

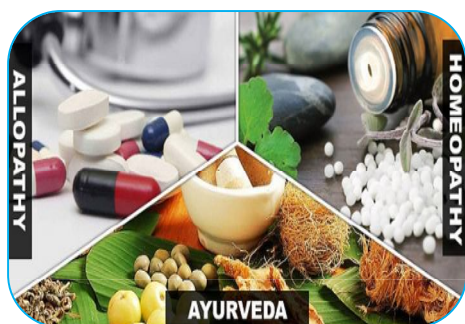


ISSN: 2249-894X  
IMPACT FACTOR : 5.7631 (UIF)  
UGC APPROVED JOURNAL NO. 48514  
VOLUME - 8 | ISSUE - 8 | MAY - 2019

## EFFECT OF ALLOPATHIC, AYURVEDIC AND HOMEOPATHIC DRUGS ON BIOCHEMISTRY OF ALLOXAN INDUCED DIABETIC ALBINO RAT

Pidiyar P. L. and Dr. V. T. Tantarapale

Post Graduate Department of Zoology, Vidya Bharati Mahavidyalaya, Amravati.



### ABSTRACT:

The presented investigation was the evaluation of Allopathic, Ayurvedic and Homeopathic drugs on biochemistry of Alloxan induced diabetic albino rat. The Allopathic Drug (Metformin) was 50 mg/kg/twice a day, Ayurvedic drug (Trigonella foenum extracts) was 50 mg/kg/ twice a day and Homeopathic Drug (Syzygium Jambolanum) was 50 µl/kg/ twice a day were administered. The diabetes was induced in rats by intraperitoneal administration of 50 mg/kg of body

weight of Alloxan for three days. On the 3<sup>rd</sup> day, animals with blood glucose levels of 250 mg/dl and above were considered for experimentation. The results were cleared that all the tested drugs observed to be effective in reducing the diabetic condition with improving biochemical profile in albino rats. Study cleared that the Ayurvedic Drug (Trigonella foenum) was found to be cheaper and promising than Homeopathic Drug (Syzygium Jambolanum) and Allopathic Drug (Metformin) in albino rat.

**KEYWORDS:** Allopathic, Ayurvedic, Homeopathic, Alloxan, diabetic albino rat.

### INTRODUCTION

Diabetes mellitus is generally known as diabetes. It is a metabolic issue that common in both created and creating nation, for example, India. It is portrayed by intermittent or tireless high glucose and easygoing plasma glucose in excess of 200 mg/dl. When all is said in done, there are three primary sorts of diabetes mellitus. The sort 1 results from the pancreas' inability to deliver enough insulin because of loss of beta cells thus this structure was recently alluded to as insulin-subordinate diabetes

mellitus or adolescent diabetes. The sort 2 starts with insulin opposition, a condition wherein cells neglect to react to insulin appropriately. As the sickness advances, an absence of insulin may likewise create. This structure was recently alluded to as non insulin-subordinate diabetes mellitus or grown-up beginning diabetes. The most well-known reason is a mix of intemperate body weight and inadequate exercise. The third kind is the gestational diabetes is the third fundamental structure, and happens when pregnant ladies without a past history of diabetes grow high glucose levels (Chiang *et al.*, 2014). Insulin is the key hormone that manages the take-up of glucose

from the blood into most cells of the body, particularly liver, fat tissue and muscle, with the exception of smooth muscle, wherein insulin acts by means of the IGF-1. In this way, insufficiency of insulin or the harshness of its receptors assumes a focal job in all types of diabetes mellitus. The body acquires glucose from three principle sources: the intestinal ingestion of sustenance; the breakdown of glycogen (glycogenolysis), the capacity type of glucose found in the liver; and gluconeogenesis, the age of glucose from non-starch substrates in the body. Insulin assumes a basic job in adjusting glucose levels in the body. Insulin can repress the breakdown of

glycogen or the procedure of gluconeogenesis, it can animate the vehicle of glucose into fat and muscle cells, and it can invigorate the capacity of glucose as glycogen (Shoback and Gardner, 2011).

Insulin is discharged into the blood by beta cells ( $\beta$ -cells), found in the islets of Langerhans in the pancreas, in light of rising degrees of blood glucose, ordinarily in the wake of eating. Insulin is utilized by around 66% of the body's cells to assimilate glucose from the blood for use as fuel, for change to other required atoms, or for capacity. Lower glucose levels result in diminished insulin discharge from the beta cells and in the breakdown of glycogen to glucose. This procedure is basically constrained by the hormone glucagon, which acts in the contrary way to insulin. On the off chance that the measure of insulin accessible is deficient, or if cells react ineffectively with the impacts of (insulin lack of care or insulin opposition), or on the off chance that the insulin itself is damaged, at that point glucose isn't assimilated appropriately by the body cells that require it, and isn't put away suitably in the liver and muscles. The net impact is constantly large amounts of blood glucose, poor protein combination, and other metabolic disturbances, for example, acidosis (Barrett, 2012).

At the point when glucose focus in the blood stays high after some time, the kidneys achieve a limit of re-ingestion, and the body discharges glucose in the pee that is glycosuria. This expands the osmotic weight of the pee and restrains re-ingestion of water by the kidney, bringing about expanded pee generation implies polyuria and expanded liquid misfortune. Lost blood volume is supplanted osmotically from water in body cells and other body compartments, causing lack of hydration and expanded thirst is polydipsia. Furthermore, intracellular glucose lack invigorates craving prompting over the top sustenance admission as polyphagia (Murray, 2012).

There is no known preventive measure for sort 1 diabetes. Type 2 diabetes records for 85 to 90% of all cases worldwide that can frequently be anticipated or deferred by keeping up a typical body weight, taking part in physical action, and eating a sound eating regimen. The best possible medicine is fundamental control the diabetic condition. A prescription is a medication used to analyze, fix, treat, or counteract ailment. The medication treatment implies pharmacotherapy is a significant piece of the therapeutic field and depends on the investigation of pharmacology for nonstop progression and on drug store for fitting administration. In India, allopathic, ayurvedic/unani and homeopathic practices are most basic in treatment of diabetes (Qato *et al.*, 2016).

Allopathic medication or allopathy is a derogatory term utilized by defenders of elective prescription to allude to present day logical frameworks of drug, for example, the utilization of pharmacologically dynamic operators or physical intercessions to treat or smother indications or pathophysiologic procedures of infections or conditions. The articulation was authored in 1810 by the maker of homeopathy, Samuel Hahnemann. Among homeopaths and other elective medication advocates, the articulation allopathic prescription is as yet used to allude to the general classification of restorative practice that is now and then called Western drug, biomedicine, proof based medication, or present day prescription (Roy, 2015). In allopathic treatment of diabetes, utilization of Metformin is extremely normal. It is taken by mouth (Malek *et al.*, 2013).

The metformin use during pregnancy contrasted with insulin alone discovered great momentary security for both the mother and child however vague long haul wellbeing. A few observational examinations and randomized, controlled preliminaries observed metformin to be as viable and sheltered as insulin for the administration of gestational diabetes. In any case, a few concerns have been raised and proof on the long haul security of metformin for both mother and kid is deficient. Contrasted and insulin, ladies with gestational diabetes treated with metformin put on less weight and are less inclined to create pre-eclampsia during pregnancy. Infants destined to ladies treated with metformin have less instinctive fat, and it has been recommended this may make them less inclined to insulin obstruction in later life (Alqudah *et al.*, 2018).

Ayurveda is an arrangement of medication with chronicled establishes in the Indian subcontinent. Globalized and modernized practices got from Ayurveda customs are a sort of elective medication. In nations past India, Ayurvedic treatments and practices have been incorporated when all is said in done health applications and now and again in medicinal use. Ayurveda treatments have differed and developed over two centuries. Treatments are normally founded on complex natural

mixes, minerals and metal substances. Plant-based treatment in Ayurveda is gotten from roots, leaves, natural products, bark, or seeds. The utilization of *Trigonella foenum - graecum* is thought to advance assimilation, instigate work and diminish glucose levels in diabetics (Sharma, 2018).

Homeopathy is an arrangement of elective prescription made in 1796 by Samuel Hahnemann, presently a day's, homeopathy is generally utilized in India. It is a sheltered, delicate, and characteristic arrangement of recuperating that works with your body to diminish side effects, reestablish itself, and improve your general wellbeing. It is incredibly sheltered to utilize, even with little youngsters and pets, has none of the reactions of numerous customary drugs is truly reasonable and produced using common substances (Frazier, 2018). In homeopathic treatment of diabetes, utilization of *Syzygium jambolanum* mother tincture is normal. This homeopathic cure is set up from the seeds of this plant. It helps in bringing down the glucose levels and pee sugar levels too it is powerful to treat foot ulcers in diabetics (Raza *et al.*, 2017).

These all allopathic, Ayurvedic and homeopathic treatments to cure the diabetes are effective and well trusted. But the record of comparative effectiveness of these therapies is not well documented. Hence, in this concern, the present investigation was an attempt to compare the effect of allopathic drug (Metformin), ayurvedic drug (*Trigonella foenum* extracts) and homeopathic drug (*Syzygium jambolanum*) on biochemistry of alloxan treated diabetic albino rat.

## MATERIALS AND METHODS

**Experimental animal:** The presented investigation was the evaluation Allopathic Ayurvedic, and Homeopathic drugs on Alloxan induced diabetic albino rat. The available albino rats of either sex weighing  $145 \pm 5$ g were used for this study. The animals were allowed to acclimatize in the research laboratory for 1 week before the commencement of the study. The animals had been maintained under standard conditions (room temperature  $25^\circ\text{C} \pm 3$ , humidity 35–60%, and light and dark period 12/12 h). All animals were fed with food and water up to satiation. The study protocols were duly approved by the Institutional Animal Ethics Committee. The study was performed in accordance with the Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA) guidelines (Ene *et al.*, 2008).

**Diabetes inducer:** Alloxan is a subsidiary of pyrimidine. It is a dangerous glucose simple which specifically decimates insulin-delivering beta cells in the pancreas when controlled to rodent. This causes an insulin-subordinate diabetes mellitus in rodent with qualities like sort 1 diabetes in people. Alloxan is specifically dangerous to insulin-delivering pancreatic beta cells since it specially aggregates in beta cells through take-up by means of the Glucose transporter 2 glucose transporter. Alloxan, within the sight of intracellular thiols, creates Reactive Oxygen Species in a cyclic response with its decrease item, dialuric corrosive. The beta cell harmful activity of alloxan is started by free radicals shaped in this redox response. The alloxan does not cause any diabetic impacts in people (Lenzen, 2008).

**Anti-diabetic drugs:** Metformin Tablet / powder is commonly used Allopathic Drug with a proper diet and exercise program and possibly with other medications to control high blood sugar. Ayurvedic Drug *Trigonella foenum* extract was prepared by maceration; 1000 g of powder was soaked in about 1000 ml of distilled water for 7 days. The extract was decanted and the remaining material was re-soaked in distilled water. Both the extracts were dried completely by using Rotary Vacuum Evaporator. Homeopathic Drug *Syzygium Jambolanum* Mother Tincture (SBL, Kolkata) is made from the extracts from the seeds of the Jambolinum plant.

**Conclusive Dose Safety Test:** For the experimental assay, the drugs were orally administrated (Kumar, 2011). Because of availability of limited animals, the dosages were finalized with intense literature survey and critical logic. The Allopathic Drug (Metformin) was 50 mg/kg/twice a day; Ayurvedic drug (*Trigonella foenum* extracts) was 50 mg/kg/ twice a day and Homeopathic Drug (*Syzygium Jambolanum*) was 50  $\mu\text{l/kg}$ / twice a day and were administrated. The doses were administrated twice a day by the intervals of 12 hours daily. No mortality was observed during the entire experiment. Animals were observed for the next 21 days. All the selected doses of had no toxic effect on the normal behavior of the rats.

**Induction Of Diabetes and Grouping :** The available albino rats of either sex weighing between 145±5 g were selected for the experimental trailer. At first, the blood of selected normal rats was analyzed for hematology and serum biochemistry. Then diabetes was induced in rats by intraperitoneal administration of 50 mg/kg of body weight of Alloxan for three days. On the 3<sup>rd</sup> day, animals with blood glucose levels of 250 mg/dl and above were considered for experimentation. The diabetic rats were conveniently divided into Groups I–III and treated with the following chart for 3 to 21 days.

The details of the groups are as given below –

Group	Code	Description	Dose
*	NDC	Non diabetic control albino rat	----
#	EDC	Experimental diabetic control rat (Alloxan)- .	50 mg/kg/day of BW
I	AYD	Ayurvedic Drug ( <i>Trigonella foenum</i> )	50 mg/kg/ twice a day
II	HPD	Homeopathic Drug ( <i>Syzygium Jambolanum</i> )	50 µl/kg/ twice a day
III	APD	Allopathic Drug (Metformin)	50 mg/kg/twice a day

**Biochemical Parameters:** After 21 days of treatment, a whole blood sample was collected from retro-orbital plexus under anesthesia. Blood collected in non-heparinized tubes were then centrifuged at 3000 r/min for 10 min. The parameters were estimated with the help of automated analyzer (Das *et al.*, 2015). The parameters estimated were Triglycerides, Cholesterol, Creatinine, Total protein, Albumen, Globulin, A/G ratio, SGOT, SGPT, Uric acid, Phosphorus, Sodium, and Blood Glucose.

**Statistical Analysis:** Data were collected, organized and analyzed using procedure of the Statistical Package for Social Sciences version 21.0 (SPSS for Windows 21.0, Inc., Chicago, IL, USA). Results were recorded as mean ± standard deviation (SD) of triplet.

## RESULT AND DISCUSSION

Diabetes mellitus is commonly known as diabetes. It is a metabolic disorder that prevalent in both developed and developing country such as India. It is characterized by recurrent or persistent high blood sugar and casual plasma glucose more than 200 mg/dl. The proper medication is necessary control the diabetic condition. A medication is a drug used to diagnose, cure, treat, or prevent disease. The drug therapy means pharmacotherapy is an important part of the medical field and relies on the science of pharmacology for continual advancement and on pharmacy for appropriate management. In India, allopathic, ayurvedic / unani and homeopathic practices are most common in treatment of diabetes for twenty one days.

During this assay, the Allopathic drug (Metformin) was 50 mg/kg/twice a day; Ayurvedic drug (*Trigonella foenum* extracts) was 50 mg/kg/ twice a day and Homeopathic Drug (*Syzygium Jambolanum*) was 50 µl/kg/ twice a day and were administrated to evaluate the effects on biochemistry of diabetic albino rat. For study, diabetes was induced in albino rats by intraperitoneal administration of 50 mg/kg of body weight of Alloxan for three days. On the 3<sup>rd</sup> day, animals with blood glucose levels of 250 mg/dl and above were considered for experimentation.

The effects of different drugs on biochemical parameters like Triglycerides, Cholesterol, Creatinine, Total protein, Albumen, Globulin, A/G ratio, SGOT, SGPT, Uric acid, Phosphorus, Sodium, and Blood Glucose were estimated. The estimations were based on the following principals suggested by Luxton and Pallister (2012).

The results of the present investigation clears that diabetes increased the serum Triglycerides, Cholesterol, Creatinine, A/G ratio, SGOT, SGPT, Uric acid, Phosphates and Blood Glucose level. The decreased in Total protein, Albumen, Globulin, Sodium were also observed in diabetic rat. In the biochemical estimations, it was remarkable that the level of Cholesterol, Creatinine, Total protein, Albumen, Globulin, A/G ratio, Uric acid, and Phosphates were excessively reduced in Allopathic Drug (Metformin) treated diabetic rat as compare to normal and Alloxan induced control diabetic rat. It can be consider as the side effects of allopathic treatment. These results cleared that Ayurvedic Drug



(*Trigonella foenum*) and Homeopathic Drug (*Syzygium Jambolanum*) were found to be more promising than and Allopathic Drug (Metformin) in treating the Alloxan induced diabetes rat.

These presented observations are in well agreement with comparisons between the earlier studies of Bulent (2009), Adikwu *et al.*, (2010), Abedulla *et al.*, (2011), Oluwole *et al.*, (2012), Bamidele *et al.*, (2013), Maiti *et al.*, (2013), Maiti *et al.*, (2014) Peddolla *et al.* (2014), Saleh *et al.*, (2015), Sharma *et al.*, (2015), Hasan and Mustafizur (2016), Manjeshwar *et al.* (2017), Sharma *et al.*, (2018), Mooventhana and Nivethitha (2019) and a name a few.

**Table 1: Effects of different drugs on Biochemical profile in control and experimental albino rat**

Sr.	Biochemistry	NDC	EDC	AYD	HPD	APD
1.	Triglycerides mg/dl	85.86	157.02	91.44	84.28	83.52
	±SD	1.71	2.80	1.92	2.46	1.53
2.	Cholesterol mg/dl	102.13	196.22	117.25	121.07	47.01
	±SD	6.92	7.40	5.60	3.43	4.07
3.	Creatinine mg/dl	0.65	2.63	0.87	0.83	0.41
	±SD	0.07	0.33	0.04	0.68	0.41
4.	Total protein g/dl	7.65	6.31	6.92	7.60	5.42
	±SD	0.39	0.18	0.20	0.82	0.24
5.	Albumen g/d	4.55	3.61	4.21	4.52	2.57
	±SD	0.22	0.33	0.25	0.17	0.15
6.	Globulin g/dl	3.12	2.09	2.70	3.17	2.89
	±SD	0.11	0.03	0.31	0.06	0.30
7.	A/G ratio	1.46	1.73	1.56	1.45	1.09
	±SD	0.08	0.05	0.18	0.11	0.06
8.	SGOT IU/L	32.74	74.88	38.64	29.45	42.88
	±SD	1.11	2.12	1.25	1.85	1.02
9.	SGPT IU/L	36.22	90.64	23.12	43.07	37.43
	±SD	1.25	2.23	1.61	2.05	0.26
10.	Uric acid mg/dl	3.80	7.95	2.72	4.21	6.42
	±SD	0.10	1.22	1.16	2.12	1.71
11.	Phosphorus mg/dl	3.94	7.10	2.91	3.40	2.74
	±SD	0.16	0.21	0.21	0.09	0.15
12.	Sodium mEq/L	148.67	118.01	125.24	122.09	121.12
	±SD	1.53	1.73	2.12	1.87	2.02
13.	Blood Glucose mg/d	86.50	262.15	119.53	195.04	117.71
	±SD	5.07	5.47	7.01	5.03	5.81
NDC – Non diabetic control rat		AYD - Ayurvedic Drug ( <i>Trigonella foenum</i> extracts) – 50 mg/kg/ twice a day				
EDC- Exp. diabetic control rat		HPD - Homeopathic Drug ( <i>Syzygium Jambolanum</i> ) – 50 µl/kg/ twice a day				
(Alloxan induced)		APD - Allopathic Drug ( <i>Metformin</i> ) – 50 mg/kg/twice a day				

## CONCLUSIONS AND RECOMMENDATIONS

In brief concluding the present investigations, it was cleared that the Allopathic Drug (Metformin), Ayurvedic drug (*Trigonella foenum*) and Homeopathic Drug (*Syzygium Jambolanum*) are commonly used to treat the diabetes. All these drugs were also observed to be effective in reducing the diabetic condition in albino rats. The finding clears the improvement to normalize the biochemical profile content after treatment with Allopathic Drug (Metformin), Ayurvedic drug (*Trigonella foenum*) and Homeopathic Drug (*Syzygium Jambolanum*) in diabetic rat.

The present investigation provided the evidences that lend credence to the safety and efficacy of Ayurvedic drug (*Trigonella foenum*) followed by Homeopathic Drug (*Syzygium Jambolanum*). Hence the use of Ayurvedic drug (*Trigonella foenum*) followed by Homeopathic Drug (*Syzygium Jambolanum*) is recommended instead of Allopathic Drug (Metformin) in treatment of diabetes to avoid the side effects.

## REFERENCES

- Abedulla K., Satyanarayana S., Eswar K., Anupama K. (2011).** Pharmacodynamic drug interaction of mexiletine with metformin in rats. *RJPBCS*.3(3): 905-999.
- Adikwu M., Uzuegbu D., Okoye T., Uzor P., Adibe M., Amadi B. (2010).** Antidiabetic effect of combined aqueous leaf extract of *Vernonia amygdalina* and metformin in rats. *J. Basic Clin. Pharma*.1(3): 197-202
- Alqudah A., McKinley M., McNally R., Graham U., Watson C., Lyons T., McClements L. (2018).** Risk of pre-eclampsia in women taking metformin: a systematic review and meta-analysis. *Diabet. Med.* 35 (2): 160-172.
- Bamidele O., Arokoyo D. S., Akinnuga A. M., Oluwarole A. O. (2013).** Antidiabetic effect of aqueous extract of *Basella alba* leaves and metformin in alloxan-induced diabetic albino rats. *Afr. J. Biotechnol.* 13(24): 2455-2458.
- Barrett K. E. (2012).** Ganong's review of medical physiology (24th ed.). McGraw-Hill Medical. ISBN 978-0-07-178003-2.
- Bulent Y. (2009).** Metformin and atorvastatin reduce adhesion formation in a rat uterine horn model. *Reproductive BioMedicine*, 18(3):436-442.
- Chiang J. L., Kirkman M. S., Laffel L. M., Peters A. L. (2014).** Type 1 Diabetes Through the Life Span: A Position Statement of the American Diabetes Association. *Diabetes Care*. 37 (7): 2034-2054.
- Das N., Goshwami D., Hasan M., Sharif R., Zahir S. (2015).** Evaluation of acute and subacute toxicity induced by methanol extract of *Terminalia citrina* leaves in Sprague Dawley rats. *J. Acut. Dis.* 4: 316-321.
- Ene A. C., Nwankwo E. A., Samdi L.M. (2008).** Alloxan-Induced Diabetes in Rats and the Effects of Black Caraway (*Carum carvi* L.) Oil on Their Body Weights. *J. Pharma. Toxicol.* 3(2):141-146.
- Frazier K. (2018).** Homeopathy Challenge: German Skeptics Offer 50,000 Euros If Test Is Passed. *Skeptical Inquirer*. 42 (5): 5-6.
- Hasan M., Mustafizur R. (2016).** Effect of Fenugreek on Type2 diabetic patients. *International Journal of Scientific and Research Publications*, 6(1): 251-256.
- Kumar M. (2011).** Hepatoprotective activity of *Sesamum indicum* Linn. against Ccl4-induced hepatic damage in rats. *Int. J. Pharm. Biol. Arch.* 2:710-715.
- Lenzen S. (2008).** The Mechanisms of Alloxan- and Streptozotocin-induced Diabetes. *Diabetologia*. 51 (2): 216-226.
- Luxton R., Pallister C. (2012).** Clinical Biochemistry. 4<sup>th</sup> ed., Bristol, UK, 264 pp.
- Maiti S, Bera T., Chatterjee C, Ghosh D. (2014).** A study of the effect of mother tincture of *Syzygium jambolanum* on metabolic disorders of Streptozotocin induced diabetic male albino rat. *Indian Journal of Research in Homoeopathy*, 8(3): 129-135.
- Maiti S., Kazi M., Jana K., Chatterjee K., De D., Ghosh D. (2013).** Ameliorating effect of mother tincture of *Syzygium jambolanum* on carbohydrate and lipid metabolic disorders in streptozotocin-induced diabetic rat: Homeopathic remedy. *Journal of Natural Science, Biology and Medicine*. 4(1): 68-73

- Malek M., Aghili R., Emami Z., Khamseh M. (2013).** Risk of cancer in diabetes: the effect of metformin. *ISRN Endocrinology*. 13: 1-9.
- Manjeshwar S. B., Princy L. P., Mohammed A., Taresh S. N., Kamble P. S. Thomas G., Jason J. D. (2017).** Anti-Diabetic Effects of Leaves of *Trigonella foenum graecum* L. (Fenugreek): Leads from Preclinical Studies. *J. Food Chem. Nanotech.* 39:67-71.
- Mooventhana A., Nivethitha L. (2019).** A Narrative Review on Evidence-based Antidiabetic Effect of Fenugreek (*Trigonella Foenum-Graecum*). *International Journal of Nutrition, Pharmacology, Neurological Diseases*, 7(4): 84-87.
- Murray R. K. (2012).** Harper's illustrated biochemistry (29<sup>th</sup> ed.). McGraw-Hill Medical. ISBN 978-0-07-176576-3.
- Oluwale A., Michael G., Abdul-Azeez S., Felix O. (2012).** Treatment of Alloxan-Induced Diabetic Rats with Metformin or Glitazones is Associated with Amelioration of Hyperglycaemia and Neuroprotection. *The Open Diabetes Journal*, 12(5): 8-12.
- Peddolla R., Rondi S. Venisetty R. (2014).** Cardio, Neuro And Renoprotective Activities of Atorvastatin in Streptozotocin-Induced Type2 Diabetic Rats Undergoing Treatment with Metformin and Glimepiride. *RJPBCS*, 5(1): 545-556.
- Qato D. M., Wilder J., Schumm L., Gillet V., Alexander G. (2016).** Changes in prescription and over-the-counter medication and dietary supplement use among older adults in the united states, 2005 vs 2011. *JAMA Internal Medicine*. 176 (4): 473-482.
- Raza, A., Butt S., Iahitsham H., Suleria A., Ansar R. (2017).** Jamun (*Syzygium cumini*) seed and fruit extract attenuate hyperglycemia in diabetic rats. *Asian Pacific Journal of Tropical Biomedicine*. 7(8): 750-754.
- Saleh A., Mohamed A., Ahmed E. (2015).** Anti-hyperglycemic activity of selenium nanoparticles in streptozotocin-induced diabetic rats. *International Journal of Nanomedicine*, 10: 6741-6756
- Sharma S., Jayant S., Mishra V., Srivastava N. (2018).** Antihyperglycemic effects of *Trigonella foenum-graecum* seeds and *Cinnamomum zeylanicum* bark on key enzymes of carbohydrate metabolism in tissues of rats with experimental diabetes. *Integrative Obesity and Diabetes*, 4(3):1-8.
- Sharma S., Mishra V., Jayant S., Srivastava N. (2015).** Effect of *Trigonella foenum graecum* on the activities of antioxidant enzyme and their expression in tissues of alloxan-induced diabetic rats. *Journal of Evidence-Based Complementary & Alternative Medicine*. 20(3): 203-211
- Sharma S., Mishra V., Jayant S., Srivastava N. (2015).** Effect of *Trigonella foenum graecum* on the activities of antioxidant enzyme and their expression in tissues of alloxan-induced diabetic rats. *Journal of Evidence-Based Complementary & Alternative Medicine*. 20(3): 203-211
- Shoback D. G., Gardner D. (2011).** Greenspan's basic & clinical endocrinology (9<sup>th</sup> ed.). McGraw-Hill Medical. ISBN 978-0-07-162243-1.
- Zar J.H. (1999).** *Biostatistical Analysis*. 4<sup>th</sup> Edition, Prentice Hall, Upper Saddle River. 345 pp.



**Pidiyar P. L.**

**Post Graduate Department of Zoology, Vidya Bharati Mahavidyalaya, Amravati.**