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BIOCHEMICAL EFFECTS OF LYCOPENE ON BLOOD GLUCOSE IN HIGH SUCROSE DIET FED MALE WISTER ALBINO RATS.

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ABSTRACT

OBJECTIVE: To evaluate the Biochemical effects of lycopene on blood glucose in high sucrose diet fed male wister albino rats. **METHODS:** An experimental research, spanning six months and carried out at LUMHS Jamshoro, utilized 60 adult male Albino Wistar rats, which were randomly assigned to four groups. Group A received 0.9% normal saline, while Group B, serving as the positive control, was given a sucrose-rich diet with no additional treatment. Experimental Groups C and D were administered the same sucrose diet along with lycopene at doses of 40 mg/kg and 60 mg/kg body weight, respectively, over a 28-day period. Lycopene was delivered daily through intragastric intubation. After the treatment phase, blood samples were collected via cardiac puncture, and serum was separated for biochemical testing to assess blood glucose levels. Statistical evaluation was carried out using SPSS software version 23.0. **RESULTS:** After four weeks, Group A (negative control) had a mean glucose level of 135.8 mg/dL, while Group B (positive control) showed a significantly higher level of 206.8 mg/dL (P=0.0001). Lycopene-treated Groups C and D exhibited reduced glucose levels of 177.1 mg/dL and 152.4 mg/dL, respectively, showed a statistically significant decrease compared to the positive control (P=0.0001). **CONCLUSION:** The study revealed that lycopene significantly lowered serum glucose levels, suggesting its potential as a safe, accessible, cost-effective, and community-friendly natural option for managing hyperglycemia.

KEYWORDS: Hyperglycemia, lycopene, Natural remedy, Wister albino rats

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INTRODUCTION

Heterogeneous group of diseases which have hyperglycemia in common comes under heading of Diabetes mellitus.1 Which is either due to insufficient insulin secretion, disturbed insulin function or both. Patients with hyperglycemia usually presents with weight loss, polydipsia, polyuria, increase in appetite, neuropathy and disturbed vision.2 Hyperglycemia is the most common sign usually picks up by the doctors. Uncontrolled diabetes mellitus leads to multiple complications and even end organ damage. Regular screening leads to early diagnosis even before appearance of signs and symptoms and also helpful in initiation of treatment at earliest. Some research data has suggested that early treatment decreases the mortality ratio in diabetic patients. Diabetes mellitus is diagnosed on the basis of 3 criterias; Fasting blood glucose ≥ 126 mg/dl, HbA1C ≥ 6.5% and Random blood glucose ≥ 200mg/dl. Although single finding of RBG ≥ 200mg/dl with some symptoms of hyperglycemia usually indicates diabetes mellitus.3 Diabetes mellitus has now become global burden. Its prevalence is increasing day by day. The global prevalence of diabetes mellitus in 2021 was estimated as 10.5% and it is going to rise to 12.2% by 2045. Its prevalence was seen comparatively higher in urban areas (12.1%) and in high income (11.1%) countries.4 International diabetes federation 10th edition has reported that in South Asia the prevalence of diabetes mellitus is continuously rising for the last 20 years. It has reported that the incidence of diabetes mellitus was 8.8% in 2021 and will rise to 11.5% by 2045 in all South Asia countries.5 Excessive use of sweeetners in soda drinks, bakery items etc and lack of physical activity are the major contributions. Sucrose is the most commonly occurred and consumed sugar in our society. Its use causes rapid rise in blood glucose levels. Excessive use of sucrose causes chronic hyperglycemia which leads to numerous health problems. 6 Which includes numerous microvasclar and macrovascular injuries, decreases immune system tendency and may even cause death.7 Although physical exercise, diet control and pharmaceutical medications serve as the first line of management but add on therapy with dietary supplements decreases the dosage of pharmaceutical medications which ultimately decreases their side effects with significant blood sugar control. Many herbs are under research to overcome this global burden of diabetes mellitus. Lycopene has outshined many herbs when it comes to its efficacy as a potent antioxidant, antiobesity and antihyperglycemic agent. It is a natural reddish pigment which is abundantly found in mature tomatoes, watermelon, guavas, papayas etc.8 Its content in different food substances can be estimated by spectrophotometery. It is highly stable molecule and can successfully undergo oxidation and photodegradation. Lycopene is carotenoid in nature without β ionic ring

in it that's why its properties differ from provitamin A.9 Epidemiological studies have demonstrated that lycopene possesses potent antioxidant properties that can mitigate oxidative stress in the pancreatic β-cells of the islets of Langerhans. By protecting these insulin-secreting cells, lycopene may enhance insulin secretion, thereby contributing to the regulation of blood glucose levels.[10] Although the growing interest in plant-based therapies, there remains a notable research gap in identifying novel herbal agents that are not only safer and more cost-effective but also demonstrate significant therapeutic efficacy. Lycopene, a naturally occurring carotenoid found in various fruits and vegetables, holds promise in this regard. Therefore, this study has been designed to evaluate the biochemical effects of lycopene on blood glucose regulation in male Wistar albino rats subjected to a high-sucrose diet. This research aims to contribute to the development of alternative strategies for glycemic control using natural compounds.

MATERIAL AND METHODS

An experimental study was conducted over a period of six months, from October 2022, to March 2023, at the Department of Biochemistry, Liaquat University of Medical and Health Sciences, Jamshoro. A total of 60 adult male Albino Wistar rats, weighing between 150–200 grams, were included in the study. The animals were selected using a non-probability purposive sampling technique, based on specific inclusion and exclusion criteria. Inclusion criteria consisted of adult male Wistar rats with the specified body weight and maintained on a sucrose-rich diet. Female rats, sick animals, and those not within the specified weight range were excluded.

The rats were randomly divided into four groups (n=15 per group). Group A, "negative control group" was administered a placebo, which was a solution of 0.9% normal saline, to ensure no active treatment was given. On the other hand, Group B, designated as the positive control group, was provided with a high-sugar diet for a duration of 28 days without receiving any additional treatment, allowing the researchers to observe the effects of the sucrose-rich diet on the rats. Group A served as the negative control and received 0.9% normal saline as a placebo. Group B, the positive control group, was administered a sucrose-rich diet without any treatment for 28 days. The experimental groups, Groups C and D, were given a sucrose-rich diet along with lycopene therapy. Group C received 40 mg/kg body weight of lycopene, while Group D received 60 mg/kg body weight. Lycopene was dissolved in 0.5 mL of corn oil and administered via intragastric intubation for 28 consecutive days. Sucrose was prepared at a concentration of 30 g/L in distilled water, and each rat received 10 mL daily in their drinking water over the same period. Following the intervention, animals from all groups underwent blood sampling. Blood was collected via cardiac puncture into EDTA tubes. The samples were then centrifuged at 5000 rpm for 15 minutes to isolate serum for biochemical analysis. Random blood glucose levels were measured and compared among the groups. Statistical analysis was performed using SPSS version 23.0 (IBM Corp., USA). Data were expressed as mean ± standard

deviation (SD), and group comparisons were made using one-way analysis of variance (ANOVA). A p-value of less than 0.05 was considered statistically significant at a 95% confidence interval.

RESULTS

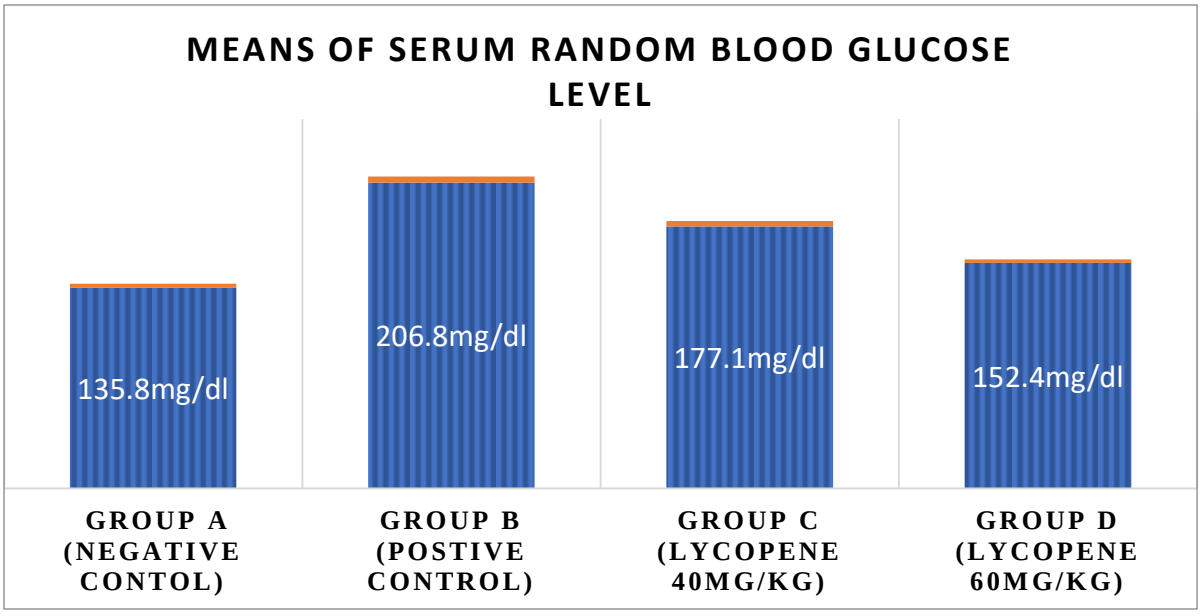
Serum Random blood glucose (mean ± SD) levels of negative and positive controls (Group A and B) and experimental groups (Group C and D) were compared between and among on SPSS package 23.0. Table shows the end experiment (after 4 weeks) results of serum Random blood glucose levels in experimental groups that were treated with Lycopene. Serum Random blood glucose levels of controls and experimental groups were analyzed for statistical significance of differences by using One-way analysis of variance.

Table showing Random blood glucose in experimental and control groups

Groups	Mean	SD	SEM	P-Value
Group A. -ve control	135.8	2.7	0.9	<0.001
Group B. +ve control	206.8	4.1	1.4	
Group C. Lycopene 40mg/kg	177.1	3.7	1.2	
Group D. Lycopene 60mg/kg	152.4	2.4	0.8	

Serum Random blood glucose levels of negative and positive controls were found as 135.8 ± 2.7 (SEM 0.9) mg/dl and 206.8 ± 4.1 (SEM 1.4) mg/dl (P=0.0001). P-Value points to the differences were statistically significant. Compared to the positive controls, the serum Random blood glucose in lycopene treated groups C and D was 177.1 ± 3.7 (SEM 1.2) and 152.4 ± 2.4 (SEM 0.8) mg/dl respectively. Significant decrease in serum Random blood glucose was noted in lycopene treated groups as compared to the positive controls (P=0.0001).

Graph showing Serum Random blood glucose levels (mg/dl) in controls and cases



DISCUSSION

The present experimental study evaluated the hypoglycemic potential of lycopene in male Wistar albino rats fed a high-sucrose diet to induce hyperglycemia. Lycopene supplementation was administered following successful induction of elevated blood glucose levels to assess its glucose-lowering efficacy. The findings demonstrated a significant reduction in serum random blood glucose levels in lycopene-treated groups compared to untreated hyperglycemic controls.

These results were supported by earlier studies. For instance, Naoto Hashimoto et al. investigated the effects of lycopene-rich versus lycopene-free tomato homogenates on serum glucose in rats over a 4-week period. The study revealed a 10% and 9% reduction in glucose levels at 15 and 30 minutes, respectively, following an oral glucose tolerance test in the group receiving lycopene-rich tomatoes.[13] This outcome aligns with our findings, reinforcing lycopene's role in improving glucose metabolism. Additionally, an experimental study by Fatima SN et al examined the impact of lycopene supplementation on thiocetamide-induced toxicity in 24 albino Wistar rats. After 12 weeks, the results showed a notable decrease in serum glucose levels in the lycopene-treated group, further validating the glucose-lowering potential of lycopene observed in our study.[14] These consistent findings across various studies support the therapeutic potential of lycopene as a natural, safe, and effective agent for managing hyperglycemia, particularly in populations at risk due to high-sugar diets.

According to a previous study which was conducted on 72 obese mice induced with a high-fat diet investigated the effects of lycopene and its combination with metformin. The mice were divided into groups, where one received lycopene alone at a dose of 45 mg/kg, and the other group received a combination of lycopene (45 mg/kg) and metformin (50 mg/kg) for 17 weeks. Post-experimental analysis revealed a reduction in blood glucose levels in both groups, with a more pronounced decrease observed in the combination group, suggesting a potential synergistic effect of lycopene and metformin.[15] Another study administered lycopene via oral gavage to rats for one month following diabetes induction using streptozotocin. Analysis of blood and urine samples showed a significant reduction in glucose levels, further supporting the hypoglycemic effect of lycopene. These findings are consistent with the outcomes of the present study.[16] Consistently Bayramoglu A et al. conducted an experimental trial where diabetes was induced in rats using streptozotocin, followed by lycopene administration at 2.5 mg/kg for seven days. Blood glucose analysis post-treatment demonstrated a marked reduction, aligning with the results of our study and further reinforcing the antidiabetic potential of lycopene.[17]

Basis on the evidence provided by previous studies, it can be suggested that lycopene has significant potential in lowering blood glucose levels, making it a promising candidate for managing hyperglycemic conditions. As per findings observed in animal models provide a solid foundation for this hypothesis, though the study is

limited by its use of a small sample size and the reliance on animal models, which may not fully replicate human physiology. Hence, future research should aim to extend these findings by conducting studies on human subjects with larger sample sizes to validate the efficacy and safety of lycopene as a therapeutic agent for hyperglycemia. Such studies could provide more conclusive evidence and support the potential application of lycopene in clinical settings for glycemic control.

CONCLUSION

As per study conclusion, lycopene demonstrates significant blood glucose-lowering potential and has been shown to effectively reduce serum blood glucose levels. Such beneficial effects could be used to address hyperglycemic conditions prevalent in the urban population of Pakistan. Being a natural compound, lycopene is not only safe and effective but also easily accessible and cost-effective, making it a viable option for community use in managing blood glucose levels.

ETHICS APPROVAL: The ERC gave ethical review approval.

CONSENT TO PARTICIPATE: written and verbal consent was taken from subjects and next of kin.

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AUTHORS' CONTRIBUTIONS:

All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated in the work to take public responsibility of this manuscript. All authors read and approved the final manuscript.

CONFLICT OF INTEREST: No competing interest declared

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