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Effect of Zinc Rich Supplementation of Sesame Seeds Incorporated Biscuits on FBG of Type-2 Diabetic Subjects

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Abstract

Introduction: The zinc ion plays an essential role with insulin in the pancreatic β cell, activating multiple cell signaling cascades. It also plays a relevant role in antioxidant defense in patients with type 2 diabetes mellitus. Supplementation of zinc has been found to improve insulin level and fasting glucose level. Sesame (*Sesamum indicum*, family Pedaliaceae) seeds are one of the richest sources of zinc, iron and also have pharmacological activities such as antidiabetic, antihypertensive, antibacterial and antioxidant effects.

Objectives: the aim of present study, to evaluate serum zinc level in normal and type-2 diabetic patients and to assess the effect of zinc food supplementation in the improvement in control of blood glucose level.

Methodology: In the study normal (n-30) and type-2 diabetic (n-30) volunteer subjects of both genders (age 35-50 years) enrolled for the study. All normal and diabetic subjects were screened for FBG and serum zinc level, to find out if there is any correlation between serum zinc level and FBG level. Then the group of diabetic subjects was supplemented biscuits prepared by incorporation of defatted sesame seeds powder with 3mg/day zinc content. Intervention was done for 45 days. All diabetic subjects were screened after zinc supplementation for FBG and serum Zn level, to compare both normal and diabetic subjects to assess the effect of zinc in diabetic subjects FBG level again.

Results: The results revealed that the mean of serum zinc level in normal subjects was 107.34±24.04 µg/dl and diabetic subjects it was 61.37±13.86 µg/dl. The mean of FBG in non-diabetic subjects was 95.86±8.13 mg/dl and in diabetic subjects was 131.06±11.64mg/dl. After the supplementation of zinc in diabetic subjects in serum zinc level was increased to 109.53±14.79 µg/dl and FBG decreased to 115.26±13.51 mg/dl and these changed were significantly at 1% level of significance.

Conclusion: Zinc supplementation in patients with diabetes improves glycemic control and promotes healthy life. So, in study the role of zinc has been found to be associated with the improvement of glycemic control.

Keywords: Diabetes, Zinc, Sesame, Supplements, Insulin.

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INTRODUCTION

Diabetes is a metabolic disorder marked by defects in insulin secretion and function of insulin, which leads to long-term harm, organ failure and dysfunction. Diabetes is a health related global concern that threatens the economy of developing nations, especially India. India is the second most populous country to have a large number of people affected with diabetes. In India, 65.1 million people are affected by diabetes and that number will increase to 109 million by 2035 (Tomic *et al*., 2022).Diabetes arises from multiple pathological mechanisms, such as insulin resistance and autoimmune death of pancreatic β-cells, which impair the metabolism of proteins, fats and carbohydrates due to insufficient insulin. Insufficient insulin secretion or reduced tissue responses can lead to deficient insulin action. These abnormalities frequently overlap in the same patient, making it difficult to identify which one causes hyperglycemia. Long-term consequences from diabetes include peripheral and autonomic neuropathy, nephropathy, eyesight loss, hypertension, increased risk of cardiovascular and cerebrovascular disorders and changes in lipoprotein metabolism (Alam *et al*., 2021).

The zinc ion plays an essential role with insulin in the pancreatic β cell, activating multiple cell signaling cascades. Zinc ions coordinate six insulin monomers (hexamerization), which enhance the stability insulin and the storage capacity of the insulin-secreting vesicles. Moreover, zinc is known for its antioxidative property as a cofactor of the important antioxidative enzyme, which may reduce the lipid peroxidation and development of insulin resistance in diabetes mellitus(Norouzi *et al*., 2017). Zinc plays a relevant role in antioxidant defense in patients with type 2 diabetes mellitus. This mineral may act by different protection mechanisms by notably being an essential cofactor for more than 300 enzymes, such as superoxide dismutase. This mineral also facilitates reduction and neutralization of free radicals. Zinc, an essential trace element, is indispensable for the proper functioning of numerous enzymes, transcription factors, and signaling pathways within the human body. Zinc plays an important role in glucose and lipid metabolism. Zinc reduces glucose absorption and synthesis, whilst promoting glucose metabolism and storage(Cruz *et al*., 2015Another important aspect which worth to notice is the beneficial effects of dietary intake of Zn and plasma Zn level on inflammatory status (Cruz *et al*., 2015). Supplementation of zinc has been found to improve fasting insulin level and fasting glucose level. Rich sources of dietary zinc in include sesame seeds, beans, nuts, almonds, whole grains, sunflower seeds and blackcurrant (USDA, 2012).

Sesame (*Sesamum indicum,*) family Pedaliaceae seeds are one of the richest sources of zinc and iron. It a present in good amount of manganese, copper, calcium, magnesium, phosphorus, vitamin B1 and dietary fiber. Sesame seeds are rich in nutrients and have the reputation of being an "all-purpose nutrient bank" and the "crown of eight grains" (Wei *et al*., 2022). In addition to these important phytonutrients, sesame seeds contain two unique substances: *sesamin* and *sesamolin*. Both of these substances belong to a group of special beneficial fibers called lignans, and have been shown to have a cholesterol-lowering effect in humans, and to prevent high blood pressure and increase vitamin E supplies in animals. Sesame contains significantly more polyunsaturated fats, including omega-3 fatty acids, which protect the heartfrom damage, regulate blood pressure, and might reduce therisk of type-2 diabetes (Silky and Bisla, 2024). Sesamin has also been found to protect the liver from oxidative damage (Shivhare and Satsangee, 2012). Sesame seeds have special significance for human nutrition on account of its high content of sulfur amino acids and phytosterols. Itis an important source of phytonutrients such as omega-6 fatty acids, flavonoid phenolic anti-oxidants, vitamins, and dietary fiber withpotential anti-cancer, as well as health promoting properties (Silky and Bisla, 2024).

The aim of present study, to evaluate serum zinc level in normal and type-2 diabetic patients and to assess the effect of zinc supplementation on in the improvement of blood glucose level.

Materials and Methods

The present study was conducted in Banasthali University and its surrounding area. Total 60 subjects including both gender (age 35-50 years) were selected, with middle socio economic status from both categories type-2 diabetic (n=30) subjects and non-diabetic subjects (n=30) to participate in the study on the basis of pre-decided criteria.

Criteria for the selection of samples:

- Subjects with diagnosed well non-diabetic and type-2 diabetics
- Age between 35-50 years
- Without any physical deformity and free from any kind of infection

- Non allergic to any food item

Criteria for exclusion:

- Pregnant women
- Subjects on insulin therapy
- Subjects have any food allergy
- Subjects having treatment for abnormal lipid profile
- Age more than 50 years and less than 35 years

Assessment of FBG and Serum Zinc level of diabetic and non-diabetic subjects

To determine the difference between the serum zinc level and FBG (fasting blood glucose) level of both groups (diabetic and non-diabetic subjects) were screened for serum zinc level and FBG level. After testing it was found that mean serum zinc level of diabetic subjects was 61.37±13.86 µg/ dL and non-diabetic subjects mean serum zinc level was 107.34±24.04 µg/dL. Mean FBG level of diabetic subjects was 131.06±11.64 mg/dL and of non-diabetic subjects was 95.86±8.13. This indicate link between serum zinc level and diabetes. For estimation of laboratory parameters fasting blood sample was collected. FBG was estimated by Glucose-oxidase and peroxidase method using auto-analyser. Serum zinc was measured by Colorimetric method. Normal reference value of serum zinc taken was 65-70µg/dL ((Hotz *et al*., 2003; Wessells and Brown, 2012).

The following stage of the study involved examination of the impact of dietary supplements of zinc rich food items on diabetic subjects. After then, fifteen diabetic subjects were randomly assigned to each of two groups:

1. Control group (N=15)
2. Diabetic supplementation group (N=15).

Food product development

Other components and the essential ingredients, defatted sesame seeds were bought from a general store in Banasthali University, Rajasthan. The seeds were cleaned and free from foreign materials. Seeds were ground and converted into powder. The biscuits were prepared by incorporation of sesame seeds powder.

Preparation of supplementation

The total amount of powder 30g (equivalent to 3mg zinc/day) incorporated in supplemented through biscuits. Each participant was required to eat two biscuits daily for 45 days (6 weeks). The parameter was assessed in the groups before and after supplementation: Fasting blood glucose (FBG) level and Serum zinc levels.

For estimation of laboratory parameters fasting blood sample was collected. FBG was estimated by Glucose-oxidase and peroxidase method using auto-analyser. Serum zinc was measured by Colorimetric method. Normal reference value of serum zinc taken was 65-70µg/dL (Hotz. *et al*., 2003; Wessells and Brown, 2012).

Table 1: General information of the diabetic subjects

Groups	Diabetic subjects	Non-diabetic subjects
Gender		
Male	17 (57%)	25 (83%)
Female	13 (43%)	5(17%)
Age		
35-40 years	15 (50%)	10 (33%)
41-45 years	10 (33%)	12 (40%)
46-50 years	5 (17%)	8 (27%)
Diabetic history		
1-2 years	10 (33%)	-
3-4 years	15 (50%)	-
5-6 years	5 (17%)	-

RESULTS AND DISCUSSIONS

Zinc has anti-oxidant properties and that zinc supplementation reduces oxidative stress. A present study confirmed these findings, and concluded that zinc supplementation in patients with diabetes improves glycemic control and promotes healthy life. Hence, it is evident that zinchas a promising potential as a novel therapeutic agent in diabetes. Studies have also shown that diabetes is commonly accompanied by hypozincemia and hyperzincuria.

Table 2: Serum Zinc level and FBG level of non-diabetic and diabetic subjects

Groups	Diabetic subjects	Non-diabetic subjects
FBG (mg/dl)	131.06±11.64	95.86±8.13**
Serum Zn (µg/dl)	61.37±13.86	107.34±24.04**

NS-non significant, *P≤0.05 and ** P<0.01 Values are in mean ± standard deviation

The mean serum zinc level of non-diabetic subjects and diabetic subjects was 107.34±24.04** µg/dl and 61.37±13.86 µg/dl respectively. The

mean fasting blood glucose level (FBG) of non-diabetic and diabetic subjects was 95.86±8.13** mg/dl and 131.06±11.64 mg/dl respectively. Using student 't'- test diabetic subjects were found to have significantly low in serum zinc level and high in FBG level as compared to the non-diabetic subjects.

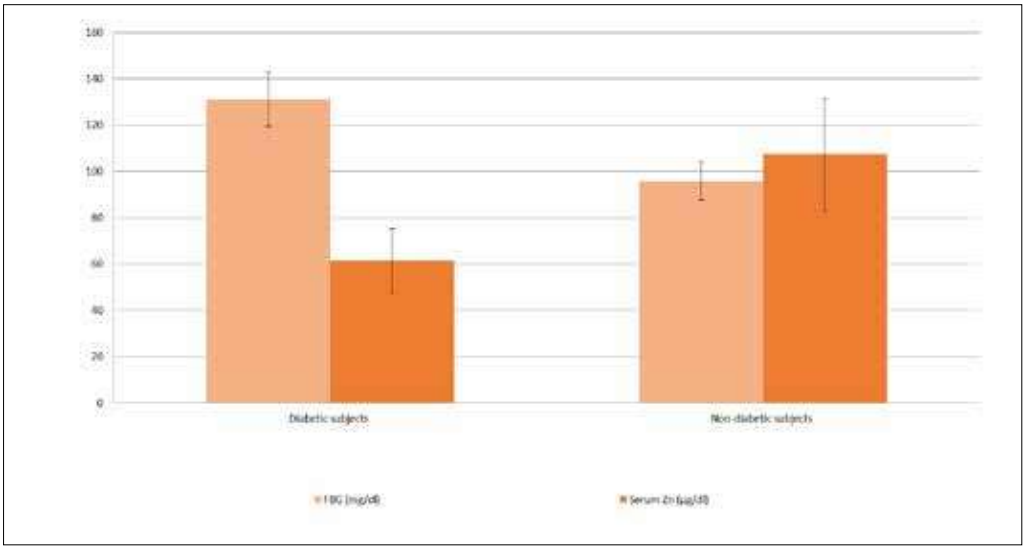

Fig. 1: Mean FBG level and serum zinc level of diabetic and non-diabetic subjects

Table 3: Effect of supplementation of zinc rich biscuits on FBG and serum zinc level of type-2 diabetic subjects

Groups	Control group (CG)		Sesame seeds supplementation (SS)	
	Before	After	Before	After
FBG (mg/dl)	130.16±12.38	129.16±7.39ns	131.06±11.64	115.26±13.51**
Serum Zn (µg/dl)	62.82±3.41	63.45±9.49ns	61.37±13.86	109.53±14.79**

NS-non significant, *P≤0.05 and ** P<0.01 Values are in mean ± standard deviation

Table 2: FBG (fasting blood glucose) of sesame seeds supplements (SS) before supplementation was 131.06±11.64 mg/dl and after supplementation was 115.26±13.51 mg/ dl. FBG level of sesame seeds supplementation was significantly decreased and no significant difference was observed in control group.

The mean of serum zinc level of sesame seeds supplementation before supplementation was 61.37±13.86 µg/dl and after supplementation was 109.53±14.79 µg/dl respectively. Serum zinc level of sesame seeds supplementation was significantly increased and no significant difference was observed in control group (CG).

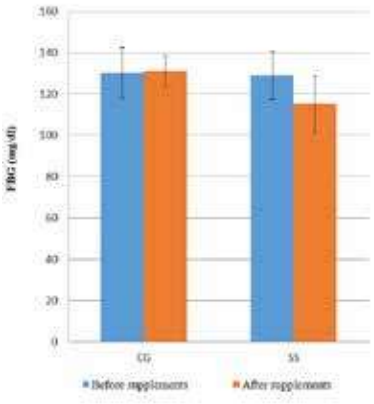

Fig. 1: Mean FBG level of diabetic subjects

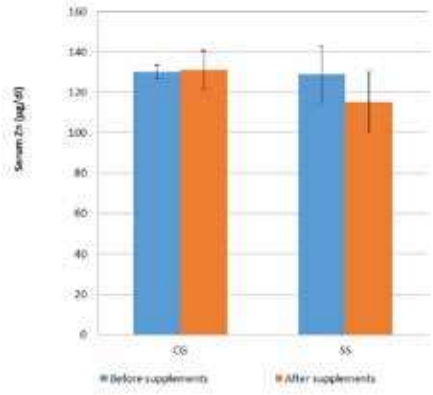

Fig. 2: Mean serum zinc level of Diabetic subjects

CONCLUSION

Zinc deficient was observed in type-2 diabetic subjects. High mean serum levels of FBG and low mean in serum zinc level were observed in the study of diabetic subjects. The effect of zinc supplementation was significant reduction in FBG, in patients with type-2 diabetes. The improvement in biscuit quality involves primarily novel recipes, process improvement, nutritional enrichment and health promotion. Zinc supplementation produce a significant improvement in glucose disposal related to increase activities of insulin independent glucose transportersThe results of this study show that zinc supplementation can modulate glycemic control in diabetic patients. Specifically, we found that zinc supplementation alone is associated with reduced blood glucose concentrations, increased insulin sensitivity, decreased non-enzymatic glycosylation, and reduced inflammation in these subjects. So, in study the role of zinc has been found to be associated with the improvement of glycemic control.

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