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Therapeutic effect of ginger garlic powder in rats with induced diabetes

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Abstract: The purpose of this study was to examine the potential hypoglycemic effects of administering ginger (*Zingiber officinale*) and garlic (*Allium sativum*) to rats with induced type 2 diabetes. A total of forty-five male adult albino rats were randomly assigned to five groups. The groups were named Normal Control, Diabetic Control, Ginger group, Garlic group, and a combination group of ginger and garlic. Diabetes was produced in all groups, except the normal control group, using an intraperitoneal injection of streptozotocin at a dosage of 60 mg/body weight. During the course of two months, rats were administered varying amounts of ginger and garlic powders as part of their treatment After the experiment concluded, measurements were taken for glycated hemoglobin, serum glucose, insulin, cholesterol, high density protein, low density protein and liver glycogen levels. These groups exhibited considerably greater serum insulin and high-density lipoprotein concentrations ($P<0.05$) compared to the diabetic control group. Conversely, body weight, fasting blood glucose, total cholesterol, low density lipoprotein, and glycated hemoglobin levels were significantly lower ($P<0.05$) in all groups compared to the diabetic control group. A statistically significant increase ($P<0.05$) increase shown in liver glycogen levels. This study proposes that the utilization of ginger and garlic powders improve the condition of type 2 diabetes and maybe reduce the risk of subsequent diabetic complications.

Keywords: Ginger garlic powder, diabetes and blood glucose.

INTRODUCTION

It is anticipated that the global number of diabetic patients would climb to 536 million in current years. Khunti *et al.* (2023) Several reasons contribute to this, including obesity, energy-dense foods and increased life expectancy. Many medicinal plants include therapeutic compounds used in both herbal and advance medication. Safe and effective concerns regarding oral hypoglycemic medicines have led to a quest for safe and organic medications for diabetes therapy.

Insulin is a crucial therapeutic agent for treating diabetes, but numerous researchers are striving to discover alternative insulin options derived from plants or synthesised for diabetes treatment. *Allium* species, such as onions and garlic, are utilised for flavouring, traditional medicine and as food items. Garlic's use as a hypoglycemic agent has Documented in Europe (Ibrahim *et al*., 2020). Garlic (*Allium sativum)* has gained recognition in modern medicine for its widespread health and biological properties include boosting immunity, detoxifying foreign compounds, reducing metabolic complications and providing antibacterial protection (Rouf *et al.*, 2020).

Garlic includes sulfur-containing molecules such as derivatives of cysteine like sulfoxide and s-alkyl. These chemicals are fragmented by an enzyme allinase in to volatile compound that are thiosulfinate and polysulphide. The chemicals exhibit fibrinolytic, hypocholesterolemia, antibacterial, antidiabetic and other biological properties (Goncharov *et al.*, 2021).

Ginger, scientifically known as *Zingiber officinale*, is a highly sought-after spice that has widespread usage across the globe. Ginger originated in Southeast Asia and subsequently moved to Europe. It has been utilized as a natural remedy for numerous years, effectively treating various symptoms such as pain, nausea, cold-induced syndromes and indigestion (Waghmare *et al.*, 2022). Ginger has been reported to contain anticlotting, anti-cancer, antidiabetic, analgesic and anti-inflammatory effects, according to Fakhri *et al*. (2023). This study aimed to examine the therapeutic effects of consuming ginger and garlic in the diet, both individually and in combination, on rats with type 2 diabetes.

MATERIALS AND METHODS

Preparation of raw material
Garlic and ginger both are herbaceous perennial plants (Ref. No. 1647) were taken from Ayub Agricultural Research Institute, Faisalabad. Both were grinded separately and mixed with according to given dose.

Animal modeling
For this experiment forty-five adult male rats with mean weight of 180±30gm were taken from the Department of physiology Government College University Faisalabad. The rats were kept in an environment with a relative humidity of 50±10% and a light/dark cycle of 12 hours of

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light followed by 12 hours of darkness. Food and water were stored in exposed receptacles affixed to the walls of the enclosures. All animals were subjected to daily cleaning and water and food were changed twice a day. The study protocol was authorized by the University's Committee of Animal Welfare and Research Ethics (Ref. No. 2772). Following a two-week period of housing, a total of 9 rats were selected as control group (NC), and provided regular diet. The remaining rats were administered varying dosages of garlic and ginger powders for a duration of 8 weeks. For inducing T2DM, nicotinamide (NIC) injected with the ratio of 110mg/kg bodyweight and after 15 minutes 60mg/kg body weight Streptozotocin injected intraperitoneally to overnight starve rats (Waghmare *et al.*, 2022).

Experimental protocol

In this in *vivo* experiment, all healthy rats were separated into five groups, each consisting of 9 rats. The groups were named based on the foods they were given.

Group 1: Normal control rats (NC)
Group 2: induce T2DM group (DC)
Group 3: rats received ginger powder GrP_{15}g/100g diet
Group 4: rats received garlic powder GrP_{15}g/100g diet
Group 5: rats received ginger and garlic powder (GnP_{15}+GrP_{15}).
g/100g diet

Normal control and diabetic control received basal rat diet. Group three received ginger powder 15g/100g diet and group four received garlic powder 15g/100g diet and group five received combination of 15g ginger and 15g garlic g/100g diet. In this experiment, rats were allocated into a Completely Randomised Design (CRD).

Sampling procedure

Sampling procedure involved sacrificing overnight fasted rats at last of the experiment. Rat liver and sample of blood obtained for more analysis. For glycated haemoglobin (HbA1c) analysis blood samples for taken and stored at 4°C. Blood sample was centrifuged at 2000 rpm for 20 minutes to obtain supernatants for serum glucose, insulin, lipid profile and liver glycogen.

Biochemical analysis

The calorimetric determination was conducted using BioMed diagnostic kits REF. 1324301. Plasma insulin levels (REF. 2346123) were assessed following the method outlined by Finlay *et al*. (2007). Glycated Haemoglobin and cholesterol level was measured using kit REF. 2371546. Glycogen level was determine using ELIZA kit from My Biosource, Catalog Number: MBS7293935.

STATISTICAL ANALYSIS

Statistical significance was assessed using one-way (ANOVA) and comparison of individual value using Duncan's multiple range (DMR) test by using SPSS (Version 24).

RESULTS

This study found that mixture dose of ginger and garlic powders effectively lowered fasting blood glucose levels in rats with STZ-diabetes. Statistically significant ($P<0.05$) results were observed regarding body weight and lipid profile which shown in table 1.

Our results found that administering garlic and ginger powder in diabetic rats, as well as their combination dose resulted to a considerable decrease in HbA1c levels as well as fasting glucose and liver glycogen related to the diabetic control group (table 2).

DISCUSSION

Our findings support (Ibrahim *et al*., 2020) research, which showed a notable decrease in serum glucose after fasting interval in diabetic mice after being treated with garlic dose of 15g in diet for four weeks Oral administration of garlic juice at a dosage of 1.5mL/100g BW daily for eight weeks notably decreased blood glucose levels in diabetic rats.

Ginger alleviated the hyperglycemia caused by diabetes with STZ. Two compound shogaols and gingerols present in ginger having anti diabetic properties that lower the increase level of glucose in induce diabetic rats (Alharbi *et al.*, 2022). Elgayar *et al*. (2020), found that injecting extract of ginger intraperitoneally with amount of 400 milli gram per kilogram body weight resulted decrease glucose in blood also fat concentrations in rats fed a control diet for 40 days. Elgayar *et al*. (2020) discovered that administering 12g powder of ginger to various individuals once did not have any impact on hyperglycemia.

Serum insulin concentration is essential for regulating appropriate blood glucose levels. This study demonstrated that administering various quantities of ginger and garlic powders for eight weeks prominently higher the value of insulin in STZ induced mice. The main sulphur compounds found in garlic demonstrate the ability to stimulate insulin secretion in both isolated beta-cells of a healthy rat pancreas and in the pancreas of diabetic rats.

Ginger contains an active component known as gingerol and gingerol-sensitive neurons may be capable of inducing insulin production in the combined GnP+GrP group (Melino *et al.*, 2021). Gingerol demonstrated a defensive impact and key enzymes α-amylase and α-glucosidase that regulate carbohydrate metabolism in relation to high blood sugar and T2DM. (Goncharov *et al.*, 2021) Haemoglobin glycation occurs during the

Table 1: Effect of ginger garlic powder on body weight and lipid profile (mg/dL)

Parameters	Treatment				
	NC	DC	GrP	GnP	(GnP+GrP)
Body weight (gm)	189.34 ± 0.64[a]	203.54 ± 6.01[a]	200.76± 0.78[c]	195.87± 7.76[b]	175.65± 3.01[b]
Cholesterol (mg/dl)	106.21± 3.25[a]	194.73 ± 3.23[c]	175.43± 2.43[c]	142.78± 2.34[b]	123.67± 1.73[b]
HDL	49.45 ± 0.43[a]	37.46 ± 0.79[d]	42.89± 0.83[c]	43.92± 0.59[c]	45.65± 0.57[b]
LDL	129.43± 0.38[a]	162.56 ± 0.65[c]	159.48± 0.69[b]	156.3± 0.21[b]	149.65±0.45[b]

Table 2: Effect of ginger garlic powder on weight management, glucose, insulin and glycogen level

	Treatment				
	NC	DC	GrP	GnP	(GnP+GrP)
HbA_{1c} (ng/ml)	12.03 ± 0.37[a]	21.13 ± 0.37[c]	16.07± 0.35[b]	14.34± 0.34[b]	12.04± 0.43[b]
Fasting Galucose (mg/dl)	105.23 ± 3.23[a]	204.87± 2.87[d]	141.65±2.21[c]	135.56±2.62[b]	117.43±3.98[b]
Insulin (uIU/mL)	4.65±0.23 [a]	2.48± 0.34 [d]	2.93±0.25 [c]	3.52±0.19 [c]	4.32±0.17[b]
Liver glycogen(umol/g)	231.68±2.72[a]	83.34±4.58[b]	87.87±2.13[b]	95.56±2.43[b]	123.58±2.39[b]

Negative control (NC), Diabetic control (DC), received ginger powder GrP_{15}g/100g diet, received garlic powder GrP_{15}g/100g diet, received ginger and garlic powder ($GnP_{15}+GrP_{15}$). Significance ($p<0.05$) is denoted by distinct letters (a, b, c, and d) within a row.

lifespan of red blood cells by the attachment of sugar in the β-chain of haemoglobin. These findings support Carvalho research, which showed that consuming 2g of ginger powder daily for 3 months led to a substantial reduction in HbA1C and LDL in type 2 diabetes individuals.

Our finding shows that regular small dose of mix powder of ginger and garlic effectively reduced the level of LDL and were nearly normalized in STZ diabetic rats treated with mix dose showing a more efficient rate compared to LDL levels in the diabetic control group. The liver is crucial for synthesising glycogen and reducing postprandial hyperglycemia. Glucose is stored intracellularly as glycogen. The concentration of insulin in tissues serves as a direct indicator of its function, which involves activating glycogen synthase and suppressing glycogen phosphorylase. This results in an elevation of intracellular glycogen levels.

Streptozotocin leads to the death of β-cells, that lower the insulin concentration. As a result, the levels of glycogen decrease in tissue which are insulin dependent like skeletal muscle and liver because they depend on insulin.

This research demonstrated a considerable drop in liver glycogen levels in the diabetic control group. However, after intervention by mix dose of ginger garlic powder, increase in liver glycogen levels was observe. Blood glucose concentration in diabetic rats decreased significantly by almost 70% of their initial levels, while the liver glycogen levels did not show a significant increase following treatment with a ginger extract. Additionally, it aligns with Rouf *et al.*, (2020) findings that administering an aqueous ginger extract to diabetic rodents led to an increase in glycogen content in the kidney, with no significant increase observed in skeletal muscle and liver glycogen levels.

CONCLUSION

The study showed that giving ginger and garlic powders to rats with STZ-induced diabetes for a period of two months significantly decrease glycated heamoglobin, liver glycogen and fasting glucose and LDL values. This powder has the ability to enhance liver glycogen and HDL levels. Our research recommends that *Zingiber officinale* and *Allium satvium* may exert useful health effects on diabetes, potentially paving the way for the creation of novel antidiabetic remedy. Finding of this work suggest that ginger garlic has a potential to provide protection and prevent complications related to diabetes.

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