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RESEARCH ARTICLE
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# INVESTIGATING THE THERAPEUTIC POTENTIAL OF (CHENOPODIUM QUINOA) WITH CINNAMON SUPPLEMENTATION AGAINST HYPERGLYCEMIA BIOMARKERS IN PRE-DIABETIC HUMAN FEMALE SUBJECTS

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**Abstract**
Glycemic indices are raised in prediabetes, a hyperglycemic state that is not yet as high as in diabetes. With an annual conversion rate of 5%–10%, prediabetes still carries a substantial risk of acquiring diabetes, despite variations in diagnostic standards across the major international professional groups. Preliminary evidence suggests a connection between prediabetes and the consequences of diabetes, such as early retinopathy, early nephropathy, small fiber neuropathy, and an increased risk of macrovascular disease. Several studies have shown that altering one's lifestyle can effectively prevent diabetes, with a 40%–70% relative risk decrease in those who already have prediabetes. People have been using cinnamon as a spice and a herbal cure for a long time. Based on research conducted in vitro and on animals in vivo, cinnamon may have anti-inflammatory, antibacterial, antioxidant, anticancer, cardiovascular, cholesterol-lowering, and immunomodulatory effects. In vitro studies suggests that cinnamon may function as an insulin mimic, enhance insulin action, or boost cellular glucose metabolism. Studies on animals have also demonstrated the substance's strong hypoglycemic effects. The anti-hyperglycemic properties of quinoa combined with cinnamon stick powder were the main focus of this investigation. 45 female pre-diabetic subjects were separated into three groups for this purpose. Treatment groups 1 and 2 had quinoa alone and quinoa with 20g of cinnamon powder for breakfast, respectively, whereas the control group received no treatment. The first and last days of the experiment, after consuming quinoa enriched with cinnamon, were used to test fasting and random blood sugar levels. In addition, HbA1c levels were assessed before and after the trial. An ANOVA test revealed that adding cinnamon stick powder to quinoa significantly lowered fasting and random blood sugar levels. HbA1c, a sign of insulin resistance, decreased in the therapy group as well. Fasting blood sugar, however, did not fall in the control or treatment groups. Results from treatment group 2 were superior to those from treatment group 1. At p0.05, all results were deemed significant.

**Keywords:** Quinoa, nutrition profile, carbohydrates, proteins, fats, β-glucans, fiber, energy

## Introduction

Impaired glucose tolerance (IGT), defined as plasma glucose two hours after ingesting 75 grams of oral glucose, and impaired fasting glucose (IFG), defined as fasting plasma glucose (FPG) of 6.1-6.9 mmol/L (110 to 125 mg/dL), are the two specific parameters used by the World Health Organization (WHO) to define prediabetes (WHO, 2006). In contrast, the American Diabetes Association (ADA) uses a lower cut-off value of 100-125 mg/dL for IFG and the same cut-off value of 140-200 mg/dL for IGT. In addition, the ADA bases its prediabetes classification criteria on hemoglobin A1c (HbA1c) levels ranging from 5.7% to 6.4%. (Nidhi Bansal., 2015).

Numerous studies have demonstrated a link between prediabetes and an increased risk of chronic renal disease and early nephropathy (Gabir et al., 2000). It is unknown what causes this association rather than the effect of prediabetes itself, as there may be other fators present that are linked to both hyperglycemia and nephropathy or an increased incidence of diabetes in this group (Tesfaye et al., 2010).

Qinoa (*Chenopodium quinoa*) seeds are a kind of pseudo or false cereals which are well known for its nutritional value and health benefits. Quinoa (Chenopodium quinoa Willd Amaranthaceae), an ancient grain from South America's Andes Mountains, is rapidly gaining popularity as a functional food and nutraceutical. (2010) Vega-Galvez et al. Among the agricultural food crops that are often sold and consumed in the United States, quinoa is a rich source of phytoecdysteroids (Kumpun et al., 2011; Zhu et al., 2001).

Physiological health benefits of quinoa cannot be denied. It possesses hypoglycemic, immune-modulatory, anti-cancerous, anti-inflammatory, hypotensive and hypo-lipidemic properties. Nutritional profile of quinoa make it an excellent source of protein, phytochemical, and antioxidants (El Hazzam et al., 2020)

In contrast, the fragrance and essence industries utilize a lot of cinnamon due to its scent, which may be used into a variety of meals, perfumes, and medicinal items. Huang Tzou-Chi et al., 2007). Cinnamaldehyde and trans-cinnamaldehyde (Cin), which are found in the essential oil and give cinnamon its scent as well as a number of health advantages, are the two major constituents of cinnamon. Chang and associates, 2007. Examining the anti-hyperglycemic effects of quinoa supplemented with powdered cinnamon stick on fasting and random blood glucose levels in persons at risk for diabetes was the aim of this study.

## Material and methods

### Collection of raw material

Quinoa was purchased from registered “Soul Food Company”. Cinnamon was purchased from “chiltanpure Organics Pvt. Ltd”.

### Cinnamon-enriched quinoa's effects on pre-diabetics are being studied in pre-diabetics

### Selection of Subjects

45 pre-diabetic patients were recruited for the study from the hospital of Lahore after commencing informed consent from them. The entire subject went through the test of random blood sugar level and those with fasting blood sugar 100-125 mg/dl were included in the study.

### Exclusion Criteria

The study excluded male individuals who had additional problems, such as ischemic heart disease. Women who were nursing or pregnant were likewise excluded. Females with diabetes were excluded from the research.

**Table 1**

| **Exclusion Criteria** | |
|---|---|
| **Gender** | Males |
| **Complications** | ischemic heart disease, other metabolic disorder |
| **Others** | Pregnant and lactating women |

**Inclusion Criteria**

All subjects had their blood biochemical analysis performed, which included evaluating their random, fasting blood sugar, and glycated hemoglobin (HbA1c)

**Table 2**

| | **Inclusion Criteria** |
|---|---|
| **Gender** | Females |
| **Disease** | Pre Diabetes |

**Study Duration**

Trail was carried out for 60days in January 2023 to February, 2023.

**Treatment Groups and Treatment Plan**

The goal was to test fasting and random blood sugar levels after consuming cinnamon-enhanced quinoa on the first and last days of the experiment. HbA1c levels were also determined before and after the research.

**Table 3:** Treatment Plan

| **Treatment Groups** | **Title** | **Treatment** |
|---|---|---|
| **$T_0$** | Control group | No treatment |
| **$T_1$** | Treatment group 1 | 250 gm. of quinoa meal prepared supplemented with Nonfat milk |
| **$T_2$** | Treatment group 2 | 1 cup of 250 gm of quinoa meal prepared with supplemented nonfat milk added with 20gm of cinnamon powder |

**Blood Glucose Level**

**Fasting blood sugar level**

Fasting blood glucose levels were measured using ACCU-check meter before fasting after every day on regular basis (Kestilä, Kirsimarja K.,2007)

**Random blood glucose level**

Random blood glucose levels were measured using ACCU-check meter before and after fasting after every day on regular basis (Muchmore, 1999)

**Glycated hemoglobin (HbA1c) monitoring**

HbA1c was measure through commercially available Swedish Kit before and after the completion of tail and values were compared with the control group after 2 months (Reynolds, Timothy M. and Patric, 2006)

**Statistical analysis**

Descriptive statistical analysis was carried out in a completely randomised design (CRD) using the independent sample t-test to determine the degree of significance (p0.05). All statistical analysis is

done using IBM SPSS Statistics 20, and the findings are shown as mean S.D. (D'Agostino & Heeren, 1987).

## Results

The purpose of this research project was to measure blood sugar levels at random and while fasting on the first and last trial days following the consumption of quinoa enhanced with cinnamon. HbA1c was also measured before and after the trial.

### Investigating the Effect of Quinoa Supplemented with Cinnamon on the Biomarkers of Hyperglycemia in Pre-diabetics

Blood glucose levels of participants were measured after fasting (8h), and random blood sugar after two hours of consuming 250 grams of quinoa with and without cinnamon. Pre-diabetic Female Subjects' Fasting Blood Sugar Levels

### Fasting blood glucose levels of Pre-diabetic Female Subjects

The study's findings demonstrated a noteworthy decrease in T2 fasting blood glucose levels. But there was no discernible variation in T1's fasting blood sugar level. Table IV indicates that throughout the course of fourteen days, the blood sugar level in the control group slightly increased.

**Table 4.** Mean ± S.D for Fasting Blood Sugar Level of Pre-Diabetic Female Subjects in mg/dl.

| Duration | $T_0$ | $T_1$ | $T_2$ |
|---|---|---|---|
| **0-day** | 121.17±11.27 | 123.47±9.82 | 124.60±11.02 |
| **60$^{th}$ day** | 131.25±10.87 | 121.83±18.74 | 109.28±9.36* |

Results were taken significantly at $p<0.05$. $T_0$=No treatment, $T_1$= 250 gm of quinoa meal, $T_2$= 250 gm of quinoa meal prepared with fat milk added with 20gm of cinnamon powder.

### Random Blood Sugar Level of Pre-diabetic Female Subjects

The study's findings demonstrated a noteworthy decrease in T2 and T1 blood glucose levels at random. Table 5 illustrates the increase in the control group's random blood sugar level over a fourteen-day period.

**Table 5.** Mean ± S.D for Random Blood Sugar Level of Pre-Diabetic Female Subjects in mg/dl.

| Duration | $T_0$ | $T_1$ | $T_2$ |
|---|---|---|---|
| **0-day** | 176.23±10.11 | 181.54±12.21 | 179.68±8.23 |
| **60$^{th}$ -day** | 182.05±5.56 | 167.03±13.28* | 148.28±9.36* |

Results were taken significantly at $p<0.05$. $T_0$=No treatment, $T_1$= 250 gm of quinoa meal, $T_2$= 250 gm of quinoa meal prepared with fat milk added with 20gm of cinnamon powder

### HbA1c Level of Pre-diabetic Female Subjects

Results of the study showed significant reduction in HbA1c levels of $T_2$. However, no significant difference in HbA1c level was observed in $T_1$. Control group showed no change in HbA1c level over the period of fourteen days as shown in table III.

**Table 6.** Mean ± S.D for HbA1c Level of Pre-Diabetic Female Subjects in mg/dl.

| Duration | $T_0$ | $T_1$ | $T_2$ |
|---|---|---|---|
| **0-day** | 121.17±11.27 | 123.47±9.82 | 124.60±11.02 |
| **60$^{th}$ -day** | 121.25±10.87 | 121.83±18.74 | 109.28±9.36* |

Results were taken significantly at $p<0.05$. $T_0$=No treatment, $T_1$= 250 gm of quinoa meal, $T_2$= 250 gm of quinoa meal prepared with fat milk added with 20gm of cinnamon powder.

## Discussions

This research study was designed to determine fasting and random blood sugar levels on the first and last day of trial after consuming quinoa supplemented with cinnamon. HbA1c was also measured before and after the trial because HbA1c has become established as the preferred monitoring test for assessing medium-term diabetes control and as a critical measure on which to base adjustments in patient therapy. However, there are some conditions in which the HbA1c can be deceiving. Because the average lifespan of a red blood cell is roughly 120 days, HbA1c may not effectively indicate diabetic management in scenarios when red cell lifespan is shortened. Clinicians must be aware of these conditions and understand the limitations of the test methods employed as the emphasis on getting lower HbA1c readings in diabetic patients grows.

Participants' blood glucose levels were assessed after 8 hours of fasting and after two hours of taking 250 grammes of quinoa with and without cinnamon. Fasting and random blood sugar levels were shown to be lower in the study. Insulin resistance was reduced in the therapy groups as well. Cinnamon was found to lower random and fasting blood sugar levels in another investigation. HbA1c levels were also lower in both therapy groups. Cinnamon reduced -glucosidase activity, assisting in the reduction of random blood sugar levels. (Mohamed Sham Shihabudeen et al., 2011). A study evaluating the insulin-potentiating effects of several spices discovered that cinnamon's aqueous extract was 20 times stronger than the other spices [108]. Methylhydroxychalcone polymer (MHCP) is a pure hydroxychalcone polymer that can promote glucose oxidation (Anderson, Richard A., et al. 2004).

Another study that looked at the hyperglycemia-regulating effect of quinoa in yoghurt found that sprouted quinoa not only reduced blood glucose levels but also dyslipidemia (Obaroakpo et al., 2020). In one of another previous findings Quinoa considerably improved hyperglycemia symptoms and anomalies in related biochemical indicators in HFD/STZ-induced diabetic rats, demonstrating a superior hypoglycemic effect. Diabetes is characterized by abnormal glucose metabolism, which is intimately linked to lipid metabolism. Furthermore, as previously demonstrated (An et al., 2021), quinoa therapy can lower TC, TG, and LDL-C values. The findings of this investigation were also related to a randomized controlled experiment that established the impact of cinnamon supplementation on elevated blood glucose levels and insulin resistance (Zare et al., 2020). As a result, hypoglycemic foods should be given more consideration. Quinoa has been proven in research to improve dyslipidemia in mice with type 2 diabetes (Noratto et al., 2019).

Furthermore, quinoa has a considerable influence on blood glucose improvement. Furthermore, histological staining studies revealed that HFD/STZ-induced islet and pancreas damage in type 2 diabetic mice, which could lead to decreased insulin secretion and hyperglycemia (Clark et al., 1988). The injured pancreatic and colon tissues of mice were significantly healed after quinoa treatment. Cinnamon exhibited the potential to regulate glucose metabolism and showed improvement in blood glucose parameters both random and fasting in about 16 randomized controlled studies including over 1000 participants. Cinnamon has also been shown in clinical trials to lower insulin resistance and related symptoms (Zhou et al., 2022). According to research, quinoa's anti-hyperglycemic impact is attributed to its ability to suppress the action of -amylase activity, an enzyme that metabolizes carbs (Ujiroghene et al., 2019).

## Conclusion

Quinoa is pseudo cereal or a seed plant with valuable nutritional profile. It contains a number of essential amino acids and proteins. It possesses many physiological benefits including hypolipidemic, anti-hyperglycemic, hypotensive properties. On the other hand, cinnamon is an important and well-known anti-hyperglycemic spice. For pre-diabetics, quinoa combined with cinnamon can be very beneficial in controlling insulin resistance and blood glucose levels. Participants because the present study's findings reveal that one serving of quinoa (meets a significant amount of the RDA for essential nutrients and chemicals that improve health). Owing to its high nutritional value and substantial commercial value, further study is required to increase people's awareness of the nutritional content

and application of this pseudo-grain, as well as to identify its nutritional advantages and explore its potential health impacts.

**Conflict of Interest**

All the authors have no conflict of interest.

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