The Hypoglycemic and hypolidaenuc effect of increasing dosages of Allium cepa Aqueous extracts on Alloxan - Induced diabetic Rattus Norvegicus

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Abstract- Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycaemia and disturbances in lipid metabolism. In many developing countries, the high cost and limited availability of synthetic drugs have encouraged the use of medicinal plants as alternatives for diabetes management. This study evaluated the hypoglycaemic and hypolipidaemic effects of *Allium cepa* (onion) aqueous extract in alloxan-induced diabetic rats (*Rattus norvegicus*).

A total of sixty-three (63) adult male Wistar rats weighing 200–250 g were used. Fifty-four (54) were rendered diabetic via intraperitoneal injection of alloxan monohydrate (150 mg/kg), while nine (9) served as non-diabetic controls. The diabetic rats were treated orally for six weeks with graded doses of *Allium cepa* aqueous extract (200, 250, and 300 mg/kg) or glibenclamide (2.5, 3.8, and 5.0 mg/kg). Blood glucose, total serum lipids, and cholesterol were determined using standard biochemical methods.

Preliminary phytochemical screening revealed the presence of flavonoids, alkaloids, saponins, tannins, glycosides, steroids, and sulphur compounds. The extract produced significant ($p < 0.05$), dose-dependent reductions in blood glucose, total lipids, and cholesterol compared to the diabetic control. The 300 mg/kg dose demonstrated maximal efficacy, with activity comparable to glibenclamide (5.0 mg/kg).

These findings indicate that *Allium cepa* contains potent bioactive constituents capable of improving glucose and lipid metabolism, supporting its traditional use as a safe, affordable natural remedy for diabetes mellitus and its associated lipid disorders.

Keywords: *Allium cepa*, Diabetes Mellitus, Alloxan, Hypoglycaemia, Hypolipidaemia, Glibenclamide, *Rattus norvegicus*

I. INTRODUCTION

Diabetes mellitus (DM) is a multifactorial metabolic disorder resulting from insufficient insulin secretion, impaired insulin action, or both. It is characterized by chronic hyperglycaemia and alterations in carbohydrate, protein, and lipid metabolism (WHO, 1999). Long-term hyperglycaemia contributes to severe complications, including neuropathy, nephropathy, retinopathy, and cardiovascular diseases (ADA, 2005). The global prevalence of diabetes is increasing rapidly, with estimates predicting a twofold rise by 2030 (Boyle et al., 2001).

The situation is more critical in low- and middle-income countries, where expensive antidiabetic medications limit accessibility. Consequently, there has been a growing reliance on herbal remedies for diabetes management (Erasto et al., 2005). Recognizing this, the World Health Organization (1980) advocates for scientific validation of plants traditionally used in the treatment of diabetes.

Allium cepa (onion), a member of the family Liliaceae, is a common dietary vegetable with established medicinal value. It contains bioactive sulphur compounds such as allyl propyl disulfide (APDS), S-methyl cysteine sulfoxide, and flavonoids like quercetin, which are known for their antidiabetic, hypolipidaemic, and antioxidant properties (Mathew & Augusti, 1975; Kumari et al., 1995).

This study aimed to evaluate the hypoglycaemic and hypolipidaemic effects of graded doses of *Allium cepa* aqueous extract in alloxan-induced diabetic *Rattus norvegicus*, comparing its efficacy to the standard antidiabetic drug, glibenclamide.

II. MATERIALS AND METHODS

2.1 Ethical Approval

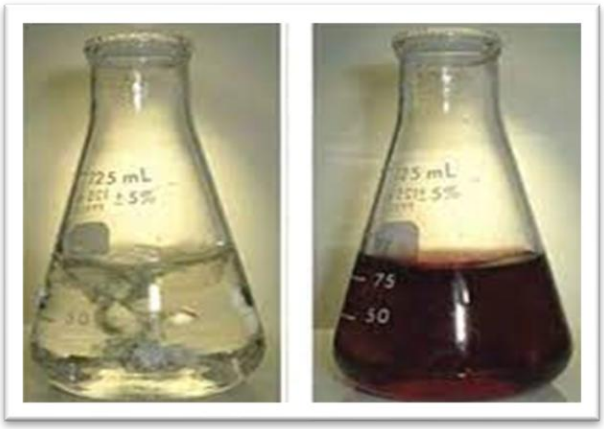
All animal procedures were conducted in accordance with the National Institutes of Health (NIH, 2011) guidelines and approved by the Institutional Animal Ethics Committee (IAEC) of Swami Ramanand Teerth Marathwada University, Nanded (Approval No.: SRTMU/IAEC/2024/07).

2.2 Plant Material and Authentication

Fresh onion bulbs (*Allium cepa*) were obtained from local region, and authenticated by a botanist at the Department of Botany.

2.3 Preparation of the Aqueous Extract

Two kilograms (2 kg) of peeled and chopped onions were homogenized and soaked in 2 L of distilled water for 24 hours with intermittent shaking. The mixture was filtered using Whatman No. 1 paper, and the filtrate was concentrated in a water bath at 60 °C to dryness, yielding a dark brown extract. The extract was stored at 4 °C and reconstituted in normal saline (0.85% NaCl) to a concentration of 1 g/mL before administration.



2.4 Phytochemical Screening

Preliminary phytochemical screening of *Allium cepa* aqueous extract was performed using standard methods described by Trease and Evans (1989). The analysis revealed the presence of several secondary metabolites known for antidiabetic and lipid-lowering activities.

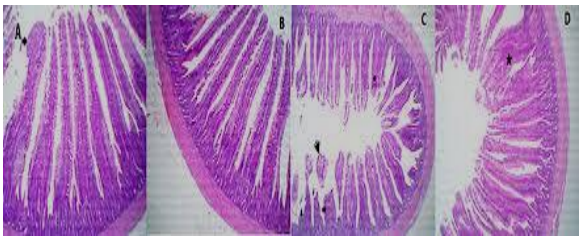


Table 1. Phytochemical Composition of *Allium cepa* Aqueous Extract

Phytochemical Constituent	Observation	Relative Abundance
Alkaloids	Present	++
Flavonoids	Strongly present	+++
Tannins	Present	++
Saponins	Present	++
Glycosides	Detected	+
Steroids	Detected	+
Sulphur-containing compounds	Strongly present	+++
Terpenoids	Trace	+

(+ = low, ++ = moderate, +++ = high)

Interpretation:
The presence of flavonoids and sulphur compounds suggests potent antioxidant and insulin-mimetic activities. These compounds are likely responsible for the observed hypoglycaemic and hypolipidaemic effects.

2.5 Experimental Animals
Sixty-three (63) adult male Wistar rats weighing 200–250 g were used. The animals were housed under standard laboratory conditions (temperature 26 ± 2 °C; 12-hour light/dark cycle) and fed standard rat pellets with free access to water. All rats were acclimatized for two weeks prior to experimentation.

2.6 Induction of Diabetes
After overnight fasting (12 h), diabetes was induced in fifty-four (54) rats by intraperitoneal injection of alloxan monohydrate (150 mg/kg) dissolved in normal saline. Rats were provided 5% glucose solution for 24 hours post-induction to prevent transient hypoglycaemia. After 72 hours, fasting blood glucose levels were measured using an Accu-Chek glucometer, and animals with levels between 250–400 mg/dL were confirmed diabetic.

2.7 Experimental Design
Table 2. Experimental Grouping and Treatments

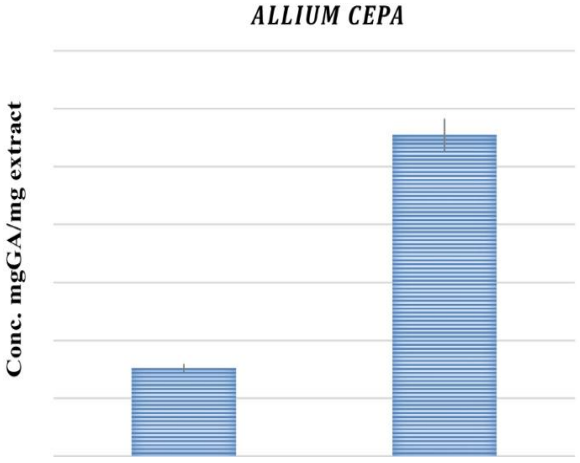
Group	Description	Treatment Administered (per kg body weight)
I	Normal control	1 mL normal saline
II	Diabetic control	No treatment
IIIa	Diabetic + *A. cepa* (low dose)	200 mg/kg extract
IIIb	Diabetic + *A. cepa* (medium dose)	250 mg/kg extract
IIIc	Diabetic + *A. cepa* (high dose)	300 mg/kg extract
IVa	Diabetic + Glibenclamide (low dose)	2.5 mg/kg
IVb	Diabetic + Glibenclamide (medium dose)	3.8 mg/kg
IVc	Diabetic + Glibenclamide (high dose)	5.0 mg/kg

All treatments were administered orally once daily for six weeks using an oral gavage.

2.8 Biochemical Analysis
After six weeks, blood samples were collected from the retro-orbital plexus under light anesthesia. Serum was separated by centrifugation at 3000 rpm for 10 minutes and analyzed as follows:

- Blood Glucose: O-toluidine reagent method (Sood, 1999).
- Total Cholesterol: Oxidation to a tetraene derivative and absorbance at 590 nm (Sood, 1999).
- Total Lipids: Phosphoric acid–vanillin method with absorbance at 546 nm (Sood, 1999).

2.9 Statistical Analysis



All data were expressed as mean ± SD (n = 9). One-way ANOVA followed by Fisher's LSD test was used to determine significance at $p < 0.05$ (GenStat, 2007).

III. RESULTS

This section presents the effects of *Allium cepa* aqueous extract on fasting blood glucose, total serum lipids, and cholesterol levels in alloxan-induced diabetic rats over a six-week treatment period. Data are expressed as mean ± standard deviation (SD) for each experimental group (n = 9). Statistical analysis using one-way ANOVA followed by Fisher's LSD test revealed significant differences ($p < 0.05$) between the treated and diabetic control groups.

3.1 Effect of *Allium cepa* Aqueous Extract on Fasting Blood Glucose

Alloxan administration caused a significant rise in fasting blood glucose levels in all diabetic groups compared to the normal control. However, oral administration of *Allium cepa* aqueous extract resulted in a steady, dose-dependent decline in glucose concentration throughout the six-week study period.

Rats treated with 200, 250, and 300 mg/kg of the extract showed percentage reductions of 62.9%, 69.7%, and 75.4% in blood glucose, respectively, relative to their baseline levels. These effects were comparable to those of glibenclamide, the standard antidiabetic drug, which achieved reductions between 76–81%.

The 300 mg/kg dose of *A. cepa* almost normalized blood glucose by week six, suggesting strong hypoglycaemic potency.

Table 3. Effect of *Allium cepa* Aqueous Extract on Fasting Blood Glucose Levels (mg/dL) Over Six Weeks

Group	Week 0	Week 2	Week 4	Week 6	% Reduction
Normal Control	95.2 ± 3.8	96.1 ± 4.1	95.5 ± 3.5	94.9 ± 3.1	—
Diabetic Control	319.7 ± 6.5	330.5 ± 7.0	339.8 ± 6.7	345.2 ± 7.1	—
A. cepa 200 mg/kg	312.8 ± 6.4	225.7 ± 5.8	145.6 ± 4.3	116.0 ± 3.9	62.9%
A. cepa 250 mg/kg	318.6 ± 5.9	202.3 ± 4.2	132.8 ± 4.8	96.3 ± 3.4	69.7%
A. cepa 300 mg/kg	314.4 ± 7.1	178.5 ± 5.2	110.6 ± 3.9	77.3 ± 2.8	75.4%
Glibenclamide 2.5 mg/kg	317.1 ± 6.2	165.2 ± 4.6	105.7 ± 3.7	73.2 ± 3.0	76.9%
Glibenclamide 5.0 mg/kg	315.8 ± 7.0	140.2 ± 4.1	91.0 ± 3.1	60.0 ± 2.4	81.0%

Values are mean ± SD (n = 9). All treated groups showed significant decreases ($p < 0.05$) compared to diabetic control.

Interpretation:

The hypoglycaemic effect of *Allium cepa* was clearly dose-dependent. By week six, the 300 mg/kg dose almost matched the performance of glibenclamide 5.0 mg/kg. This suggests that the bioactive compounds in onions—likely flavonoids and sulphur derivatives—can enhance insulin secretion or glucose utilization in diabetic states.

3.2 Effect of *Allium cepa* Aqueous Extract on Total Serum Lipids

Serum lipid levels were markedly elevated in diabetic control rats due to alloxan-induced hyperglycaemia and lipid mobilization. Treatment with *Allium cepa* extract caused a significant reduction in total lipid concentrations across all doses compared with the untreated diabetic group.

The reduction was 27.7%, 29.4%, and 44.4% for the 200, 250, and 300 mg/kg doses, respectively, while glibenclamide at 5.0 mg/kg produced a 48.2% reduction. The lipid-lowering effect observed in the 300 mg/kg *A. cepa* group was statistically comparable to the standard drug.

Table 4. Effect of *Allium cepa* Aqueous Extract on Total Serum Lipids (mg/dL)

Group	Total Serum Lipids (mg/dL)	% Reduction vs. Diabetic Control
Normal Control	420.8 ± 9.4	—
Diabetic Control	872.3 ± 12.5	—
A. cepa 200 mg/kg	630.5 ± 10.6	27.7%
A. cepa 250 mg/kg	602.4 ± 9.2	29.4%
A. cepa 300 mg/kg	487.3 ± 8.5	44.4%
Glibenclamide 2.5 mg/kg	490.5 ± 8.1	43.8%
Glibenclamide 5.0 mg/kg	452.1 ± 7.5	48.2%

Values are mean ± SD (n = 9). Significant differences ($p < 0.05$) observed between all treated groups and diabetic control.

Interpretation:
The hypolipidaemic activity of *Allium cepa* may be due to improved insulin action, resulting in decreased mobilization of fatty acids and reduced hepatic lipid synthesis. The results demonstrate that higher doses of the extract are capable of restoring lipid homeostasis close to normal physiological levels.

3.3 Effect of *Allium cepa* Aqueous Extract on Total Serum Cholesterol
Total serum cholesterol levels were significantly elevated in diabetic rats compared with normal controls. Treatment with *Allium cepa* extract resulted in a pronounced, dose-related decrease in cholesterol concentration. The 300 mg/kg dose reduced serum cholesterol by 27.5%, closely approaching the 32.1% reduction produced by glibenclamide (5.0 mg/kg).

Table 5. Effect of *Allium cepa* Aqueous Extract on Total Serum Cholesterol (mg/dL)

Group	Total Cholesterol (mg/dL)	% Reduction vs. Diabetic Control
Normal Control	115.5 ± 4.2	—
Diabetic Control	232.8 ± 6.2	—
A. cepa 200 mg/kg	185.3 ± 5.8	20.4%
A. cepa 250 mg/kg	177.9 ± 5.4	21.9%
A. cepa 300 mg/kg	160.8 ± 5.2	27.5%
Glibenclamide 2.5 mg/kg	158.1 ± 4.8	28.1%
Glibenclamide 5.0 mg/kg	144.3 ± 4.5	32.1%

Values are mean ± SD (n = 9). All treatments significantly reduced cholesterol levels ($p < 0.05$) compared to diabetic control.

Interpretation:
The cholesterol-lowering effect of *Allium cepa* supports previous findings that its bioactive constituents—such as quercetin, S-methyl cysteine sulfoxide, and allyl propyl disulfide—can modulate lipid metabolism. This likely occurs through enhanced LDL clearance, suppression of cholesterol biosynthesis, or improved antioxidant defense mechanisms.

Results

Parameter	Effect Observed	Most Effective Dose	Comparable to Drug?
Fasting Blood Glucose	Significant dose-dependent decrease	300 mg/kg	Yes (≈ glibenclamide 5.0 mg/kg)
Total Serum Lipids	Marked reduction across all doses	300 mg/kg	Yes
Total Serum Cholesterol	Significant reduction	300 mg/kg	Yes

General Interpretation:
The findings collectively indicate that *Allium cepa* aqueous extract possesses potent hypoglycaemic and hypolipidaemic properties in alloxan-induced diabetic rats. The effects were dose-dependent, with the highest dose (300 mg/kg) showing comparable efficacy to glibenclamide, a standard antidiabetic medication. These outcomes strongly suggest that onion's bioactive compounds can modulate carbohydrate and lipid metabolism, supporting its traditional use in managing diabetes mellitus and its associated dyslipidaemia.

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