, Kasumov S, et al. Plasma ceramides are elevated in obese subjects with type 2 diabetes and correlate with the severity of insulin resistance. *Diabetes*. 2009; 58 (2):337–343.
- Oh KB, Chang IM, Hwang KJ, Mar W, Detection of antifungal activity in *Portulaca oleracea* by a single-cell bioassay system, *Phytotherapy Research*, 1998; 14(5): 329-332.
- Verma OP, Kumar S, Chatterjee SN, Anti-fertility effects of common edible *Portulaca oleracea* on the reproductive organs of male albino mice. *Indian Journal of Medical Research*, 1998; 75: 301-310.
- Chao, L. Adipose tissue is required for the antidiabetic, but not for the hypolipidemic, effect of Thiazolidinediones *Journal of Clinical Investigation*. 2000; 106: 1221-1228.
- Musa, K.Y., A. Ahmed, G. Ibrahim, O.E. Ojonugwa, M. Bisalla, H. Musa and U.H. Danmalam. Toxicity studies on the methanolic extract of *Portulaca oleraceae* L. (Fam. Portulacaceae). *Journal of Biological. Science*, 2007;7: 1293-1295.

14. Elksnis A, Martinell M, Eriksson O and Espes D. Heterogeneity of metabolic defects in type 2 diabetes and its relation to reactive oxygen species and alterations in beta-cell mass. *Front. Physiol.* 2019; 10(13): 107.
15. Solomon Matthias Gamde, Chinenye J. Ugwah-Oguejiofor, Aminu Garba, Godwin O Avwioro, Akinpelu Moronkeji, Abdullahi Abiodun Jimoh. Histologic and Biochemical Effect of *Balanite aegyptiaca* Fruit Extract on Alloxan-Induced Diabetes in Wistar Rats. *Ethiop J Health Sci.* 2023;33(3):441. doi:http://dx.doi.org/10.4314/ejhs.v33i3.7 .
16. Gamde SM, Kabiru H, Abdulaziz A, Abubakar KA, Musa AA, Perede A. Histopathological and Biochemical Effects of Aqueous Leaf Extract of *Cadaba farinosa* on the Liver of Adult Wistar Rats. *Int J Res Med Sci.* 2019;7:3716-21.
17. Fossati, P. and L. Prencipe. Serum triglycerides determined colorimetrically with an enzyme that produces hydrogen peroxide. *Clin. Chem.*, 1982; 28: 2077-2080.
18. Roeschlau, P., E. Bernt and W. Gruber. Enzymatic determination of total cholesterol in serum. *Z. Klin. Chem. Klin. Biochem.*, 1974; 12: 226-226.
19. Friedewald, W.T., R.I. Levy and D.S. Fredrickson. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifug. *Clin. Chem.*, 1972; 18: 499-502.
20. Ugwah-Oguejiofor, Aminu Garba, Godwin O Avwioro, Akinpelu Moronkeji, Abdullahi Abiodun Jimoh. Histologic and Biochemical Effect of *Balanite aegyptiaca* Fruit Extract on Alloxan-Induced Diabetes in Wistar Rats. *Ethiop J Health Sci.* 2023;33(3):441. doi:http://dx.doi.org/10.4314/ejhs.v33i3.7
21. Jung HO, Soo HK, Young MC, Soo L, Jang HC, Kyong SP, Nam H C. 10-year trajectory of  $\beta$ -cell function and insulin sensitivity in the development of type 2 diabetes: A community-based. *Lancet Diabetes & Endocrinology.* 2016;4:27-34.
22. H.-R. Won and S.-H. Kim, "Antihyperlipidemic effect of diet containing *Portulaca oleracea* L. ethanol extract in high fat diet-induced obese mice," *Journal of the Korean Society of Food Science and Nutrition*, 2011; (40)4: 538–543.
23. Maqsood A, Fatima Z, Tanveer S & Muhammad Z. C. Antidiabetic and Hypolipidemic Effects of *Aqueous Methanolic* Extract of *Acacia Nilotica* Pods in Alloxan-Induced Diabetic Rabbits. *Scandinavian Journal of Laboratory Animal Science*, 2008; 35 (1)29-34.
24. Wojtowicz Z, W Wrona, G Kis, M Blaszczyk & A Solecka. Serum total cholesterol, triglyceride and High-density lipoproteins (HDL) levels in rabbit during the course of experimental diabetes. *Annals of University of Mariae Curie Sklodowska*, 2004; 59: 258-260.
25. Wang W, Gu L, Dong L, Wang X, Ling C, Li M, Protective effect of *Portulaca oleracea* extracts on hypoxic nerve tissue and its mechanism. *Asia Pacific Journal of Clinical Nutrition.* 2007; 16(Suppl-1): 2007, 227-233.
26. Chawla A, Chawla R, Jaggi S. Microvascular and macrovascular complications in diabetes mellitus: distinct or continuum? *Indian J Endocrinol Metab.* 2019;81(4):546.



27. A. Villarruel-López , D. A. López-de la Moral , O. D. Vázquez-Paulino, A. G. Puebla-Mora, Ma R. Torres-Vitela, L. A. Guerrero-Quiroz, and K. Nuño. Effect of Moringa oleifera consumption on diabetic rats. *BMC Complementary and Alternative Medicine*. 2018; 18:127. <https://doi.org/10.1186/s12906-018-2180-2>.

Access this Article in Online	
	Website: <a href="http://www.ijcrims.com">www.ijcrims.com</a>
	Subject: Medicinal Plants
Quick Response Code	

How to cite this article:

Chindo Ishaya Ezekiel, Solomon Matthias Gamde, Debora Murna Jonathan, Emmanuel Ifeanyi Obeagu, Simon Peter Ariba, Amos Dangana. (2023). Antidiabetic and Cytotoxic Effect of Aqueous and Methanolic Leaf Extract of *Portulaca oleracae*. Int. J. Curr. Res. Med. Sci. 9(5): 22-30.

DOI: <http://dx.doi.org/10.22192/ijcrms.2023.09.05.XXX>