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## A STUDY TO ASSESS THE EFFECTIVENESS OF FLAXSEED POWDER SUPPLEMENTATION ON BLOOD GLUCOSE PROFILE OF DIABETIC INDIVIDUALS

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### Abstract

Diabetes mellitus a silent and a heterogeneous syndrome characterized by absolute or relative impairment of insulin secretion and its action. It has now been recognized as one of the fastest growing threats to public health in almost all the countries of the world. The present study was focused on testing the efficacy of flaxseed powder in reducing and maintaining the glucose profile of diabetic individuals. Diabetic subjects free from serious complications were selected from board hospital in palvancha town, Telangana state. The selected subjects were divided into two groups viz. Group E and C. Group E having 80 subjects and group C having 100 subjects. Subjects of group E were provided 30g of flaxseed powder for a period of 2 months, while group C was not given any supplementation. Anthropometric measurements, blood pressure, blood glucose, before and after the supplementation period were recorded. A significant ( $p < 0.01$ ) decrease in systolic and diastolic BP, was reported in group E. Supplementation of 30 g of flaxseed powder reduced fasting blood glucose level from 157.7 to 124.79 and post prandial blood glucose from 232.94 to 185.63 in the subjects of group E. It is concluded that improvement in anthropometry, blood pressure, blood glucose were observed in group E. It could be due to the presence of  $\alpha$ -linolenic acid, lignan, dietary fiber, folate and vitamin B6, magnesium, phosphorus and copper and phytonutrient. Hence it can be inferred from the results that better improvement in the nutritional status of diabetic subjects was seen among the subjects of E group.

### Introduction

Diabetes Mellitus is a chronic disorder which is accompanied by hyperglycemia due to deficiency of insulin or the body's sensitivity to insulin (Reddy, 2018). Type of diabetes may vary for different reasons. There would be gestational diabetes, type 1 and type 2 diabetes.

Diabetes of type 2 is more frequently diagnosed in young adults and adolescents and the obvious reason for this would be increasing obesity among young generation (Zheng et al 2016). Developing countries are harbouring more than 80% of diabetes mellitus cases worldwide. Asia is now considered as the 'diabetes epicenter' of the world (Chen et al 2011). Apart from chronic complications, some acute complications of diabetes would be hypoglycemia, decrease in blood glucose levels, and diabetic keto acidosis which is most commonly seen in type 1 diabetic patients (Cengiz et al 2013). Diabetes mellitus effects bone mineral density and should be considered an important risk factor especially for hip fracture (Valderrábano et al & Linares et al 2018).

Studies demonstrate that patient education, individual counseling, regular physical activity, intensive lifestyle change awareness (Franz et al 2002). Supplementing diet with fresh and fibre-rich fruits and vegetables, leafy greens, nuts and seeds are effective in managing diabetes and insulin activity. One such diabetic superfood that can be effective for diabetes diet is flax seed.

Flaxseed is a rich source of the omega-3 fatty acid, alpha-linolenic acid (ALA) and is high in a class of phytoestrogens known as lignans. It is composed of 41% fat, 20% protein, 28% dietary fiber, 7.7% moisture, and 4% ash, iron, calcium, manganese, thiamin, magnesium, phosphorus, and copper (Mani et al 2011). Flaxseed and its components are proved to exhibit hypoglycemic, hypolipidemic and anti-oxidant properties (Prasad et al & Dhar et al 2016). Flaxseed is well known and easily available functional food for dietary consumption and it is having proven benefits for reducing inflammation, glycemic control and oxidative stress (Rhee et al & Brunt et al 2011).

### Methodology

#### Locale of the Study

Palvancha, an industrial area located in bhadradi district, Telangana state was selected purposively for the study for convenience of researcher.

#### Selection of Subjects

People who work in power generation corporation industry and their family members who are living with them were selected as the subjects for the study. The subject should be: male or female, suffering from type 2 diabetes, Aged between 35 -55 years, Free from serious complications. A sample of 180 diabetic patients were selected and divided into two groups i.e., E group was given flaxseed supplementation of 30g and they were asked to continue their medication for a period of 60 days. Group C treated as self-control group, as no flaxseed supplementation was provided to the subjects, but they were on medication.



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## Collection Of Data

### General information

The required data was collected through the personal interview technique using the especially structured schedule. The information was collected by the interview schedule pertaining to age, education, occupation, marital status, family type, family size, percapita income, activity, family history of diabetes, symptoms, complications etc.

### Dietary survey

Dietary intake of the subjects was recorded for three consecutive days by "24-hour recall-cum-weighment method", using standardized containers, before and after the Supplementation period. Dietary intake of the subjects was recorded for 3 consecutive days by "24-hour recall-Cum-weighment method", The average daily nutrient intake of the diet was calculated by using nutritive calculator App provided by NIN(National institute of nutrition) The average raw amounts in gram (of each and every item of food consumed for three consecutive days for each subject was fed in the application and nutritive value of diets were recorded.

### 4.4.3 Anthropometric Parameters

Various anthropometric parameters viz. height, weight, Waist and hip circumference were recorded. Body mass index (BMI) and waist to hip ratio (WHR) was calculated before and after supplementation period according to the method given by Jelliffe (1966). The techniques applied were practiced and standardized on five preliminary diabetic subjects.

### 4.4.4 Blood Pressure

Omron Blood Pressure HEM-7120-IN is designed to measure the blood pressure and pulse rate simply and quickly. Omron Blood Pressure HEM-7120-IN is a compact and fully automatic blood pressure monitor which works on the oscillometric principle to measure your blood pressure and pulse rate without fuss.(Marrey, 1876).

### 4.5.1 Collection of Blood Samples

Blood samples were collected early in the morning at fasting and post-fasting. Blood samples (10ml) were collected in the beginning and at the end of the study, from anticubital arm area into a centrifuge tube by the technician using 10ml disposable syringe. Serum samples were analyzed for glycemc index.

### 4.5.2 Flaxseed Supplementation

Flaxseeds were procured from local grocery store. Flaxseeds were cleaned, washed, sun dried and roasted at 150°C for 5 minutes and grinded in a grinder. Flaxseed in powdered form was supplemented in 30g to Experiment group for a period of 60 days. The powder was provided in zip lock bags weekly which further helped to monitor their consumption. The subjects were advised to add flaxseed powder to cooked food (dhal, vegetable), stuffed in chapatti, curd or take as such with water etc. They were also advised to keep flaxseed powder in a refrigerator so as to prevent rancidity of powder due to high amounts of PUFA.

### 4.6 Statistic Analysis

The data was analyzed in computer with the help of various statistical tools such as mean, standard error of the mean (SE), percentage, mean. To test the significance student's "t test was applied using Microsoft Excel Computer Programme Package on all the parameters viz. food and nutrient intake, anthropometric measurements, blood parameters etc.

## Results and Discussion

### General Information of the Subjects

#### Age

All the subjects selected for the study suffering from type 2 diabetes Mellitus (NIDDM) were in the age group of 45-55 yrs. It was observed that the mean age of people in experimental group is 49.84 years while the mean age of control group is 49.9 years. Ramachandaran et al (2001) reported that in developing and developed countries, the majority of diabetic patients were in the age range of 45-64 yrs and > 65 yrs respectively.

#### Annual Income

It was observed that majority of the subjects i.e., 62.5% and 52. % had Annual income of Rs. >5lakhs and the data also revealed that per capita income of the subjects having Rs. >3lakhs to Rs. < 5 lakhs and among them the percentage ranged from 22.5% and 26% percent and 15 % and 22% percent between group E and group C. Higher living standards of the people are responsible for sedentary lifestyle and over eating.



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## Lifestyle Related Information of the Subjects

### Physical Exercise

The data from study revealed that majority of the subjects 42.5 and 55% percent of subjects in E and C groups did not perform any physical exercise. Where 36.7 and 23.3% percent of subjects in all the groups performed physical exercise and the time spent was 30- 60 minutes. Mozaffarian et al (2009) reported that the persons who are physically active had an 82% lower incidence of diabetes.

### Sleep Hours

From the above table it was observed that majority i.e., 97.5% and 95% of the subjects were sleeping for 6-8 hours adequately. Whereas only very few subjects i.e., 2.5% and 4% were getting a sleep less than 6 hours. Many studies conducted earlier had proven that the brain without adequate sleep and rest cannot maintain biochemical balances needed for effective functioning of heart as well as other organs of the body.

### Vegetarian or Non-Vegetarian

From the table 5.4 it was observed that greater number of the subjects i.e., 96.25 and 96% percent are non-vegetarian in group E and C respectively on weekly basis. 2.5 % and 4% percent from group E and C are following a vegetarian diet.

## Diabetic Information of the Subjects

### Duration Of Diabetes

It was observed that majority of the subjects from group E and C were suffering from diabetes since 1- 5 years and further 36.25 and 37 % percent of the subjects are suffering from diabetes from 6-10 years in group E and C respectively. A Very less i.e., 21.25 and 27 % percent of the subjects were suffering from diabetes from more than 10 years from group E and C respectively.

### Comorbidities

The observations revealed that majority of the population in the study i.e 26.25 and 32% percent of the subjects are suffering from hypertension, E and C respectively. Further 22.5 and 18% percent of the subjects are suffering from multiple disorders like obesity, hypertension, hyper cholestrolemia posing high risk towards early mortality. Further, 8.75 and 10% of the study population are suffering with thyroid disorders along with diabetes, group E and C respectively.

## Nutrient Intake of the Subjects Before and after Supplementation of Flaxseed Powder

### Energy

The data revealed that the initial mean daily intake of energy among the subjects in E and C groups was 1796±326.66 and 1783±328.2 Kcal respectively. The final mean intake was 1676.90±239 and 1813.3±240 Kcal in both the groups, respectively. There was a highly significant (p<0.01) decrease in energy intake in group E but a non-significant decrease in energy intake was observed in group C. The decrease in the experimental groups could be due to presence of high fibre in flaxseed powder leading to higher satiety value which decreased consumption of other energy rich foods.

### Protein

The data revealed that the initial and final mean daily intake of protein was 59.90± 12.29, 59.48± 13.95g and 62.3±13.59, 61.13±14.65g Respectively, in both the groups. The final mean values for both the groups was 59.482 and 61.13 in E and C groups respectively. The intake of protein was higher than the suggested intake of 46 - 55grams. No significant decrease was observed in both the groups. Kaur (2006) also reported that there was higher intake of protein among the type 2 diabetic subjects.

Mean daily intake of nutrients of the subjects before and after the supplementation (Mean)				
Nutrient	Before	After	difference	P- value
Energy (Kcal)				
E	1796.3 ±326.66	1676.9 ±239	119.4	0.002
C	1783.16 ±328.2	1813.33 ±240	-30.17	
Carbohydrate (g)				
E	262.37 ±50.843	209.51 ±32.37	52.86	0.04
C	59.88 ±52.52	260.44 ±33.96	-200.56	
protein (g)				



E	59.9 ±12.293	62.3 ±13.593	-2.4	0.04
C	59.48 ±13.95	61.13 ±14.65	-1.65	
Total fat (D)				
E	47.8 ±11.66	43.64 ±21.39	4.16	0.001
C	47.34 ±12.95	68.84 ±22.65	-21.5	

**Carbohydrates**

The initial and final mean intake of carbohydrates was 262.37±50.84, 259.88±52.52g and 209.51±32.37, 260.44± 32.96g in respectively. The intake of carbohydrates was found to be far greater as compared to the suggested intake range of 130g. A highly significant decrease was observed in group E (p<0.05). whereas a non-significant decrease was observed in group C. the decrease could be due to low intake of cereals, root vegetables and sugar& jaggery.

**Total Fat**

The initial and final mean daily intake of fat was 47.80±11.66, 47.34±12.95g and 43.64±21.39, 68.84± 22.65g in both the groups. The intake was slightly higher in both the groups as compared to the suggested intake of 20g. It was observed in the present study that total fat intake decreased (p<0.01) significantly in the group E. Lecithin present in the flaxseed breaks up the fat present in food and which has left in the digestive tract. These are unwanted fats that are trapped in the body so because of lecithin these fats do not turn into body fat.

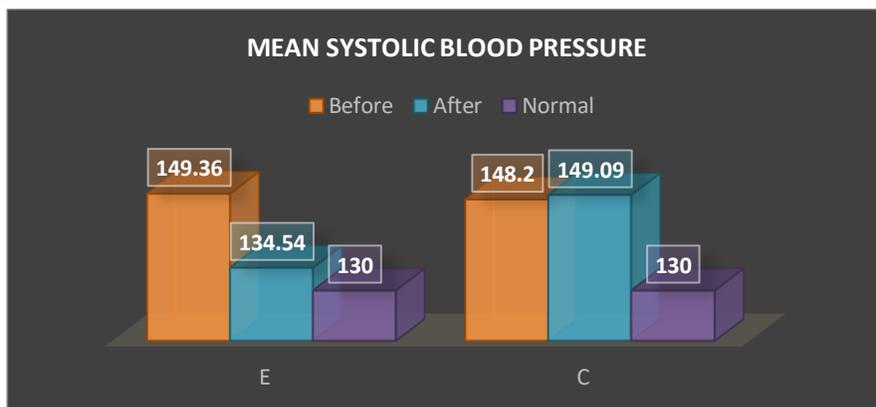
**Anthropometric Parameters of the Subjects Before and After Flaxseed Powder Supplementation**

Anthropometric measurements of the subjects before and after the supplementation (Mean SE)				
Variable	Before	After	Difference	p-value
E (n=80)				
Height (cm)	1.68 ±0.08	1.68±0.08	0	0.02
Weight (kg)	80.24 ±10.81	79.08±10.85	1.16	0.001
BMI (kg•m <sup>2</sup> )	28.46 ±2.25	28.037±2.23	0.423	0.001
WHR	0.91 ±0.04	0.92±0.04	-0.01	0.002
C (n = 100)				
Height (cm)	1.7 ±0.07	1.7 ±0.07	0	-
Weight (kg)	81.23 ±7.50	81.56 ±7.58	-0.33	-
BMI (kg' m.2J	28.44 ±5.23	28.96 ±1.74	-0.52	-
WHR	0.92 ±0.03	0.93 ±0.03	-0.01	-

**Blood Pressure**

**Systolic Blood Pressure (SBP)**

The initial and the final mean value for SBP reported in group E and C was 149.36±16.33,148.2±19.12 mm Hg and 134.5±16.10,149.09±17.06 mm Hg, respectively. A significant (p< 0.01) decrease was observed in E (14.8mm Hg), whereas a non-significant increase i.e., 1.11 mm Hg was observed in groupC. The decrease in blood pressure in the experimental groups could be due to the soluble fibre and a- linolenic acid (ALA) present in flaxseeds which decreased arterial blood pressure. The decreased in the blood pressure of group C could be due to hypotensive drugs because they were on medications.



**Mean Systolic Pressure of the Subjects Diastolic (Blood Pressure DBP)**

The data recorded revealed that the mean initial and final diastolic blood pressure recorded as  $91.2 \pm 10.07$ ,  $87.4 \pm 11.85$  and  $83.8 \pm 9.89$ ,  $89.2 \pm 10.44$  in both the groups respectively. A significant decrease in group E (7.6 mm Hg) in DBP was observed in group E, whereas non-significant decrease was observed in group C. The decrease in blood pressure was highly appreciable in group E.

The perusal of the data revealed that the mean blood pressure in the experimental groups decreased ( $p=0.01$ ) significantly after the supplementation period, whereas a non-significant decrease in blood pressure was observed in control group. The decrease was due to the presence of soluble fibre and ALA in flaxseed powder. Fibre delays the absorption of glucose. Flaxseed is also a good source of magnesium which helps to bring high blood pressure levels.

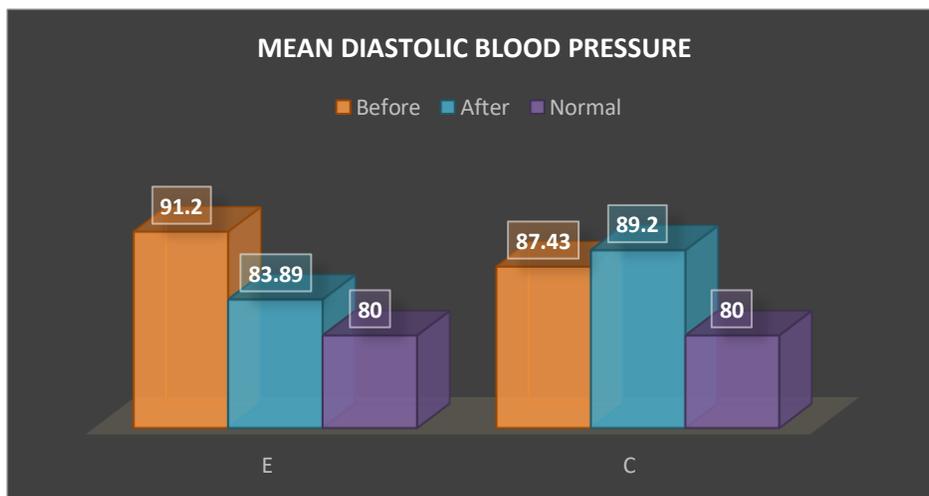


Fig.- 5.8 mean diastolic pressure of subjects

**Blood Glucose Levels of the Subjects Before and After Flaxseed Powder Supplementation**

Fasting Blood Glucose Levels (FBS): The mean initial, intermediate and final FBS levels of the subjects in the two groups were  $157.7, 17 \pm 22.12$ ,  $178.47 \pm 34.43$  mg/dL; and  $124.7 \pm 24.69$ ,  $191.6 \pm 32.19$  mg/dL after supplementation period it decreased. A highly significant ( $p < 0.05$ ) decrease in blood sugar levels was observed in group E whereas a non-significant decrease was observed in group C. The reduction in blood glucose levels of experimental groups could be due to the flaxseed powder supplementation, being a rich source of both soluble and insoluble fiber. The insoluble fiber found in flaxseed helps to slow the release of sugar into the bloodstream following a meal, preventing spikes in blood glucose levels.

**Post Prandial Glucose Levels (PPBS)**

The data revealed that the mean initial, intermediate and final PPBS levels were recorded as  $232.9 \pm 41.68$ ,  $270.6 \pm 39.22$  mg/dl and  $185.6 \pm 41.60$ ,  $290.6 \pm 39.71$  mg/dl. A highly significant ( $p < 0.05$ ) decrease in blood glucose levels was observed in group E whereas a non-significant decrease was observed in group C.

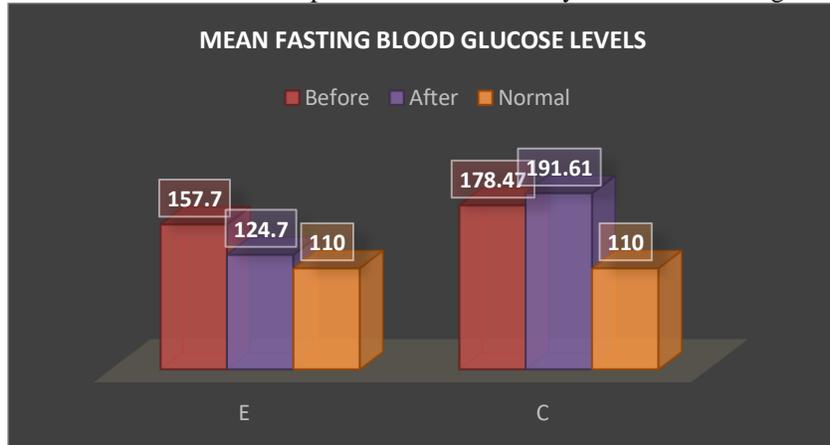


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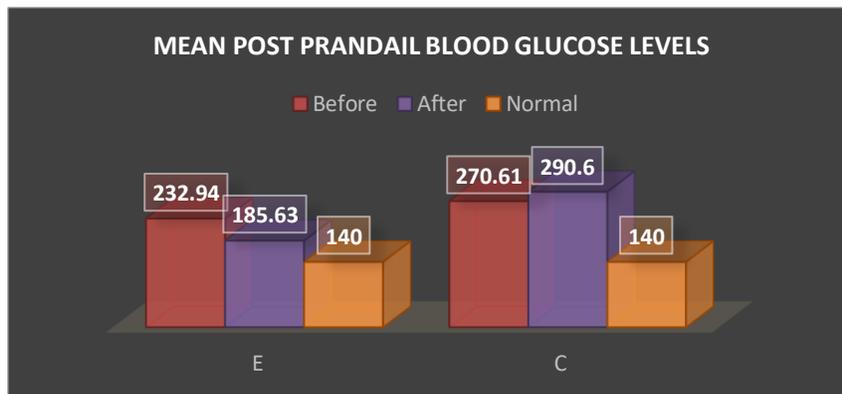


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Thus, in the present investigation after two months of flaxseed supplementation there was a significant improvement in the glucose levels in group E shown by mean values of fasting and postprandial glucose levels which decreased significantly from the initial values. This study confirmed the findings of the study carried out by LeAnne et al (2008) who proved that flaxseed improved the insulin sensitivity and decreases blood glucose levels. Maximum change was observed in group E. It could be concluded that flax seed supplementation seemed to improve glycemic control in type 2 diabetic subjects, which appeared to be due to the presence of both soluble and insoluble fibre in the flaxseed which improves insulin sensitivity and lowers blood glucose levels.



Mean Fasting Blood Glucose Level



Mean Post Prandial Blood Glucose Level

Summary & Conclusion

The present study entitled "To assess the effectiveness of flaxseed supplementation on glucose profile of Diabetic patients" was carried out on 180 subjects in the age group of 45 -55 yrs from the selected hospital in palvancha, which is one among the industrial areas in telangana the major risk factors observed among the subjects were hypertension, obesity, high cholesterol and inactive lifestyle.

The selected subjects were equally divided into two groups i.e., Experimental and control groups. The objective of the study was to study the effect of flaxseed powder on selected type 2 diabetic subjects. The study was conducted in three phases. In phase I, general information regarding age, education, occupation and marital status, family type and size, income, lifestyle, diabetes, food habits and food intake of all the subjects were recorded through the questionnaire. Dietary intake of the subjects was collected by "24 hr recall method" using standardized containers for three consecutive days. Anthropometric measurements and blood pressure of the subjects were recorded. Blood analysis was done for blood glucose of the selected subjects. Impact of flaxseed supplementation on food intake, anthropometric parameters, blood pressure and blood glucose levels was seen.

After flaxseed supplementation, a highly significant (p<0.01) decrease in body weight from 80.24 to 79.08 kg was observed in group E and a highly significant (p<0.01) decrease in BMI from 28.4kg/m to 28.0 kg/m was observed in group E. The total reduction of weight in E was 1.16kg while a non-significant increase in Weight and BMI was observed in group C. After the supplementation period a significant (p<0.01) reduction in SBP i.e., from 149.3 to 1134.5 was observed in group E and a significant (p<0.01) reduction in DBP from 91.2 to 83.8 was observed in group E.



A highly significant ( $p < 0.01$ ) decrease in fasting blood sugar was observed in group E i.e., from 157.7 to 124.7 mg/dl. Similarly a highly significant ( $p < 0.01$ ) decrease in postprandial blood sugar was observed in group E; i.e., from 232.9 to 185.6 mg/dl. A non-significant increase in FBS and PPBS was observed in group C.

## Conclusion

In the light of the present investigation, following conclusions were drawn:

- sedentary lifestyle and poor eating habits had a strong association with increased incidence of diabetes.
- BMI of the subjects was high due to faulty eating habits and less physical activities and high standards of living.
- Significant changes in anthropometric parameters like decrease in weight, BMI, waist hip ratio, was observed after the flaxseed supplementation especially in subjects of group E
- Delay in the absorption of glucose could be due to the presence of fiber in flaxseed.
- Decrease in blood pressure could be due to the presence of magnesium in flaxseed and magnesium helps to lower down blood pressure.
- A positive and significant correlation was observed between nutrient intake i.e., energy, carbohydrate and fat;
- Intake of 30g flaxseed powder is effective in improving blood profile of the individual.

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