Indian Journal of
Nutrition

Open Science Publications

Volume 11, Issue 2 - 2024

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Effect of Zinc Supplementation on Fasting Blood Glucose Level of Type 2 Diabetic Subjects

Research Article

Silky[1]* and Gita Bisla[2]

Department of Food Science and Nutrition, Banasthali Vidyapith, Rajasthan, India

***Corresponding author:** Silky Sharma, Department of Food Science and Nutrition, Banasthali Vidyapith, Rajasthan, India. E-mail Id: sharmasilky3003@gmail.com

Article Information: **Submission:** 29/08/2024; **Accepted:** 13/09/2024; **Published:** 16/09/2024

Abstract

Introduction: The role of zinc in incidence of diabetes has been established. Supplementation of zinc has been found to improve insulin level and fasting glucose level. Pumpkin (Cucurbita pepo) seeds are an excellent source of zinc, protein and also have pharmacological activities such as antidiabetic, antihypertensive, antibacterial and antioxidant effects.

Objectives: The aim of present study, to evaluate serum Zn level in normal and type-2 diabetic patients and to assess the effect of zinc food supplementation in the improvement in the 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 Zn level, to find out if there is any correlation between serum Zn level and FBG level. Then the group of diabetic subjects was supplemented biscuits prepared by incorporation of defatted pumpkin 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 Zn level in normal subjects was101.37±25.76µg/dl and diabetic subjects it was 62.70±11.74µg/dl. The mean of FBG in normal subjects was 99.27±8.40mg/dl and in diabetic subjects was 135.94±13.51mg/dl. After the supplementation of zinc in diabetic subjects in serum zinc level was increased to 112.89±17.04µg/dl and FBG decreased to 109.86±32.97mg/dl and these changed were significantly at 1% level of significance.

Conclusion: Zinc supplementation produce a significant improvement in glucose disposal and increase activities of insulin independent glucose transporters. So, in study the role of zinc has been found to be associated with the improvement of glycemic control.

Keywords: Diabetes; Pumpkin; Zinc;Biscuits; Supplements

Introduction

Diabetes mellitus (DM) is a serious, chronic disease that occurs as a result of either when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces. It remains an important public health problem of the 21st century across all over the world, affecting both developed and developing countries. Evidences show that the increasing trend of prevalence of diabetes mellitus was observed in developing countries. There are different types of diabetes mellitus, where more than 90% are categorized under type-2 diabetes mellitus (T2DM) (Feyisa et al., 2022) [1].

Zinc is involved in over 300 enzymatic reactions and plays a role in DNA synthesis, protein synthesis, wound healing, immune function, and sensory perception, among others, despite its importance. Zinc deficiency is a prevalent problem worldwide, particularly in developing countries. Zinc intake to promote optimal health, this has led to a greater understanding of the mechanisms underlying zinc's role in nutrition and the importance of zinc supplementation in addressing deficiencies (Ozturk et al., 2023) [2]. Zinc determines a greater number of critical life functions than any other single micronutrient. It has catalytic, structural, and regulatory roles that are essential to metabolic pathways, gene expression, hormone

ISSN: 2395-2326

function, immune defense mechanisms and much more making it vitally important to health and growth across the life course (Wessels et al, 2021) [3].

Zinc deficiency is thought to be one of the possible causes of the development of diabetes mellitus. Zinc is directly involved in the synthesis, storage and secretion of insulin. It also maintains the structural stability of insulin. Zinc deficiency was also incriminated in the development of diabetic complications. This was attributed to its antioxidant effect and its contribution as a key component of many anti-oxidases. It inhibits the damage associated with lipid peroxidation and induces the clearance of free radicals (Hussein, 2021) [4].

Supplementation of zinc has been found to improve fasting insulin level and fasting glucose level. The pumpkin seed has many health benefits and are consider as nutritional powerhouses, with a wide variety of nutrients ranging from magnesium and manganese to zinc, copper and protein. The pumpkin seeds have anti-parasitic activity due to the presence of cucurbitin. Pumpkin seeds are generally considered as waste product and it is rich in bioactive compounds with nutraceutical properties. Pumpkin seeds contain remarkably high proportions of essential amino acids along with various elements like K, Cr, Na, Mg, Zn, Cu, Mo and Se; etc. D-chiro-Inositol, isolated from pumpkin has been considered as an insulin action mediator (insulin sensitiser) and has been linked to its antidiabetic activity(Silky and Bisla, 2024) [5].

The aim of present study, to evaluate serum Zn level in normal and type-2 diabetic patients and to assess the effect of Zn supplementation 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 well non-diabetic and diagnosed type-2 diabetes
- 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
- Taking any medication related to diabetes

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

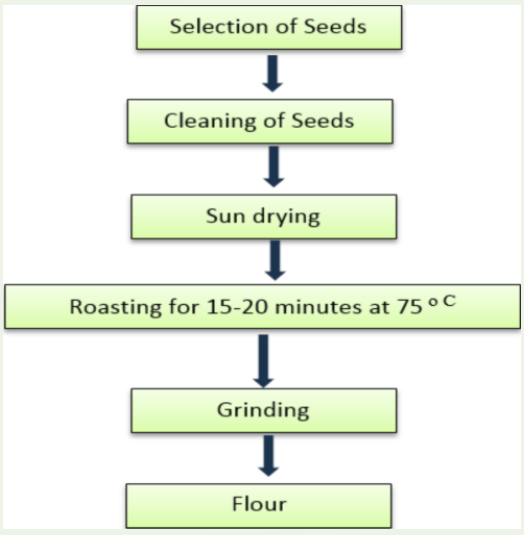
To determine the difference between the serum zinc level and FBG (fasting blood glucose) level of both groups (diabetic and non-diabetic subjects) were screened for serum zinc level and FBG level. After testing it was found that mean serum zinc level of diabetic subjectswas 62.70±11.74 µg/dL and non-diabetic subjects mean serum zinc level was 101.37±25.76 µg/dL. Mean FBG level of diabetic subjects was 135.94±13.51 mg/dL and of non-diabetic subjects was 99.27±8.40. This indicate link between serum zinc level and diabetes. 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

Preparation of pumpkin seeds flour: Other components and the essential ingredients, defatted pumpkin 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 incorporating pumpkin seeds powder in different proportion as a main ingredient. The four variations of product were prepared. In the development process biscuits were prepared with pumpkin seeds powder used in four proportions variants A- 5%, B-10%, C-20% and D-30% and one Std-control sample of biscuits were prepared. The developed biscuits were gone through sensory analysis by a semi trained panel of 20 university going females (25-28yrs) from Department of Home Science (Food Science and Nutrition), Banasthali Vidyapith, Rajasthan. The judges were served biscuits with one control and four variant samples in food lab. Judges were assigned to measure the degree of acceptance of product based on color, flavor, appearance, texture, taste and overall



Flow chart representing of pumpkin seeds flour.

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acceptability using a score card of 9-point Hedonic Rating Scale from "like extremely and dislike extremely". 30% of pumpkin seeds biscuits were the most acceptable variant of biscuits.

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 (Hashim et al., 1996; Wessells and Brown, 2012) [6,7].

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 plays an important role in glycemic control. It is important in insulin action and carbohydrate metabolism. Oxidative stress plays an important role in the pathogenesis of diabetes and its complications. Zinc is a structural part of key anti-oxidant enzymes such as superoxide dismutase, and zinc deficiency impairs their synthesis, leading to increased oxidative stress. Zinc supplementations in patients with diabetes mellitus, namely improved glycemic control and lipid parameters, with probable improvement in anti-oxidant status. Glycemic control is one of the most important therapeutic challenges in present day diabetes care; our meta-analysis shows that zinc supplementation causes significant reduction in FBG in patients with type-2 diabetes. Several molecular mechanisms are believed to be involved in the regulation of blood glucose levels following zinc supplementation.

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

Groups	Diabetic subjects	Normal subjects
FBG (mg/dl)	135.94±13.51	99.27±8.40**
Serum Zn (µg/dl)	62.70±11.74	101.37±25.76**

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 101.37±25.76 µg/dl and 62.70±11.74 µg/dl respectively. The mean fasting blood glucose level (FBG) of non-diabetic and diabetic subjects was 99.27±8.40 mg/dl and 135.94±13.51 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 (Figures 1-4).

Table 3: FBG (fasting blood glucose) of pumpkin seeds supplements (PS) before supplementation was 135.94±13.51mg/dl and after supplementation was 109.86±32.97mg/dl. FBG level of pumpkin seeds supplementation was significantly decreased and no significant difference was observed in control group. The mean of serum zinc level of pumpkin seeds supplementation before supplementation was 62.70±11.74 µg/dl and after supplementation was 112.86±17.02 µg/dl respectively. Serum zinc level of pumpkin seeds supplementation was significantly increased and no significant difference was observed in control group (CG).

Groups	Control group (CG)		Pumpkin seeds supplementation (PS)	
	Before	After	Before	After
FBG (mg/dl)	130.6±11.48	129.26±7.49ns	135.94±13.51	109.86±32.97**
Serum Zn (µg/dl)	61.43±11.43	62.96±3.34ns	62.70±11.74	112.86±17.02**

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

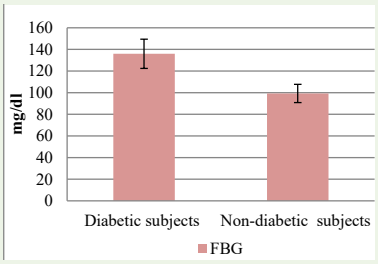

Figure 1: Mean FBG level of diabetic and non-diabetic subjects

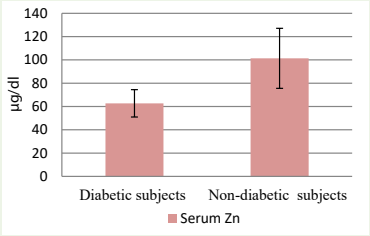

Figure 2: Mean serum zinc level of diabetic and non-diabetic subjects.

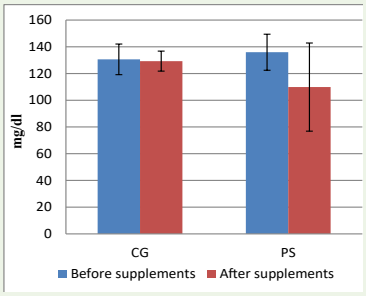

Figure 3: Mean FBG level of diabetic subjects.

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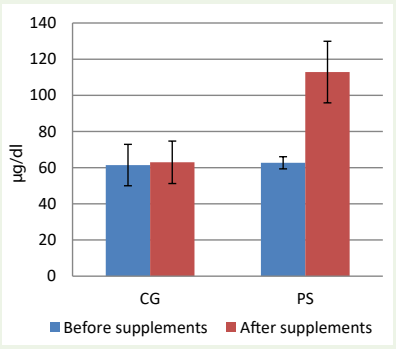

Figure 4: Mean serum zinc level of Diabetic subjects.

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 in patients with type-2 diabetes demonstrates that zinc supplementation has beneficial effects on glycemic control and promotes healthy life. Zinc supplementation produce a significant improvement in glucose disposal related to increase activities of insulin independent glucose transporters. The results of our meta-analysis 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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