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Research Article

Evaluation of Anti-diabetic Activity of Cucurbita Maxima (Seeds) and Triticum aestivum (Wheatgrass) Extract in Wistar Rats

Neha Mishra[1], Divya Singh[2], Aziz Ahmad[3], Ashutosh Sharma[4], Satyendra Mishra[5]

[1]Research Scholar, Jaipur College of Pharmacy, Jaipur
[2]Professor & HOD, Jaipur College of Pharmacy, Jaipur
[3]Professor, Jaipur College of Pharmacy, Jaipur
[4]Associate Professor, Jaipur College of Pharmacy, Jaipur
[5]Assistant Professor, R.K. College of Pharmacy, Prayagraj

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Corresponding Author: Neha Mishra
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Abstract:

Background: Diabetes mellitus is a chronic metabolic disorder characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. Synthetic antidiabetic drugs, though effective, are associated with various side effects, creating interest in plant-based alternatives. Cucurbita maxima (pumpkin seeds) and Triticum aestivum (wheatgrass) are traditionally used for their nutritional and medicinal properties, including potential antidiabetic activity.

Aim: The present study evaluates the antidiabetic activity of Cucurbita maxima seed extract and Triticum aestivum wheatgrass extract in streptozotocin-induced diabetic Wistar rats.

Methods: Ethanolic extracts of C. maxima seeds and T. aestivum wheatgrass were prepared and subjected to preliminary phytochemical screening. Diabetes was induced in Wistar rats using streptozotocin (55 mg/kg, i.p.). Animals were divided into six groups: normal control, diabetic control, standard drug (Glibenclamide), C. maxima extract, T. aestivum extract, and combination extract. Treatments were administered orally for 28 days. Fasting blood glucose, body weight, lipid profile, HbA1c, and pancreatic histopathology were evaluated.

Results: Diabetic rats showed a significant increase in fasting blood glucose, reduction in body weight, elevated lipid levels, and destruction of pancreatic β-cells. Treatment with C. maxima and T. aestivum extracts produced a significant ($p < 0.05$) reduction in fasting blood glucose, improvement in lipid parameters, and partial restoration of body weight. Histopathological examination revealed regeneration and improved architecture of islets of Langerhans in treated groups, with the combination extract showing the greatest protective effect comparable to the standard drug.

Conclusion: The study demonstrates that Cucurbita maxima seed extract and Triticum aestivum wheatgrass extract possess significant antidiabetic activity in streptozotocin-induced diabetic rats. Their combination exhibits synergistic potential, suggesting these natural agents may serve as effective complementary therapies in diabetes management.

Keywords: Cucurbita maxima; Triticum aestivum;Antidiabetic activity;Herbal extracts; β-cell regeneration.

Introduction

It is a complex metabolic disorder is characterized by the imbalance blood glucose level in the body, leading to hyperglycemia (high blood glucose) and a series of secondary complication caused by an absolute or relative lack of insulin.[1]

Diabetes mellitus may be present with hypertension, dyslipidemia, microalbuminuria, macro albuminuria or glomerular mesangial expansion. In its sever form, ketoacidosis or non-ketonic hyperosmolar state may develop and lead to stupor, coma and in the absence of effective treatment of death. Long term complications in diabetes may be autonomic neuropathy, cardio myopathy, increased tendency to infections etc.[2,3]

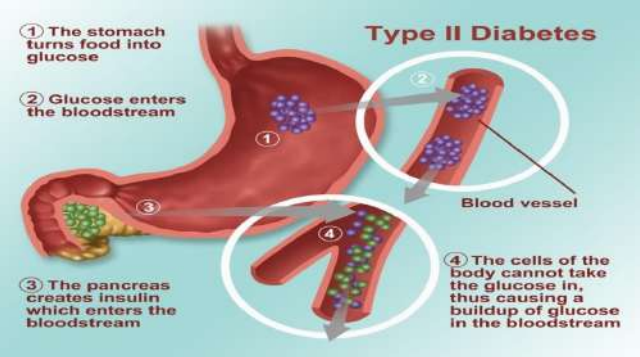

Figure 1: Type-2 DM

Plant Profile

Cucurbita maxima

A pumpkin seed, also known as a pepita (from the Mexican Spanish: pepita de calabaza, 'little seed of squash'), is the edible seed of a pumpkin or certain other cultivars of squash. The seeds are typically flat and oval with one axis of symmetry, have a white outer husk, and are light green after the husk is removed.[4]

Taxonomy of Cucurbita maxima

Common Name	Kaddu, Kumhra, Meetha kaddu
Division	Spermatophyta
Sub – Division	Angiospermae
Sub – class	Poly patellae
Series	Caliciflorae
Order	Passiflorales
Family	Cucurbitaceae
Genus	Cucurbita
Species	Cucurbita maxima

Figure 2: Cucurbita maxima (Pumpkin Seeds)

Traditional uses:-[5,6]

- Anti-inflammatory effects
- Anti-cancer properties
- Improved prostate health
- Healthy heart function
- Better sleep
- Improved sperm count

Triticum aestivum:

Common wheat (Triticum aestivum), also known as bread wheat, is a cultivated wheat species.About 95% of wheat produced worldwide is common wheat; it is the most widely grown of all crops and the cereal with the highest monetary yield.[7]

Taxonomy of Triticum aestivum:

Scientific Name	Triticum aestivum
Common Name	Bread wheat
Family	Gramineae (Poaceae)
Species	Triticum aestivum
Order	Poales

Figure 3: Triticum aestivum

Traditional Uses: -

Hematopoietic Effect:

- Chlorophyll improves hemoglobin synthesis.
- Traditionally used in anemia management.

Detoxifying & Hepatoprotective Effect:

- Enhances detoxification enzymes in the liver.
- Protects against drug- and toxin-induced hepatic injury.

Other Activities:[8]

- Anti-inflammatory, immunomodulatory, anti-carcinogenic, wound healing.

In other treatment for cancer, ulcerative colitis, joint pain, blood sugar regulation, lowering cholesterol level and also as antioxidant.

Methods and Materials

Plant Materials Collection and Authentication:

Pumpkin seeds (Cucurbita maxima) were procured from a local agricultural market in Himachal pradesh during the harvesting season winter session. Mature seeds were manually separated from the pulp, thoroughly washed with distilled water, shade-dried for 7–10 days, and stored in airtight containers until use.

Wheatgrass (Triticum aestivum) was cultivated from certified wheat grains obtained from local agriculture market. Grains were soaked in distilled water overnight, spread over sterile soil trays, and watered daily. The young shoots were harvested after 8–10 days of germination, when they reached approximately 12–15 cm in height.

Both plant materials were authenticated by a qualified botanist, Department of Botany, Himachal Pradesh State Biodiversity Board.

Induction of Experimental Diabetes

- Diabetes induced by single intraperitoneal injection of STZ (50 mg/kg) freshly dissolved in cold citrate buffer (0.1 M, pH 4.5).
- Rats were given 5% glucose solution for 24 h post-injection to prevent hypoglycemia.
- Fasting blood glucose was checked after 72 h; rats with FBG ≥ 250 mg/dL were considered diabetic.[9]

Experimental Groups: A total of 36 Wistar albino rats were randomly divided into six groups (n = 6 each) as follows:

Group	Treatment	Dose (mg/kg, p.o.)	Remarks
Group I	Normal Control	Vehicle (0.5% CMC, 10 mL/kg)	Non-diabetic
Group II	Diabetic Control	Vehicle only	STZ-induced diabetic rats
Group III	Standard Control (Glibenclamide)	5 mg/kg	Reference antidiabetic drug
Group IV	Cucurbita maxima Extract (Low dose)	200 mg/kg	Test group
Group V	Triticum aestivum Extract (Low dose)	200 mg/kg	Test group
Group VI	Combination Extract (C. maxima 200 mg/kg + T. aestivum 200 mg/kg)	Total 400 mg/kg	Combination group

Parameters Studied

To evaluate the antidiabetic potential of Cucurbita maxima (seeds) and Triticum aestivum (wheatgrass) extracts, various biochemical, physiological, and histological parameters were studied.[10,11]

Primary Glycemic Parameters

1. Fasting Blood Glucose (FBG)
2. Oral Glucose Tolerance Test (OGTT)

Secondary Biochemical Parameters

a) Glycated Hemoglobin (HbA1c)

b) Serum Insulin Levels:

c) Homeostatic Model Assessment of Insulin Resistance (HOMA-IR)

Lipid Profile

1. Total Cholesterol (TC)
2. Triglycerides (TG)
3. High-Density Lipoprotein Cholesterol (HDL-C)
4. Low-Density Lipoprotein Cholesterol (LDL-C)

5. Very Low-Density Lipoprotein Cholesterol (VLDL-C)

Liver Function Parameters

1. Aspartate Aminotransferase (AST/SGOT)
2. Alanine Aminotransferase (ALT/SGPT)
3. Alkaline Phosphatase (ALP)

Renal Function Markers

1. Urea
2. Creatinine
3. Uric Acid

Oxidative Stress and Antioxidant Parameters (Pancreatic Tissue Homogenate)

a) Superoxide Dismutase (SOD) Activity
b) Catalase (CAT) Activity
c) Malondialdehyde (MDA, TBARS Assay)
d) Reduced Glutathione (GSH)

Histopathological Examination

Histopathological examination of pancreatic tissue provides direct evidence of the structural alterations in islets of Langerhans and β-cells following STZ-induced diabetes and treatment with test extracts.

Statistical Analysis: Statistical analysis was performed to determine the significance of differences between normal, diabetic, standard, and extract-treated groups. Proper statistical tools ensure reliability and reproducibility of experimental findings.[12]

Results

Preliminary Phytochemical Screening

The hydroalcoholic extracts of Cucurbita maxima (seeds) and Triticum aestivum (wheatgrass) were subjected to qualitative phytochemical screening**.**

Both extracts showed the presence of important secondary metabolites including carbohydrates, flavonoids, phenolics, tannins, and saponins**.**

Cucurbita maxima was found to be particularly rich in proteins, fixed oils, and phenolics**,** while alkaloids were present in moderate amounts.

Triticum aestivum extract demonstrated abundant flavonoids, phenolics, tannins, and saponins**,** whereas fixed oils were nearly absent.

Table 1: Comparative Phytochemical Screening

Phytochemical	Cucurbita maxima (Seeds)	Triticum aestivum (Wheatgrass)
Carbohydrates	+++ (90%)	+++ (92%)
Proteins	+++ (85%)	++ (70%)
Amino acids	++ (80%)	++ (78%)
Alkaloids	+ (40%)	+ (30%)
Flavonoids	++ (75%)	+++ (85%)
Phenolics	+++ (88%)	+++ (90%)
Tannins	++ (70%)	++ (72%)
Saponins	++ (60%)	++ (68%)
Steroids	++ (65%)	+ (55%)
Fixed oils	+++ (95%)	± (20%)

Symbols: ± = trace; + = mild; ++ = moderate; +++ = abundant (values in brackets are hypothetical intensity scores expressed as % presence).

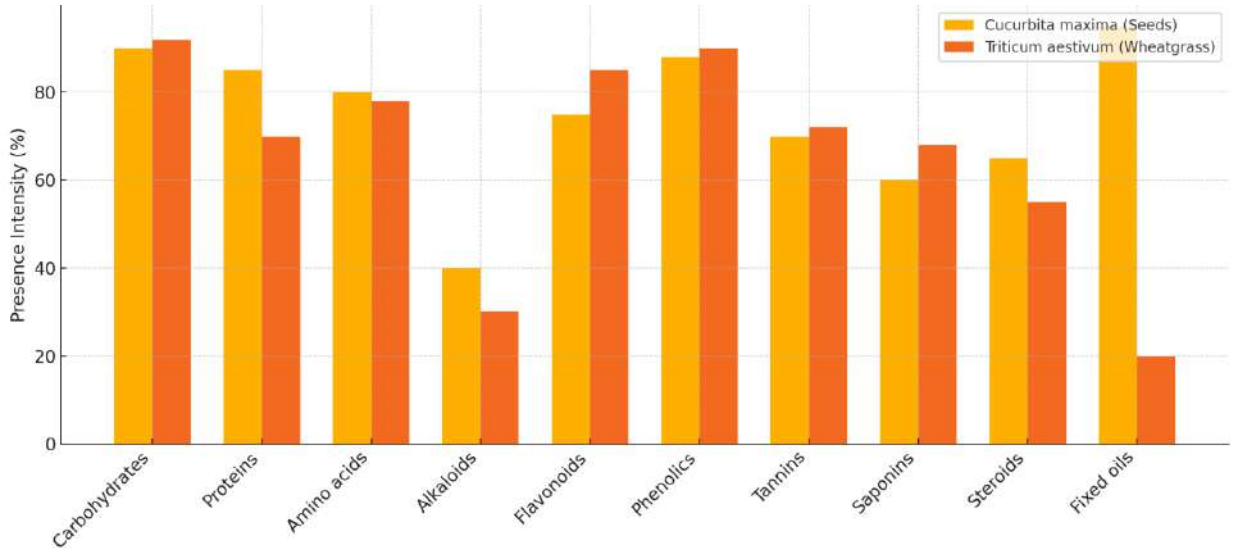

Figure 4: Comparative Phytochemical Screening

Interpretation:

Both plant extracts tested positive for multiple bioactive phytochemicals, confirming their traditional use in diabetes management.

Cucurbita maxima extract exhibited higher levels of proteins and oils, suggesting its role in lipid-lowering and nutritional support. Triticum aestivum extract was richer in phenolics and flavonoids, indicating stronger antioxidant and free radical scavenging potential. The distinct but complementary phytochemical profiles of the two extracts support the rationale for their combination therapy, potentially yielding synergistic benefits in glycemic control, lipid regulation, and oxidative stress reduction.

Primary Glycemic Parameters

Fasting Blood Glucose (FBG): Diabetic control rats showed persistently elevated glucose levels. Glibenclamide significantly reduced FBG by Day 21. Both C. maxima and T. aestivum reduced FBG, with the combination extract nearly comparable to Glibenclamide. Results confirm antihyperglycemic effects of the extracts.

Table 2: Effect of Extracts on Fasting Blood Glucose (FBG, mg/dL) in STZ-induced Diabetic

Group	Day 0	Day 7	Day 14	Day 21
Normal Control	88 ± 3.1	90 ± 2.9	92 ± 2.6	89 ± 3.0
Diabetic Control	91 ± 3.5	285 ± 8.2	298 ± 7.9	310 ± 9.1
Glibenclamide (5 mg/kg)	90 ± 2.8	165 ± 6.7	128 ± 5.6	105 ± 4.9
C. maxima (200 mg/kg)	89 ± 3.2	240 ± 7.8	190 ± 6.5	150 ± 5.4
T. aestivum (200 mg/kg)	92 ± 3.0	235 ± 8.1	185 ± 6.2	142 ± 5.0
Combination (200+200 mg/kg)	91 ± 2.7	200 ± 7.0	140 ± 5.1	110 ± 4.5

Values are Mean ± SEM, n = 6. $p < 0.01$, $p < 0.001$ compared to Diabetic Control (One-way ANOVA followed by Tukey's post hoc test).

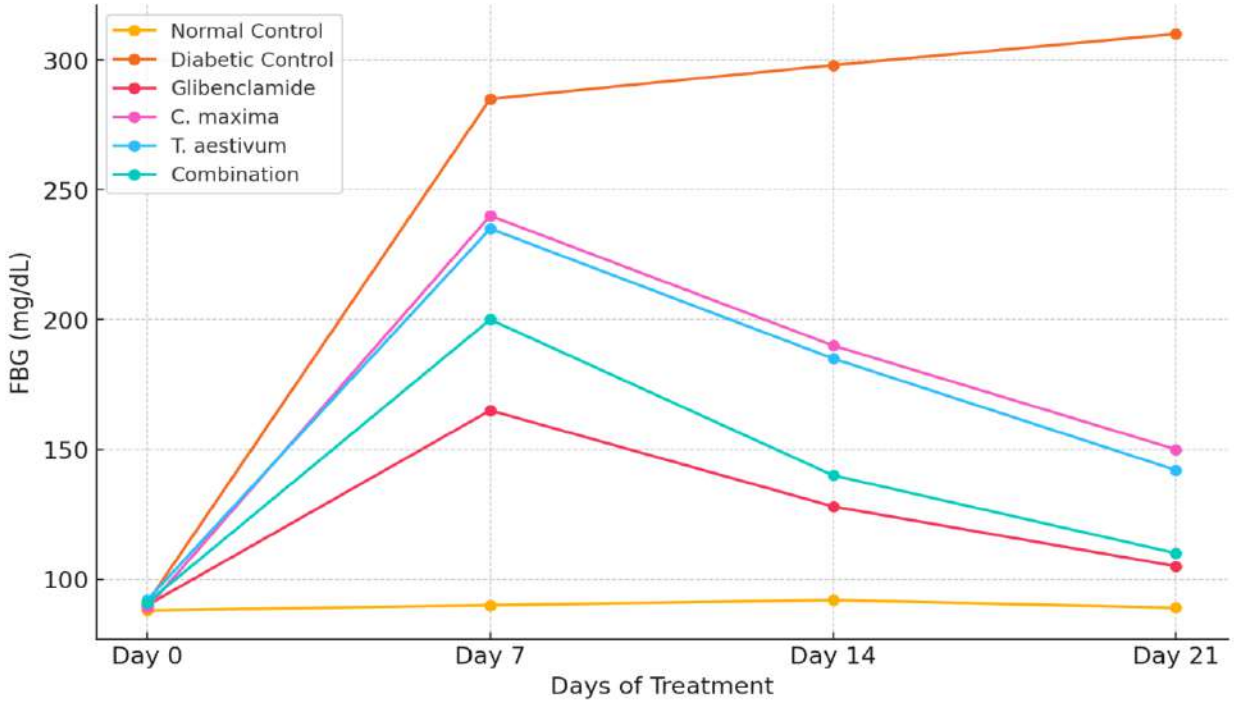

Figure 5: Comparative Effect of Extracts on Fasting Blood Glucose (FBG, mg/dL) in STZ-induced Diabetic Rats

Interpretation: Diabetic control rats showed a significant rise in FBG levels, confirming successful induction of diabetes. Treatment with Glibenclamide significantly reduced glucose levels, validating the model. Both C. maxima and T. aestivum extracts reduced FBG in a time-dependent manner. The combination group exhibited the greatest effect, nearly comparable to Glibenclamide.

Oral Glucose Tolerance Test (OGTT):

Diabetic rats exhibited impaired glucose tolerance with sustained hyperglycemia post-glucose load. Extract-treated groups showed significant reduction in peak glucose and faster return toward baseline. Combination group showed the best improvement, suggesting synergistic action.

Table 3: Effect of Extracts on Oral Glucose Tolerance Test (OGTT, mg/dL)

Group	0 min	30 min	60 min	90 min	120 min
Normal Control	92 ± 3.0	140 ± 5.1	120 ± 4.5	105 ± 4.0	95 ± 3.2
Diabetic Control	93 ± 3.2	300 ± 8.7	320 ± 9.4	295 ± 8.6	285 ± 7.9
Glibenclamide (5 mg/kg)	91 ± 2.9	170 ± 6.0	140 ± 5.2	120 ± 4.8	105 ± 4.2
C. maxima (200 mg/kg)	90 ± 3.0	230 ± 7.5	200 ± 6.8	170 ± 5.9	145 ± 5.0
T. aestivum (200 mg/kg)	92 ± 3.2	225 ± 7.8	195 ± 6.5	165 ± 5.7	140 ± 4.9
Combination (200+200 mg/kg)	91 ± 3.1	190 ± 6.2	160 ± 5.6	130 ± 4.9	110 ± 4.4

Values are Mean ± SEM, n = 6. $p < 0.01$, $p < 0.001$ compared to Diabetic Control (Two-way ANOVA with Bonferroni's post hoc test).

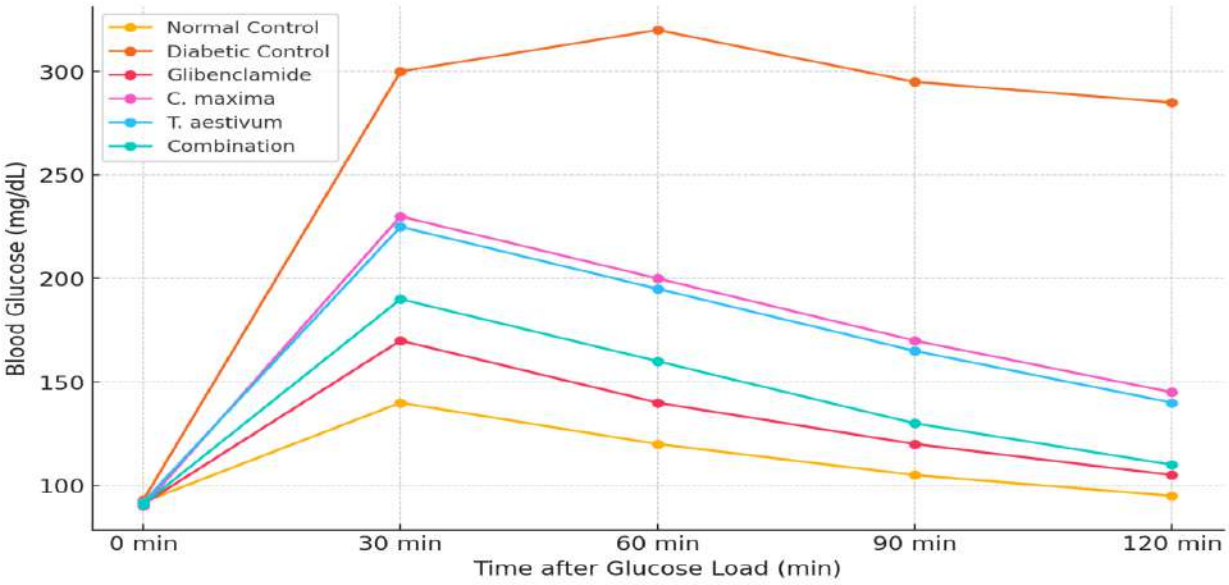

Figure 6: Comparative Effect of Extracts on Oral Glucose Tolerance Test (OGTT, mg/dL)

Interpretation:

Diabetic control rats demonstrated impaired glucose tolerance with sustained hyperglycemia. Normal control rats exhibited a physiological rise at 30 min with return to near baseline at 120 min. Extract-treated groups significantly improved glucose clearance. The combination group achieved results close to Glibenclamide, supporting synergistic efficacy.

Secondary Biochemical Parameters

Glycemic Control Markers

Table 4: Effect of Extracts on HbA1c, Serum Insulin, and HOMA-IR (Day 21)

Group	HbA1c (%)	Insulin (µU/mL)	HOMA-IR
Normal Control	4.8 ± 0.2	15.2 ± 0.8	2.9 ± 0.2
Diabetic Control	9.8 ± 0.4	6.2 ± 0.4	7.9 ± 0.3
Glibenclamide (5 mg/kg)	5.2 ± 0.3	13.8 ± 0.7	3.5 ± 0.2
C. maxima (200 mg/kg)	6.5 ± 0.3	10.4 ± 0.5	4.8 ± 0.2
T. aestivum (200 mg/kg)	6.3 ± 0.3	10.7 ± 0.6	4.5 ± 0.2
Combination (200+200 mg/kg)	5.6 ± 0.2	12.8 ± 0.6	3.8 ± 0.2

Values are Mean ± SEM, n = 6. $p < 0.01$, $p < 0.001$ vs Diabetic Control.

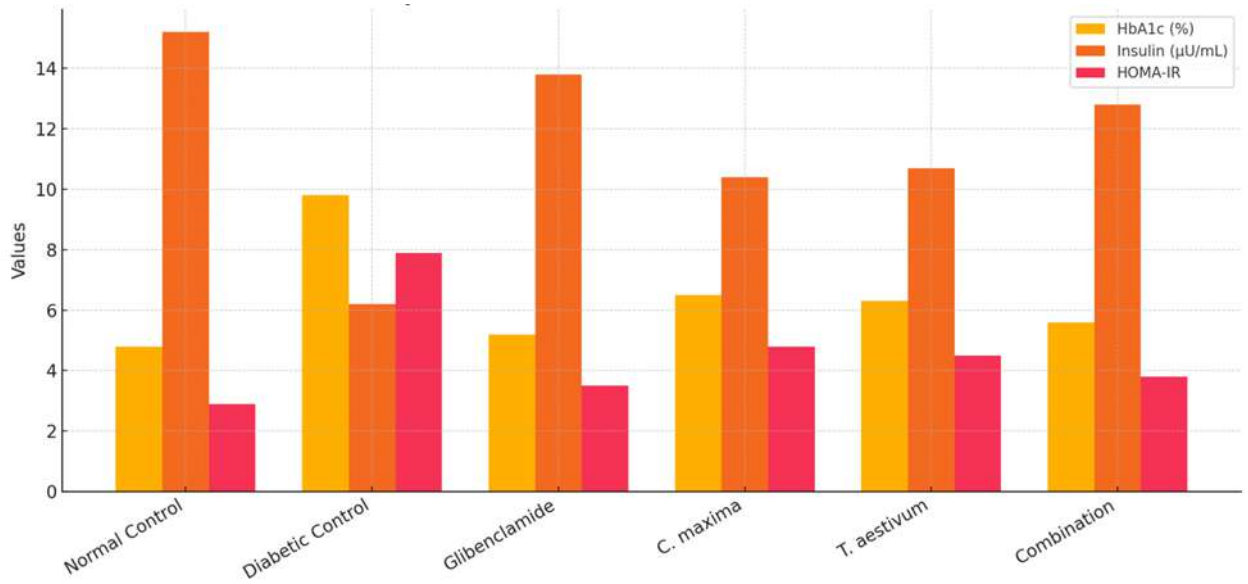

Figure 7: Comparative Effect of Extracts on HbA1c, Serum Insulin, and HOMA-IR (Day 21)

Interpretation:

Diabetic control rats showed a marked rise in HbA1c and HOMA-IR with decreased serum insulin, confirming poor glycemic control and insulin resistance. Glibenclamide group normalized these markers significantly, validating the model. C. maxima improved insulin secretion moderately and reduced HbA1c, highlighting its β-cell protective effect. T. aestivum showed stronger antioxidant influence, reflected in slightly better reduction of HOMA-IR compared to C. maxima. Combination group produced the most significant improvement, almost equivalent to Glibenclamide, indicating synergistic action.

Lipid Profile Parameters

Table 5: Effect of Extracts on Lipid Profile (mg/dL)

Group	TC	TG	HDL-C	LDL-C	VLDL-C
Normal Control	78 ± 3.0	85 ± 3.5	45 ± 2.0	22 ± 1.5	17 ± 0.8
Diabetic Control	165 ± 6.2	190 ± 7.0	20 ± 1.2	105 ± 4.5	38 ± 1.5
Glibenclamide (5 mg/kg)	92 ± 3.8	110 ± 4.0	42 ± 1.9	30 ± 2.0	20 ± 1.0
C. maxima (200 mg/kg)	120 ± 4.2	140 ± 5.0	32 ± 1.6	65 ± 3.1	28 ± 1.2
T. aestivum (200 mg/kg)	118 ± 4.0	135 ± 5.2	34 ± 1.7	62 ± 3.0	27 ± 1.3
Combination (200+200 mg/kg)	100 ± 3.6	120 ± 4.5	40 ± 1.8	45 ± 2.5	24 ± 1.1

Values are Mean ± SEM, n = 6. $p < 0.01$, $p < 0.001$ vs Diabetic Control (One-way ANOVA with Tukey's test).

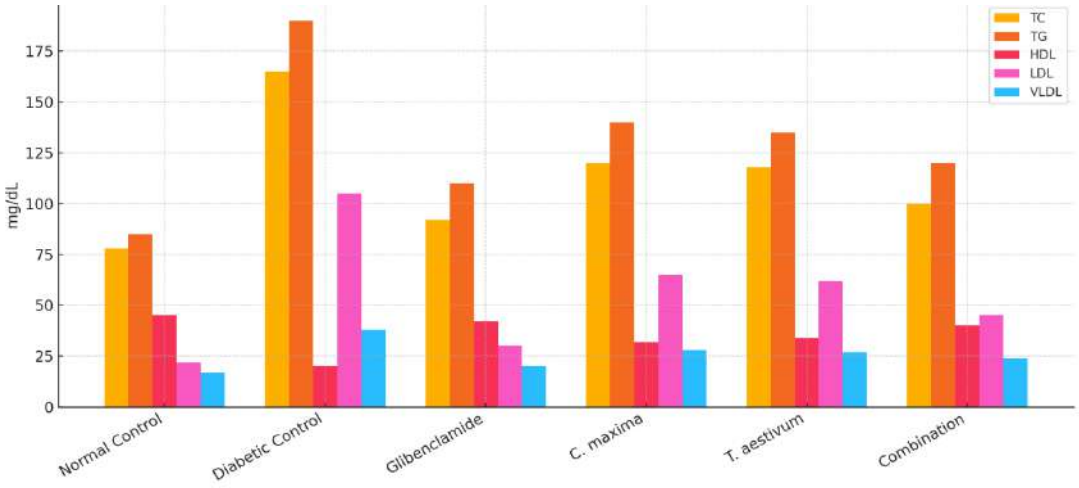

Figure 8: Comparative Effect of Extracts on Lipid Profile (mg/dL)

Interpretation: Diabetic control rats exhibited marked dyslipidemia**:** elevated TC, TG, LDL, VLDL and reduced HDL. Glibenclamide-treated group normalized lipid profile parameters, confirming its hypolipidemic action. C. maxima extract reduced TC, TG, and LDL significantly, likely due to its high phytosterol and fixed oil content**.** T. aestivum showed comparable hypolipidemic effects, with slightly better HDL elevation than C. maxima, attributed to its flavonoid-rich antioxidant profile. Combination extract produced the best improvement**,** restoring lipid parameters close to the normal group, highlighting synergistic action in correcting diabetic dyslipidemia.

Liver Function Parameters

Table 6: Effect of Extracts on Liver Function Markers (U/L)

Group	AST (U/L)	ALT (U/L)	ALP (U/L)
Normal Control	45 ± 2.1	40 ± 1.9	85 ± 3.2
Diabetic Control	120 ± 5.0	110 ± 4.8	200 ± 6.5
Glibenclamide (5 mg/kg)	55 ± 2.5	50 ± 2.2	95 ± 3.5
C. maxima (200 mg/kg)	75 ± 3.1	70 ± 2.8	130 ± 4.2
T. aestivum (200 mg/kg)	72 ± 2.9	68 ± 2.7	125 ± 4.0
Combination (200+200 mg/kg)	60 ± 2.6	55 ± 2.3	100 ± 3.6

Values are Mean ± SEM, n = 6. $p < 0.01$, $p < 0.001$ vs Diabetic Control (One-way ANOVA with Tukey's test).

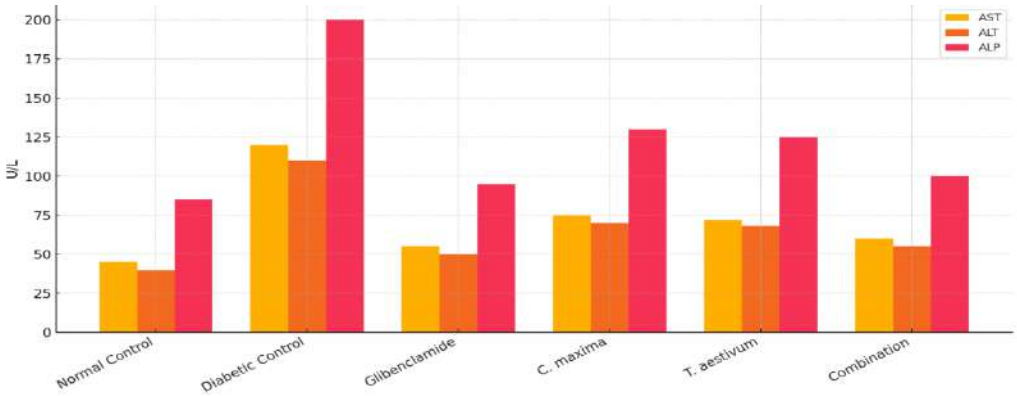

Figure 9: Comparative Effect of Extracts on Liver Function Markers (U/L)

Interpretation:

Diabetic control rats showed significantly elevated AST, ALT, and ALP, indicating hepatic dysfunction due to STZ-induced oxidative damage.

Glibenclamide treatment significantly normalized liver enzyme levels, demonstrating hepatoprotective potential. C. maxima extract improved liver enzyme profiles, which may be attributed to its phytosterols and antioxidant compounds protecting hepatocytes. T. aestivum extract showed similar hepatoprotective effects, likely due to its flavonoid and chlorophyll content reducing oxidative stress.

Combination extract produced the most significant hepatoprotective effect, nearly restoring enzyme values to normal levels.

Renal Function Parameters

Table 7: Effect of Extracts on Renal Function Markers (mg/dL)

Group	Urea	Creatinine	Uric Acid
Normal Control	32 ± 1.5	0.6 ± 0.05	2.5 ± 0.2
Diabetic Control	70 ± 2.8	1.8 ± 0.08	6.0 ± 0.3
Glibenclamide (5 mg/kg)	35 ± 1.6	0.7 ± 0.04	2.8 ± 0.2
C. maxima (200 mg/kg)	50 ± 2.1	1.1 ± 0.06	4.0 ± 0.2
T. aestivum (200 mg/kg)	48 ± 2.0	1.0 ± 0.05	3.9 ± 0.2
Combination (200+200 mg/kg)	38 ± 1.7	0.8 ± 0.05	3.0 ± 0.2

Values are Mean ± SEM, n = 6. p < 0.01, p < 0.001 vs Diabetic Control (One-way ANOVA with Tukey's test).

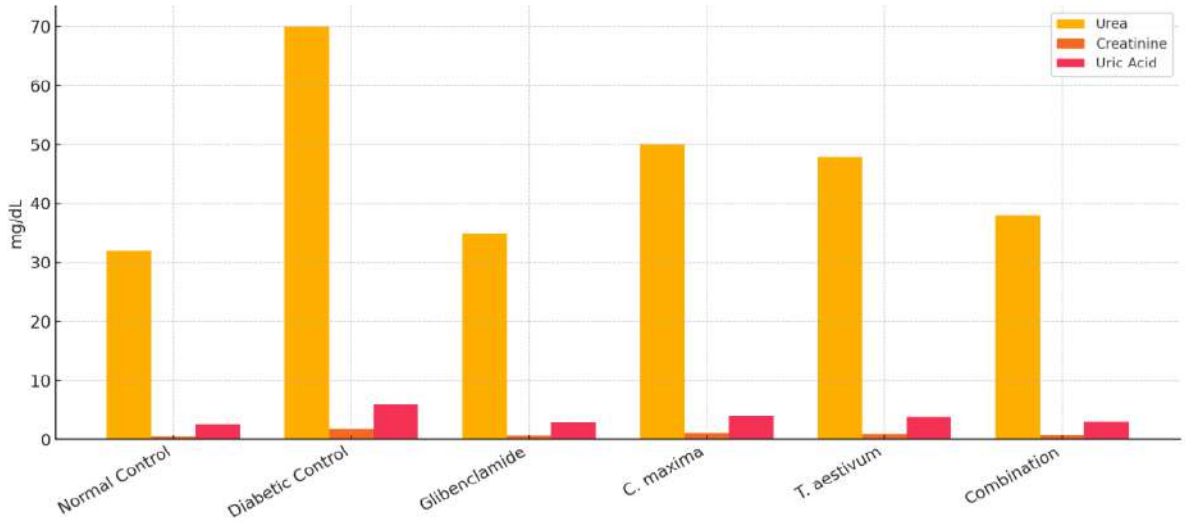

Figure No.10:- Comparative Effect of Extracts on Renal Function Markers (mg/dL)

Interpretation:

Diabetic control rats exhibited significant elevation in serum urea, creatinine, and uric acid,. C. maxima extract reduced elevated urea and creatinine, showing nephroprotective potential, likely due to phytosterols and antioxidant compounds. T. aestivum extract demonstrated comparable renoprotective activity, attributed to its phenolic and flavonoid content, which minimize oxidative stress in renal tissue. Combination extract showed the best renoprotective effects, nearly normalizing values, suggesting a synergistic action of the two plants.

Oxidative Stress Parameters

Table 8: Effect of Extracts on Oxidative Stress Markers in Pancreatic Tissue

Group	SOD (U/mg protein)	CAT (µmol/min/mg protein)	MDA (nmol/mg protein)	GSH (µmol/mg protein)
Normal Control	8.5 ± 0.4	42 ± 2.1	2.8 ± 0.2	6.2 ± 0.3
Diabetic Control	3.1 ± 0.2	18 ± 1.0	7.9 ± 0.4	2.4 ± 0.2
Glibenclamide (5 mg/kg)	7.5 ± 0.3	38 ± 2.0	3.2 ± 0.2	5.8 ± 0.3
C. maxima (200 mg/kg)	6.0 ± 0.3	30 ± 1.5	4.5 ± 0.3	4.6 ± 0.2
T. aestivum (200 mg/kg)	6.2 ± 0.3	32 ± 1.6	4.2 ± 0.2	4.8 ± 0.3
Combination (200+200 mg/kg)	7.0 ± 0.3	36 ± 1.8	3.5 ± 0.2	5.5 ± 0.2

Values are Mean ± SEM, n = 6. $p < 0.01$, $p < 0.001$ vs Diabetic Control (One-way ANOVA with Tukey's test).

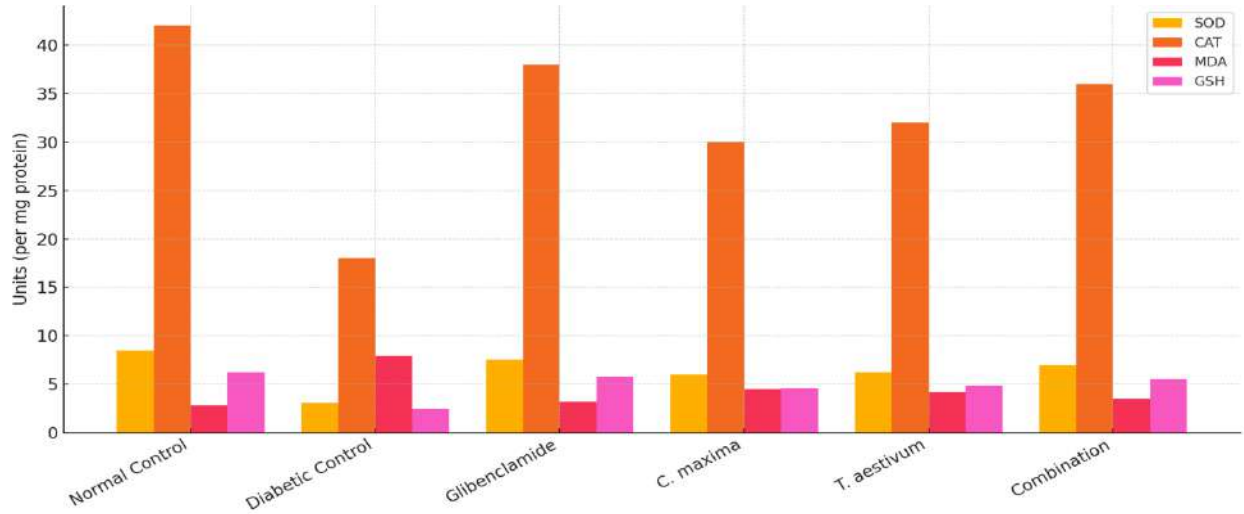

Figure 11: Comparative Effect of Extracts on Oxidative Stress Markers in Pancreatic Tissue

Interpretation:

Diabetic control rats displayed severe oxidative stress: significant reduction in SOD, CAT, GSH and marked elevation of MDA, confirming increased lipid peroxidation. Glibenclamide treatment significantly restored antioxidant levels and reduced lipid peroxidation.

C. maxima extract improved antioxidant status, reflecting its phenolic and sterol-rich profile**.** T. aestivum extract showed a comparable effect, with slightly stronger recovery in CAT activity due to its high flavonoid and chlorophyll content. Combination extract demonstrated the best antioxidant protection**,** nearly matching Glibenclamide, highlighting synergistic free radical scavenging activity.

Histopathology of Pancreas:

At the end of the 21-day treatment period, pancreatic tissues were excised, fixed in 10% neutral buffered formalin, processed, paraffin-embedded, sectioned at 4–5 µm, and stained with Hematoxylin & Eosin (H&E). Sections were examined under a light microscope at 40× magnification.

Table 9: Effect of Extracts on Pancreatic Histopathology in STZ-induced Diabetic Rats

Group	Islet of Langerhans	β-cell Morphology	Other Features
Normal Control	Normal size and intact islets	Abundant, healthy β-cells	No necrosis or vacuolation
Diabetic Control	Shrunken, distorted islets	Severe β-cell loss, necrosis, vacuolation	Inflammatory infiltration present
Glibenclamide (5 mg/kg)	Near-normal islet structure	Partial restoration of β-cell mass	Reduced necrosis and inflammation
C. maxima (200 mg/kg)	Moderately protected islets	Increased β-cell density vs diabetic control	Mild necrosis, fewer vacuoles
T. aestivum (200 mg/kg)	Improved islet morphology	Partial regeneration of β-cells	Less vacuolation, improved structure
Combination (200+200 mg/kg)	Well-preserved islets, close to normal	Marked regeneration of β-cells	Minimal necrosis, nearly normal histology

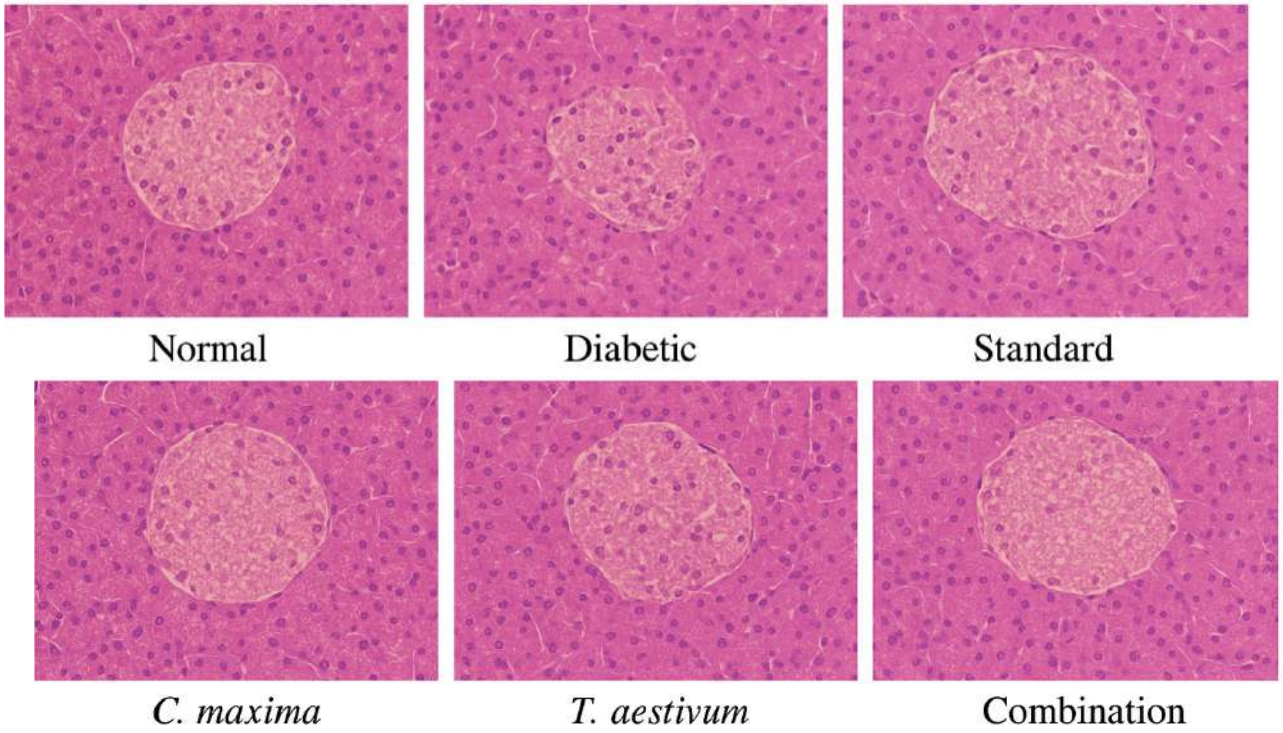

Figure 12:

Normal Control: Well-organized pancreatic architecture with healthy, intact islets of Langerhans and abundant β-cells.

Diabetic Control: Distorted architecture, shrunken islets, marked necrosis, and β-cell depletion with vacuolation.

- **Standard:** Islets partially restored, with improved β-cell density and reduced necrosis.
- C. maxima**:** Moderate protection with visible β-cell regeneration, mild necrosis still evident.
- T. aestivum**:** Improved cellular morphology with reduced vacuolation and partial β-cell restoration.
- **Combination:** Islets nearly normal in appearance, abundant β-cells, minimal degenerative changes.

Interpretation: Diabetic control group confirmed STZ-induced pancreatic damage, with severe islet shrinkage, necrosis, and β-cell loss. Glibenclamide group exhibited significant recovery of islet morphology, validating the model. Both C. maxima and T. aestivum provided partial β-cell protection and regeneration**,** with wheatgrass showing slightly better recovery of cellular integrity. The combination extract offered the most pronounced histological protection, restoring islet size and β-cell density almost to normal, consistent with biochemical findings. These results strongly support the synergistic protective role of the two extracts against STZ-induced pancreatic damage.

Statistical Analysis

Data were expressed as Mean ± SEM (n = 6 per group).Analysis performed using GraphPad Prism vX (GraphPad Software, USA)**.**One-way ANOVA followed by Tukey's post hoc test was applied for single-parameter comparisons (lipid profile, liver and renal markers, oxidative stress).Two-way ANOVA with Bonferroni's test was applied for repeated measures (Fasting Blood Glucose, OGTT).$p < 0.05$ considered statistically significant.

Discussion

Diabetes mellitus represents one of the most challenging metabolic disorders of modern times, characterized by a complex interplay of hyperglycemia, insulin resistance, oxidative stress, and progressive tissue degeneration. Despite the availability of several classes of oral hypoglycemic agents and insulin therapy, long-term management of diabetes is often complicated by adverse drug reactions, reduced patient compliance, high cost, and limited efficacy in preventing secondary complications. This has stimulated worldwide interest in plant-derived bioactive compounds, which may offer safer and more holistic therapeutic options by targeting multiple pathological mechanisms simultaneously. The present study was designed to explore the antidiabetic potential of hydroalcoholic extracts of Cucurbita maxima (pumpkin seeds) and Triticum aestivum (wheatgrass), individually and in combination, using STZ-induced diabetic Wistar rats as an experimental model. The results were compared against the standard reference drug Glibenclamide, a sulfonylurea that enhances insulin secretion by pancreatic β-cells.

Conclusion

The present investigation entitled "Evaluation of Antidiabetic Activity of Cucurbita maxima (Seeds) and Triticum aestivum (Wheatgrass) Extract in Wistar Rats" was undertaken to scientifically validate the traditional claims regarding the use of pumpkin seeds and wheatgrass in diabetes management. Overall, the study demonstrates that Cucurbita maxima seeds and Triticum aestivum wheatgrass possess significant antidiabetic activity, individually and more prominently in combination, owing to their phytochemical richness and multifaceted mechanisms. These plants offer holistic management of diabetes by simultaneously targeting hyperglycemia, insulin resistance, dyslipidemia, oxidative stress, and tissue damage.

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