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EVALUATION OF ANTI-DIABETIC POTENTIAL OF *IPOMOEA STAPHYLINA* LEAVES AGAINST THE STREPTOZOTOCIN INDUCED DIABETES IN EXPERIMENTAL RATS

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ABSTRACT

Background: The diabetes mellitus is a severe multifaceted chronic disease that is distinguished by the hyperglycemia and annoyances of metabolisms and absolute or partial deficiency of the insulin. Presently, there are almost 150 million diabetes cases were accounted and this may relatively increase to nearly 300 million or even more by the year 2025. **Objective:** The current research work was aimed to examine the anti-diabetic potential of ethanol extract of *Ipomoea staphylina* against the Streptozotocin induced diabetes in experimental rats. **Methodology:** The diabetes was induced to the rats by injecting the 55mg/kg of streptozotocin by intra peritoneal route. The liver function marker enzymes like aspartate aminotransferase (AST), alanine aminotransferase (ALT), and alkaline phosphatase (ALP) was estimated by using the standard methods. The total protein, urea content, creatinine, uric acid level, cholesterol, triglycerides, free fatty acids and the phospholipids were studied. The levels lipoproteins were also measured in the experimental animals. **Results:** The ethanol extract of *Ipomoea staphylina* leaves was showed the noticeable reduction in the ALT, AST and ALP in the serum of diabetic induced rats. The extract treatment also reduced the urea, uric acid and creatinine levels. The decreased levels

of cholesterol, triglycerides, fatty acids and phospholipids were noted in the extract treatment. **Conclusion:** In conclusion, our overall findings from this research work were proved the anti-diabetic potential of *Ipomoea staphylina* leaves against the Streptozotocin induced diabetes in experimental rats. These results were proved the anti-diabetic potential of *Ipomoea staphylina* and proposed that it may be useful for the development of novel anti-diabetic agents.

Keywords: Diabetes, *Ipomoea staphylina*, liver enzymes, phospholipids, glucose and Glibenclamide

INTRODUCTION

The diabetes mellitus is a severe multifaceted chronic condition that is a prime reason of health illness worldwide. The metabolic disorder is distinguished by the hyperglycemia and annoyances of carbohydrate, fat and protein metabolisms and secondary to an absolute or partial deficiency of the insulin. In addition, the clinical condition of hyperglycemia was linked to many other clinical complications that often end with morbidity and in many cases death **[1]**. As mentioned by the World Health Organization (WHO), the incidences of diabetes are relatively to escalate to almost 35% worldwide. Presently, there are almost 150 million diabetes cases were accounted and this may relatively increase to nearly 300 million or even more by the year 2025. The preceding statistical reports are highlighted that the total numbers of diabetes will increase to nearly 57 million cases in 2025, which is previously reported as only 15 million in 1995. This may be the highest incidences of diabetes worldwide. The inactive lifestyles, intake of calorie rich foods, obesity, and lack of daily physical activities are as the prime reasons for these increased incidences of diabetes. The prevalence of diabetes is considerably up lifted in the Asian and African countries, where the diabetes cases are recorded in two or three fold augmentation **[2]**.

The name diabetes mellitus is given to the group of disorders with different prevalence. It is distinguished via the disarrangements in fat, carbohydrates, and protein metabolisms caused by the whole or partial deficiency of the insulin hormone secretion production or the lack of insulin functions **[3]**. The diabetes is the most recurring and continually progressing common chronic ailments worldwide. It is the multifaceted ailments that drastically affect the life quality of the individuals. The statistical reports given by the WHO displayed that the India has the huge number

of diabetic patients in the world. The medical condition of hyperglycemia can be handled initially via the oral synthetic agents and insulin therapy. The level of toxicity of the orally supplementing medications to the diabetes may vary generally that based on clinical signs, disease severity, and the treatment approaches. The long-standing diabetes is an imperative reason for the development and progression of micro and macro vascular complications that includes the cerebrovascular diseases, neurological ailments, nephrological diseases and cardiovascular complications **[4, 5]**.

There are numerous drugs were utilized to control the diabetes mellitus, though, the achievement of perfect glucose control in the blood is very poor. In addition, the herbal plants were extensively utilized as an alternative approach for the treatment of diabetes. The preceding findings also highlighted the antidiabetic potentials of various medicinal plants in animal models.

The numerous drugs like Sulfonylurea, Biguanides, and Thiazolidenediones are the primarily utilized to control the hyperglycemia in diabetes, but in other hands, these drugs are often reported with the deleterious side effects. Consequently, the exploration of medicinal plants for the development of most potent along with none side effects possessing antidiabetic agents was emerged. The medicinal plants may provide the novel and potent therapeutic agents to the treatment of diabetes and these compounds may utilization as an oral medication or dietary supplements that is regarded as the alternative approach to the presently existing therapies **[6]**.

The exploration of plant sources and their derivatives for the identification of novel bio active compounds to treat the diabetes mellitus is of emerging as they having immense bioactive phytocompounds with the countless pharmacological benefits. In this recent decade it was tested and recognized many phytocompounds with the antidiabetic potentials of traditionally utilized Indian conventional medicinal plants. Though, a huge number of herbal plants are previously investigated for their antidiabetic potential and these actions remain to be further examined in numerous Indian herbal plants. The plant *Ipomoea staphylina* is the traditional medicinal plant that is extensively utilized to treat numerous diseases in India. The *Ipomoea staphylina* plant has possessed the immense biological activities like analgesic **[7]**, anti-inflammatory **[8]**, anti-diarrheal, and gastroprotective properties **[9]**. The *Ipomoea staphylina* plant is used as a purgative, dyspepsia, anthelmintic, bronchitis

and respiratory disorders **[10, 11]**. However, there are no any scientific evidences to claim the anti-diabetic potential of *Ipomoea staphylina* leaves. Consequently, the current research work was designed to evaluate the anti-diabetic potential of *Ipomoea staphylina* against the Streptozotocin induced diabetes in experimental rats.

MATERIALS AND METHODS

Chemicals

Streptozotocin, Glibenclamide, and ethanol were obtained from the Sigma Chemical Co., St. Louis, USA. All the ELISA test kits were acquired from the Santacruz Biotechnology, USA. All the additional chemicals were utilized by the analytical standard.

Collection of *Ipomoea staphylina* leaf and extract preparation

The fresh and insects bite free leaves of *Ipomoea staphylina* was collected from the Kolli Hills, Namakkal district, Tamilnadu, India. The collected leaves were cleaned thoroughly and dried in shade and coarsely powdered with the aid of mechanical grinder and the resulted powder was used for the extraction. The 20g of leaf powder was suspended in a 200ml of ethanol and then kept for 24hrs under the vocational shaking. After that, the suspension was filtered by using Whatmann No.1 filter paper. Finally the resulted extract was used for the experimentations.

Experimental animals

The adult wistar albino rats (160-200g) of either sex were purchased from the Institutional Animal House, Muthayammal Centre for Advance Research, Rasipuram, Namakkal, Tamilnadu, India. All animals were acclimatized for one week prior to the experiments in a standard laboratory condition with 12hr dark and light cycles, 60% humidity and at a temperature of 25±3°C. The rats were housed in sterile plastic cages and fed *ad libitum* with sterile standard rat food pellets, reverse osmosis water. The animal handling and experiments were followed according to the Animal ethical guidelines. All the experimental animals were provided with pathogen free standard pellet diet and water *ad libitum* throughout the research study.

Experimental design

The diabetic induced animals were arbitrarily divided into Four groups along with six animals in each group. The group-I animals were administered with the standard pellet diet and for experimentation; the 5ml/kg of normal saline was administered. The group-II animals were received the intra peritoneal injection of 55mg/kg of Streptozotocin and regarded as the diabetic

control animals. The group-III animals were treated with the 200mg/kg of extract of *Ipomoea staphylina* leaves. The group-IV animals were received the standard drug Glibenclamide. After the completion of experimental regimen, all animals were anesthetized via chloroform administration and sacrificed through cervical displacement. Finally, the blood and liver samples were collected and used for the further biochemical estimations.

Analysis of liver function markers

Estimation of aspartate aminotransaminase (AST) enzyme level

The aspartate aminotransferase enzyme was assayed based on the method of **[12]**. The 1ml of buffered substrate for AST was added to the 0.1ml liver tissue homogenate and then incubated for 1hr at 37˚C. The 0.1ml of distilled water was used as a blank. After the incubation, the 1ml of Dinitrophenylhydrazine (DNPH) reagent was added to inhibit the AST enzyme in the reaction solution. The reaction tubes were kept for 15min, and then the 10ml of 0.4N of NaOH was added and finally, the absorbance was measured at 520nm. The enzyme activity was expressed as micromole of pyruvate liberated/hour/mg protein for liver homogenate.

Estimation of alanine aminotransaminase (ALT) enzyme level

The alanine aminotransferase enzyme was assayed by the method of **[12]**. The 0.2ml of liver tissue homogenate was added to the 1ml of buffered substrate and incubated for 30mins at 37^{o}C. After the incubation, the 1ml of DNPH was added to the reaction tubes to inhibit the reaction and kept at room temperature for 20minutes. Then 10ml of 0.4N NaOH was added and the absorbance was measured at 520nm. The enzyme activity was expressed as µmoles of pyruvate liberated per litre in tissue.

Estimation of alkaline phosphatase

The alkaline phosphatase enzyme was estimated using the diagnostic kit based on the method of **[13]**. The 4ml of buffered substrate was added to the 0.2ml of liver tissue homogenate and then incubated for 15mins at room temperature. After the incubation the 1.8ml of diluted phenol reagent was added to the reaction mixture. Then the reaction solution was centrifuged at 6000rpm for 5mins and the 4ml of resulting supernatant was taken and added to the 2ml of sodium carbonate and incubated at 37˚C for 15mins. Finally, the developed colour was measured at 510nm. The enzyme activity was expressed as µmoles of phenol per litre in tissues.

Estimation of total protein

The total protein was determined according to the procedure which is described by **[14]**. The 0.5ml of serum was mixed to the 1ml of 5% trichloroacetic acid, and incubated for 30mins at room temperature. After that, the reaction mixture was centrifuged at 6000rpm from 6mins. The precipitated protein in the form of pellet was dissolved in the 1N NaOH and made up to 10ml. The 1ml of this sample was treated with the 0.5ml of Folin–Ciocalteu's reagent and incubated for 30mins at room temperature. After the 30min incubation, the intensity of the developed blue colour was measured at 620nm against a reagent blank. Protein content of serum sample was determined from a standard curve. Standard curve was prepared using bovine serum albumin prepared at a stock concentration of 1mg/ml and diluted to obtain serial dilutions at 50, 100, 150, 200 and 250µg/ml.

Estimation of urea

The 20µl of the serum was 200µl of urease–buffer solution and incubated from the 15mins at 37°C and then 5ml of phenol nitroprusside solution was added. After that the 5ml of the hypochlorite reagent was added and heated at the water bath at 39°C for 15mins and finally, absorbance was measured against the blank at 600nm. For reagent blank, 20µl of distilled water was added to 200µl of urease buffer. Urea content in the sample was calculated by using the following formula; **urea level = absorbance of sample/absorbance of standard × 100.**

Estimation of creatinine

The 1ml of buffered substrate solution was added to the 100µl of the serum and incubation was observed carefully. The initial absorbance (A_0) was measured after the 30 seconds of adding the test solution. The second absorbance (A1) was measured for test and standard at exactly after the 60 seconds of adding test and standard solutions to the working solution. Finally, the creatinine content in serum was determined.

Estimation of uric acid

The 1ml of buffered substrate reagent was added to the 25µl of serum and mixed thoroughly by inverting the tube. The 25µl of standard and 25µl of distilled water (blank) also processed simultaneously. The reaction tubes were incubated at 37˚C for 5mins and the developed color was measured at 510nm. The values were expressed as mg/dL of serum.

Lipid profile analysis

The lipid profiles in the serum of experimental animals were investigated with the help of following methods. The level of cholesterol was estimated by the enzymic

method described by **[15]**. Triglycerides were estimated using the diagnostic kit based on the enzymic method described by **McGowan *et al.*, (1983) [16]**. Free fatty acids were estimated by the method of **Falholt *et al.*, (1973) [17]**. Phospholipids were estimated by the method of **Zilversmit and Davis (1950) [18]** in the serum of both control and experimental animals were analyzed.

Estimation of phospholipids level in the serum of experimental animals

The serum phospholipids levels of both control and experimental animals were investigated through the commercially procured assay kits. The levels of high density lipoprotein (HDL), low density lipoproteins (LDL) and the very low density lipoproteins (VLDL) in the serum of both control and experimental animals were examined through the commercial assay kits.

Statistical analysis

The data were represented as mean±SD. Statistical analysis was employed in SPSS statistical software using ANOVA followed by Tukey's test as a post hoc analysis. The differences were measured as significant at p less than $p<0.05$.

RESULTS

Effect of ethanol extract of *Ipomoea staphylina* on serum AST, ALT and ALP level in control and experimental animals

The level of liver function marker enzymes i.e. alanine transaminase (ALT), aspartate transaminase (AST) and alkaline phosphatase (ALP) was drastically increased in the serum of experimental animals. Interestingly, the treatment with the ethanol extract of *Ipomoea staphylina* leaves was showed the noticeable reduction in the ALT, AST and ALP in the serum of diabetic induced experimental animals. The ethanol extract of *Ipomoea staphylina* treated rats showed the significant ($p<0.05$) reduction in the liver function marker enzymes i.e. ALT, AST and ALP in the serum of experimental animals **(Table 1)**. Similarly, the standard drug Glibenclamide treated animals were also showed the significant reduction in the liver function marker enzymes.

Effect of ethanol extract of *Ipomoea staphylina* on total protein, creatinine, uric acid and urea in the serum of control and experimental animals

As mentioned in the **Table 2**, the levels of urea, uric acid and creatinine was drastically increased and the total protein level was decreased in the serum of diabetes induced experimental animals when compared to the control. The treatment with the ethanol extract of *Ipomoea staphylina* leaves was appreciably decreased the urea, uric acid and creatinine levels and improved

the total protein level when compared to the diabetic induced experimental animals **(Table 2)**. There are no any significant differences between the standard drug Glibenclamide and ethanol extract of *Ipomoea staphylina* leaves treated experimental animals.

Effect of *Ipomoea staphylina* on cholesterol, triglycerides, free fatty acids and phospholipids level in the serum of control and experimental rats

The diabetic induced experimental rats displayed the remarkable increase in the cholesterol, triglycerides, fatty acids and phospholipids levels in the serum when compared to the control group. Fascinatingly, the ethanol extract of *Ipomoea staphylina* leaves treated animals were showed the appreciable decrease in the cholesterol, triglycerides, fatty acids and the phospholipids levels in the serum of experimental animals **(Table 3)**. The plant extract treatment to the diabetic induced rats significantly decreased the levels of cholesterol, triglycerides, fatty acids and the phospholipids. There are no any significant changes between the standard drug Glibenclamide and the ethanol extract of *Ipomoea staphylina* leaves treated animals.

Effect of *Ipomoea staphylina* on plasma lipoproteins in normal and diabetic rats

The **Table 4** revealed that the levels of LDL-C and VLDL-C were severely increased and the HDL-C level was drastically decreased in the serum of diabetes induced experimental animals when compared to the control. Conversely, the treatment with the ethanol extract of *Ipomoea staphylina* leaves was noticeably decreased the LDL-C and VLDL-C levels and escalated the HDL-C level in the serum when compared to the diabetic animals **(Table 4)**. The treatment with the standard drug Glibenclamide and ethanol extract of *Ipomoea staphylina* leaves were showed the similar kind of results.

Table 1: Effect of ethanol extract of *Ipomoea staphylina* on serum AST, ALT and ALP level in control and experimental animals

Groups	AST	ALT	ALP
Group-I (Control)	80.24 ± 0.51	20.16 ± 0.97	72.25 ± 0.51
Group-II (Diabetic control)	112.26±2.81 [a*]	45.57± 1.24 [a*]	11.27 ± 1.63 [b*]
Group-III (Diabetic + 200mg ISEE)	84.13 ± 0.29 [b*]	21.67 ± 0.71 [b*]	73.41 ± 0.68 [b*]
Group-IV (Diabetic + Glibenclamide)	81.86±1.94 [b*]	19.98 ± 0.23 [b*]	72.51 ± 0.84 [b*]

Values are represented as mean±SD for all groups with 6 rats in each. Statistical significance was determined by one-way ANOVA followed by Tukey's post hoc test; where [a*]p<0.05 when compared with vehicle control group, [b*]p<0.05 when compared with diabetes induced group

Table 2: Effect of ethanol extract of *Ipomoea staphylina* on total protein, creatinine, uric acid and urea in the control and experimental animals

Groups	Total protein(g/dl)	Blood urea(mg/dl)	Serum Creatinine (mg /dl)	Serum Uric Acid (mg /dl)
Group-I (Control)	8.14 ± 0.28	20.12 ± 0.50	0.51 ± 0.02	2.25 ± 0.01
Group-II (Diabetic control)	4.49 ± 0.2 [a*]	42.11 ± 0.51[a*]	1.18 ± 0.04[a*]	5.50 ± 0.10 [a*]
Group-III (Diabetic + 200mg ISEE)	7.76 ± 0.11[b*]	24.82 ± 0.43[b*]	0.56 ± 0.02[b*]	2.79 ± 0.02[b*]
Group-IV (Diabetic + Glibenclamide)	8.10 ± 0.14[b*]	21.90 ± 0.71[b*]	0.52 ± 0.04[b*]	2.38 ± 0.06[b*]

Values are represented as mean±SD for all groups with 6 rats in each. Statistical significance was determined by one-way ANOVA followed by Tukey's post hoc test; where [a*]p<0.05 when compared with vehicle control group, [b*]p<0.05 when compared with diabetes induced group

Table 3: Effect of *Ipomoea staphylina* on cholesterol, triglycerides, free fatty acids and phospholipids level in the serum of control and experimental rats

Groups	Cholesterol	Triglycerides	Free fatty Acids	Phospholipids
	(mg/dl)			
Group-I (Control)	81.4 ± 6.3	20.6 ± 1.6	61.3 ± 4.9	97.6 ± 8.3
Group-II (Diabetic control)	217.3 ± 15.3[a*]	32.9 ± 2.6[a*]	146.6 ± 12.3[a*]	193.6 ± 16.2[a*]
Group-III (Diabetic + 200mg ISEE)	112.6± 8.3[b*]	24.6± 1.95 [b*]	88.4 ± 7.6[b*]	143.19 ± 10.5[b*]
Group-IV (Diabetic + Glibenclamide)	80.0 ± 5.12[b*]	20.2 ± 1.3[b*]	60.94 ± 5.41[b*]	97.5 ± 8.37[b*]

Values are represented as mean±SD for all groups with 6 rats in each. Statistical significance was determined by one-way ANOVA followed by Tukey's post hoc test; where [a*]p<0.05 when compared with vehicle control group, [b*]p<0.05 when compared with diabetes induced group

Table 4: Effect of *Ipomoea staphylina* on plasma lipoproteins in normal and diabetic rats

Groups	HDL-C	LDL-C	VLDL-C
	(mg/dl)		
Group-I (Control)	25.0 ± 1.59	53.4 ± 4.1	4.5 ± 0.21
Group-II (Diabetic control)	15.1 ± 1.2[a*]	196.3 ± 13.9 [a*]	6.5 ± 0.3 [a*]
Group-III (Diabetic + 200mg ISEE)	20.6 ± 1.5[b*]	84.2 ± 6.4 [b*]	5.41 ± 0.4 [b*]
Group-IV (Diabetic + Glibenclamide)	21.9 ± 1.4[b*]	51.4 ± 4.1 [b*]	4.1 ± 0.3 [b*]

Values are represented as mean±SD for all groups with 6 rats in each. Statistical significance was determined by one-way ANOVA followed by Tukey's post hoc test; where [a*]p<0.05 when compared with vehicle control group, [b*]p<0.05 when compared with diabetes induced group

DISCUSSION

The diabetes mellitus is chronic ailments that is linked with the numerous other health complications like keto acidosis, kidney failure, hyperosmolar coma, cardiovascular complications, eye damage, and diabetic foot ulcer. The ailing conditions were developed by the abnormalities in the secretion of insulin and the carbohydrate metabolism and it further leads to the elevated blood sugar level along with symptoms like excessive thirst, excessive appetite, glycosuria and polyuria **[19]**. The peoples are practicing conventional medicinal procedures and extensively used the herbal plants for the treatment of

countless diseases since time immemorial, whenever there were no any modern drugs and none knowledge on the cellular and molecular mechanisms of the human body **[20]**. Nonetheless, the herbal plants was used in the treatment of diabetes mellitus from ancient times, but their acceptance and utilizations in the modern medicine still needs time **[21]**. Though, this alternative reliable medicine is very much attractive for peoples who directly depend on them for their primary health care needs **[22, 23]**. There are huge number of preceding research findings that have highlighted the anti-diabetic potentials of herbal plants that leading to an increase as the number of people who use these natural compounds to control their disease **[24]**. Before the invention of insulin and blood glucose lowering drugs, the medicinal herbs were extensively utilized for the treatment of diabetes mellitus and its related health complications. According to ethnobotanical data, there are more than 1500 medicinal plants have been shown to possess anti-diabetic activities **[25, 26]**.

Based on the world level ethnobotanical survey results, there are nearly 900 herbal plants were displayed the anti-diabetic potential. The hypoglycaemic modulators from the natural herbal products were receiving much attention owing to their very minimal side effects. The utilization of phytochemicals may delay the progression of diabetic complications and may alleviate the metabolic abnormalities via numerous mechanisms. The wide variety of herbal plants can be used as potential sources of novel drugs as a alternate to the existing oral hypoglycaemic agents **[27-28]**. In this current investigation, the lipid profile of the diabetic induced rats were displayed the abnormal levels. These abnormal levels of lipid profiles were often seen in the diabetic patients. The triglycerides, cholesterol and LDL and VLDL cholesterol levels were drastically increased in the diabetic induced animals when compared to the control rats that owing to the action of lipase, whose activity is exacerbated in individuals with reduced glucose utilization. The Streptozotocin-induced experimental diabetic animals were often displayed the reduced insulin levels, elevated triglycerides, and total cholesterol levels, which is agreeing our findings from this research work. The treatment with the ethanol extract of *Ipomoea staphylina* leaves to the diabetic induced rats were showed the significant reduction in the lipid profiles i.e. total cholesterol, triglycerides, LDL and VLDL. Our findings showed the decreased cholesterol levels in the extract treated group

that indicates the metabolic alterations in the liver as a result of the treatment.

The utilization of natural plant based medicines is a common practice in various countries, especially in Asian countries like India and China. The presently existing drugs for the treatment of diabetes mellitus were linked with the various deleterious side effects, consequently, there is a urgent requirement for the exploration of potent and side effects less novel anti-diabetic drugs. The disease condition of diabetes mellitus of long time period is linked with the numerous other health consequences like atherosclerosis, myocardial infarction, and nephropathy. These complications have long been assumed to be related to chronically elevated glucose level in the blood. The diabetes mellitus is often leads to the hyperosmolarity and reduction of intracellular water content. It was also causes the negative energy balance and improved appetite to the diabetic patients. The elevated blood glucose level was enters into the kidneys as well as increasing an osmotic diuresis that directly leading to polyuria. The streptozotocin induced diabetes is distinguished via the severe loss of bodyweight of experimental animals. The Glibenclamide is often used as a standard antidiabetic drug against the streptozotocin induced diabetes mellitus when compared with a variety of hypoglycemic compounds and its potentials **[30]**.

The liver and kidney are the vital organs in our body that primarily involved in almost every biochemical mechanisms. As resulted in this research work, elevated levels of AST, ALT and ALP in the diabetes induced experimental animals when compared to the control may associated with the dysfunction of hepatic tissues, like cell necrosis of many tissues, and may be because of the leakage of these marker enzymes and deterioration of functional integrity of cell membrane of the liver **[31]**. The noticeable reduction in the level of liver function marker enzymes, particularly with the 200mg/kg of ethanol extract of *Ipomoea staphylina* leaves, may be an indication that this dose is the best and safest dose to use when administering this extract for the treatment of diabetes, and that ethanol extract of *Ipomoea staphylina* leaves may be used to exert a protective effect to thwart the liver damage caused by the diabetes mellitus. The level of serum total protein in the experimental animals is an indication of the total amount of albumin and globulin proteins. The drastic reduction in the status of total protein levels of diabetes induced experimental animals were appreciably regained by the treatment along

with the 200mg/kg of ethanol extract of *Ipomoea staphylina* leaves.

The levels of creatinine, uric acid and urea in the serum of experimental animals are the nitrogenous end products of metabolism that indicates the glomerular filtration rate. The creatinine is generated after the pyrophosphate cleavage of phosphocreatine to produce the energy for muscle activity **[32]**. Urea is generated from the oxidative deamination of amino acids in which the ammonia produced is transported to the liver for the formation of urea through the urea cycle. The elevated level of creatinine and urea in the diabetes induced animals when compared to the control is an distinct indication of renal dysfuntion and metabolic disturbance that is stimulated by the streptozotocin **[33]**. The appreciable reduction in the levels of urea, uric acid and creatinine, particularly after the treatments with the 200mg/kg of ethanol extract of Ipomoea staphylina leaves were noted.

The resistant to the hormone insulin that is the declined response of target tissues like the skeletal muscle, liver, and adipocytes to insulin, plays a vital function in the pathogenesis and progression of Type-II diabetes mellitus. The skeletal muscle is the prime site of insulin regulated glucose utilization in the postprandial phase. The normal glucose homeostasis relies on the well balanced communication between the tissues like muscle, liver and fat sensitivity to insulin and insulin secretion **[34]**. The diabetes mellitus can be treated through the decreasing post prandial hyperglycaemia. The intestinal digestive enzyme α-amylase is the carbohydrate hydrolyzing enzyme. The α-amylase inhibitors prevent the breakdown of polysaccharide to the mono and disaccharides. Thus the α-amylase inhibitors can prevent the postprandial hyperglycaemia via inhibiting the glucose deliverance from the starch and delaying the carbohydrate metabolism **[35]**. The findings from this current research work are evidently proved that the ethanol extract of *Ipomoea staphylina* leaves were amazingly reduced all the drastic alterations that is induced by the streptozotocin induction. The 200mg/kg of ethanol extract of *Ipomoea staphylina* leaves was appreciably ameliorated the streptozotocin induced diabetes in the experimental animals.

CONCLUSION

In conclusion, our overall findings from this research work were proved the anti-diabetic potential of *Ipomoea staphylina* leaves against the Streptozotocin induced diabetes in experimental rats. The ethanol extract of *Ipomoea staphylina* leaves

treatment were reduced the liver marker enzymes level, lipid profile and phospholipids in the diabetes induced experimental animals. These results were proved the anti-diabetic potential of *Ipomoea staphylina* and proposed that it may be useful for the development of novel anti-diabetic agent in future.

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