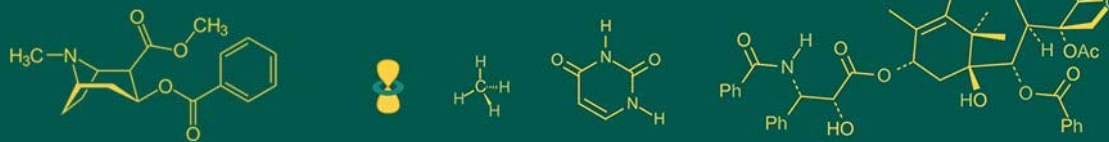


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Impact of fiber rich diets in clinical manifestation and dietary nutrients intake management of human type ii diabetes mellitus (With special reference to Gwalior)

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Abstract

Diet is an influential element in the management of Diabetes mellitus. Fiber rich diet is one of the approaches for the management of the disease. Fiber is significant for maintenance of digestion, weight management, blood sugar regulation, cholesterol maintenance and metabolism. Moreover, it reduces the intensity of the disease by relieving its clinical symptoms. Oats are good sources of fiber. It helps to promote a healthy digestive system, lower cholesterol level and regulate blood sugar level. A study was carried out to evaluate the impact of fiber rich diets in clinical manifestations and dietary intake management under three conditions viz. control diet (no fiber), low fiber diet (5 gm fiber), high fiber diet (10 gm fiber) were given to Control group, Experimental group 1, Experimental group 2 respectively. After three months of supplementation, the data was recorded and statistically analyzed. The analysis displayed evidently that the level of various clinical features like, polyuria, polyphagia, blurred vision, skin irritation etc. was declined. A similar effect was also observed in protein intake of the subjects. Further, it was also observed that the fiber content of the diet had no role to play in the management of carbohydrate, calorie and fat intake of the subject.

Keywords: Diabetes mellitus, fiber, clinical symptoms, oats, dietary intake management

Introduction

Type II diabetes is a chronic condition that affects the way your body metabolizes sugar (glucose). It is an important source of fuel for your body. With Type II diabetes, your body either resists the effects of insulin, which is a hormone that regulates the movement of sugar into your cells, or doesn't produce enough insulin to maintain normal glucose levels. If diet and exercise aren't enough to manage your blood sugar well, you may also need diabetes medications or insulin therapy. Signs and symptoms of type 2 diabetes often develop slowly. The symptoms which are mainly seen are increased thirst, frequent urination, increased hunger, unintended weight loss, fatigue, blurred vision, slow-healing sores, frequent infections, areas of darkened skin, usually in the armpits and neck^[9].

Type II diabetes is the most common type of diabetes, making up around 90% of cases of diabetes. Pre-diabetes is the stage before Type II diabetes. Two types of pre-diabetic conditions are impaired glucose tolerance and impaired fasting glucose, caused due to insulin resistance. Type I diabetes is an autoimmune disease. It is seen due to a lack of insulin hormone. Up to 10% of people who have diabetes have Type I diabetes. Gestational diabetes develops in some people during pregnancy. Fasting blood glucose test, Random glucose test, and A1C are the tests used to diagnose diabetes^[1].

Treatment

Treatment for Diabetes involves following a regimen of diet, exercise, self-monitoring of blood glucose, and taking medication or insulin injections. The requisition of calories is based on a person's age, sex, occupation, height, and weight. People with diabetes should include 45-60% of total calories as carbohydrates. It should be provided in the form of vegetables, fruits, beans, whole grains, and other fiber-rich sources. The percentage of fat and protein of the calories should be 25-35% and 12-20% respectively. Best types of fats are monounsaturated and Omega-3 polyunsaturated fats.

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In spite of Red meat Fish, Soy and Poultry are better protein choices. If BMI is found 25 - 29 (overweight) or higher (obese), weight reduction is advised [2].

Fiber

Dietary fiber (DF) refers to non-digestible plant carbohydrates in foods, which are usually a mix of polysaccharides that cannot be broken down by the human digestive tract. In clinical studies, glucose levels are inversely proportional to dietary fiber intake in diabetic patients. One clinical study compared two groups of patients with T2DM. The intervention group consumed 50 grams of fiber per day; the control group consumed 24 grams. The results of the six-week study showed that the participants in the intervention group maintained consistently lower glucose, insulin, and lipid levels compared to those of the control group [3].

Significant role in digestion and regulation, weight management, blood sugar regulation and cholesterol maintenance are the important functions of fiber. It has also been linked to longevity and decreasing the risk of cancer [5]. Insoluble and soluble fibers are the two types of fiber. Some insoluble fibers are cellulose, hemicellulose and lignin which makes stool soft and bulky. This action facilitates easily passing of stools through bowel and thus constipation is prevented. On the other hand Gums and pectins are known as soluble fibers. It has been proven by the different studies that cholesterol level may be reduced with the help of soluble fiber in the blood. Soluble fibers also slow down digestion and delays sudden release of energy, especially from carbohydrates into the bloodstream. It maintains the stability of blood sugar levels, which is desirable for people with diabetes [5].

Requirement of fiber

Current Canadian guidelines prescribe at least 26 grams of fiber. According to these guidelines ideally 26 to 35 grams should be consumed daily by healthy adults. Ideally 25 to 50 grams per day should be consumed by people with diabetes [5].

As per the National Academy of Sciences, US, 5 to 14 grams per day are the average American's daily intake of fiber. The current recommendations are to achieve an adequate intake (AI) of fiber based on one's gender and age [4].

British Nutrition Foundation advises that healthy adults should include 18g fiber per day in the diet [4].

In reference to Indian circumference, it was analyzed by the data from diets of the Western part of the country that the dietary fiber content is about 30-40 gm/day. The amount of fiber was being increased by increasing level of energy intake, 39 gm - 47 gm/day in young men. The fiber intake among women is lower (15-30 gm/day) and is much less in tribal population (15-19 gm/day). It was also exhibited by another report from North India that the average total fiber intake per day is about 52 gm. More data needs to be generated in the Indian context to understand the phenomenon of health transition [6].

Oats

Oats is considered as a protein packed, full of fiber and low on fat food. These are designed to boost energy levels and help lead a healthy lifestyle. Wide range of nutrients like fiber, vitamin E, essential fatty acids is available in Oats. It

is rich in soluble fibers (known as beta glucan) which help in lowering cholesterol levels. Furthermore it is a low calorie food which slows digestion and makes you feel full longer. Cholecystokinin, a hunger-fighting hormone, is increased with the oatmeal compound beta-glucan [7].

Table 1: Amount of nutrients per serving of one cup (156.0 g) of Oats [8]

Calories	607 Kcal
Total fat	10.8 g
Saturated fat	1.9 g
Poly unsaturated fat	4.0 g
Mono saturated fat	3.4 g
Cholesterol	0 mg
Sodium	3 mg
Total Carbohydrate	103.4 g
Dietary Fiber	16.5 g
Protein	26.3 g

g: grams

mg: milligrams

Materials and Methodology

For conducting the research work, Probability random sampling method has been followed to select the sample from Type II Diabetic population of Diabetic camp, centre for translational research, Jiwaji University, Gwalior. The samples included male and female subjects in the age group of 35 to 65 years. Subjects were divided into following three groups:

1. Control group (diabetic subjects without fiber diet)
2. Experimental group 1 (diabetic subjects with low fiber diet 5 g)
3. Experimental group 2 (diabetic subjects with high fiber diet 10 g)

Subjects were chosen randomly from various areas of greater Gwalior city.

Size and Classification of Sample

100 diabetic subjects were randomly chosen irrespective of sex, age (35-65), occupation, income, religion etc. Out of these, 50 were assigned as control group and other 50 as Experimental group 1. The same 50 subjects, assigned as Experimental group 1, were then assigned as Experimental group 2 (after three months of intervention).

A self made interview schedule was applied to collect the information from the subjects. This schedule was prepared considering all the possible aspects related to study.

Blood sugar level: Blood sugar level was estimated by a glucometer. A glucometer is a medical tool that determines the amount of glucose in the blood. There are many different types of glucometers available in market. Accu check glucometer was used in study for determination of blood sugar level.

Clinical Assessment: Each subject was asked about the presence of these symptoms like weight loss, polyuria, polyphagia, polydipsia, fatigue, frequent infections, wounds healing, irritation, blurred vision, etc. before and after intervention.

Dietary Pattern Assessment

As dietary factors play an important role in Type II Diabetes mellitus, it is very essential to collect the information related to nutrient intake levels. The dietary intake of subjects under

study was recorded by 24 hour recall method. The subjects reported the consumption of cooked food in the previous 24 hours. These were recorded in local or standard volumetric measure and then converted to raw weight of the food in grams. Further nutritional value of the food items was calculated. This procedure was carried out before and after intervention.

Formulation of Different Test Diets

In order to carry out the study in a systematic manner, it was planned to formulate three test diets. First of which would contain no fiber, the second would have low fiber while the third one would have high fiber.

(a) Formulation of Control Diet

Firstly rice flakes and Bengal gram were roasted separately. Bengal gram was dehusked and then rice flakes and Bengal gram were mixed. After that measured amount of oil was taken, heated up to desired temperature and then spices were added into oil. This oil was mixed into mixture of bengal gram and rice flakes. At last salt was added to this in required amount. All the ingredients were mixed properly. Three different diets were prepared as per table

Table 2: Amount of ingredients for formulation of control diet

Ingredients	P1	P2	P3
Rice flakes (gm)	40	50	60
Bengal gram(gm)	30	20	10
Oil (ml)	5	5	5

P1, P2, P3, etc. denote various diet preparations with different amounts of ingredients.

As per the table three different proportions of ingredients were taken for the formation of control diet. No fiber source was used. Processing of ingredients was done according to the formulation procedure mentioned earlier.

(b) Formulation of Test diet I

Firstly rice flakes and oats were roasted separately. Rice flakes and oats were mixed. After that measured amount of oil was taken, heated up to desired temperature and then spices were added into oil. This oil was mixed into mixture of oats and rice flakes. At last salt was added to this in required amount. All the ingredients were mixed properly. Here also three different diets were also prepared as per the ingredients.

Table 3: Amount of ingredients for formulation of Test diet I

Ingredients	P4	P5	P6
Oats (gms)	25	50	-
Wheat bran (gms)	6	-	15
Rice flakes (gms)	40	20	50
Oil (ml)	3	3	3

As per the table three different proportions of ingredients were taken for the formation of Test diet I. Oats and wheat bran were used here as a fiber source. Processing of ingredients was done according to the formulation procedure mentioned earlier.

(C) Formulation of Test diet II

Firstly Oats and coriander seeds were roasted separately. The coriander seeds were crushed and then oats and coriander seeds were mixed together. After that measured amount of oil was taken, heated up to desired temperature and then spices were added into oil. This oil was mixed into mixture of oats and coriander seeds. At last salt was added to this in required amount. All the ingredients were mixed properly.

Table 4: Amount of ingredients for formulation of Test diet II

Ingredients	P7	P8	P9
Oats (gms)	35	-	70
Rice flakes (gms)	25	50	
Wheat bran (gms)	10	20	-
Coriander seeds (gms)	5	5	5
Oil (ml)	1	1	1

As per the table three different proportions of ingredients were taken for the formation of Test diet II. Oats and wheat bran were used here as a fiber source. Processing of ingredients was done according to the formulation procedure mentioned earlier.

P1 (Control diet), P5 (Test diet I), P9 (Test diet II) were found adequate for Control group, Experimental group 1 and Experimental group 2 respectively based on sensory assessment scores.

Statistical Assessment

Simple comparisons between different diets were made with the Percentage method. ANCOVA (software by SPSS 13.0) was followed for drawing more robust and statistically significant conclusions.

Results and Discussion

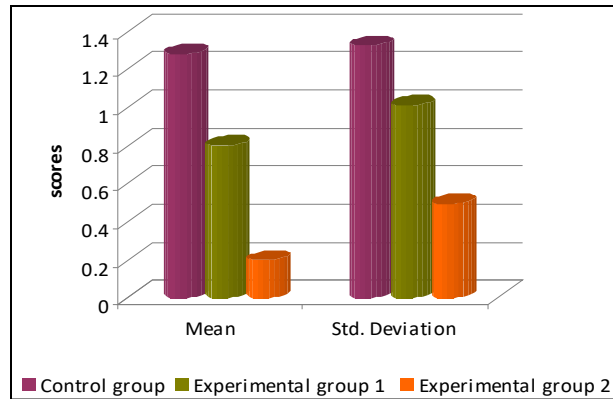
The observed results have been tabulated below during the study. Also the data have been represented by bar diagrams for quick and better understanding.

Table 5: Distribution of subjects across three groups based on fiber intake

Groups	Value Label	Number of subjects
Control group	No fiber	50
Experimental group 1	5 g fiber (Test diet I)	50
Experimental group 2	10 g fiber (Test diet II)	50

Table 6: Table presents the descriptive statistics like Mean, Standard deviation of post scores of Clinical Symptoms among subjects categorized into three conditions based on fiber intake at breakfast: no fiber, 5 g fiber and 10 g fiber.

Group	Mean	Std. Deviation	N
Control group	1.2800	1.32542	50
Experimental group 1	.8000	1.01015	50
Experimental group 2	.2000	.49487	50
	.7600	1.09103	150



Graph 1: The graph illustrates the descriptive statistics like Mean, Standard deviation of post scores of clinical symptoms among subjects categorized into three conditions based on fiber intake at breakfast: no fiber, 5 g of fiber, and 10 g of fiber.

Table 7: Table provides a concise summary of the statistical analysis using one way ANCOVA of post scores of clinical symptoms among subjects categorized into three conditions based on fiber intake at breakfast: no fiber, 5 g fiber and 10 g fiber.

Source	Type III Sum of Squares	df	Mean Square	F	Remark
Group	20.134	2	10.067	21.031	$p < 0.05$
Error	69.887	146	.479		
Total	264.000	150			
Corrected Total	177.360	149			

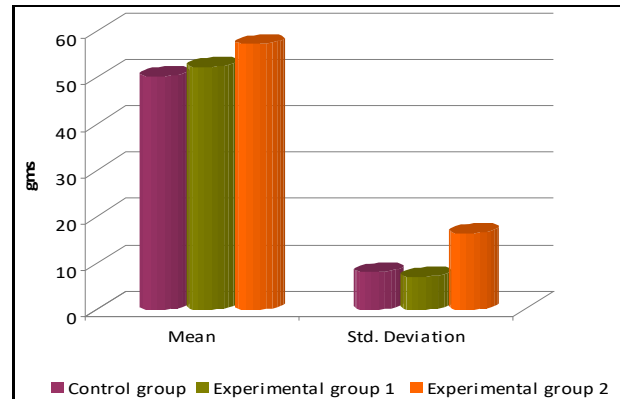
ANCOVA: Analysis of covariance df: Degree of freedom
 F: Variance ratio P : Probability
 Std. Deviation: Standard deviation

The statistical analysis reveals a significant F value of 21.031 with $df = 2/146$ ensuring substantial differences in the adjusted mean scores of Clinical symptoms among subjects under three experimental conditions: no fiber, 5 g fiber and 10 g fiber in the breakfast while considering the baseline of clinical symptoms as a covariate, differ significantly so null hypothesis “There is no significant difference in the adjusted mean scores of clinical symptoms when the subjects are not given fiber; when they are treated with test diet I (5 g fiber in the breakfast) and when they are treated with test diet II (10 g fiber in the breakfast)” is decisively rejected, suggesting that the mean clinical symptom scores differ significantly among the groups based on their respective fiber intake levels.

From the adjusted mean scores of ANCOVA it is obvious that test diet II group subjects showed the lowest clinical symptoms (delivering that they are away from the range of diseased condition) and test diet II group subjects showed a lower score of clinical symptoms than the subjects of control group.

Table 8: Table presents the descriptive statistics like Mean, Standard deviation of post scores of Protein intake (g) among subjects categorized into three conditions based on fiber intake at breakfast: no fiber, 5 g fiber and 10 g fiber

Group	Mean	Std. Deviation	N
Control group	50.1760	7.98163	50
Experimental group 1	52.1310	6.97040	50
Experimental group 2	57.1140	16.40610	50
	53.1403	11.57728	150



Graph 2: The graph illustrate the descriptive statistics like Mean, Standard deviation of post scores of Protein intake (g) among subjects categorized into three conditions based on fiber intake at breakfast: no fiber; 5 g fiber and 10 g fiber

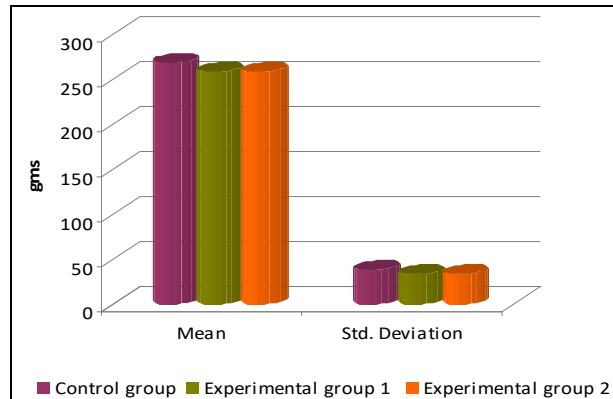
Table 9: Table provides a concise summary of the statistical analysis using one way ANCOVA of post scores of Protein intake of subjects categorized into three conditions viz. based on fiber intake at breakfast: no fiber, 5 g fiber and 10 g fiber.

Source	Type III Sum of Squares	df	Mean Square	F	Remark
Group	847.126	2	423.563	5.099	$p < 0.05$
Error	12127.520	146	83.065		
Total	44355.243	150			
Corrected Total	19970.988	149			

The statistical analysis represents a significant F value for group being 5.099 is significant with $df = 2/146$ which confirms that the adjusted mean scores of Protein intake among subjects under three conditions: no fiber, 5 g fiber and 10 g fiber in the breakfast, while considering the baseline of protein intake as a covariate, differ significantly. Therefore the null hypothesis “There is no significant difference in the adjusted mean scores of protein intake of the subjects when they are not given fiber; when they are treated with test diet I (5 g fiber in the breakfast) and when they are treated with test diet II (10 g fiber in the breakfast)” is rejected. This result provides evidences that including fiber rich diet like oatmeal in breakfast could potentially influence protein intake and thereby reducing weight creating an impact in the BMI of the individuals
 From the adjusted mean scores of ANCOVA it is obvious that test diet II group subjects showed the greatest Protein intake and test diet II group subjects showed a greater score of Protein intake than the subjects of control group.

Table 10: Table presents the descriptive statistics like Mean, Standard deviation of post Scores of Carbohydrates Intake (g) among subjects categorized into three conditions based on fiber intake at breakfast: no fiber; 5 g fiber and 10 g fiber

Group	Mean	Std. Deviation	N
Control group	267.7760	38.71336	50
Experimental group 1	257.5740	33.82868	50
Experimental group 2	257.5800	33.82864	50
	260.9767	35.62047	150



Graph 3: The graph illustrates the descriptive statistics like Mean, Standard deviation of post scores of Carbohydrates Intake (g) among subjects categorized into three conditions based on fiber intake at breakfast: no fiber, 5 g fiber and 10 g fiber.

Table 11: Table provides a concise summary of the statistical analysis using one way ANCOVA of post scores of Carbohydrate Intake among subjects categorized into three conditions based on fiber intake at breakfast : no fiber, 5 g fiber and 10 g fiber

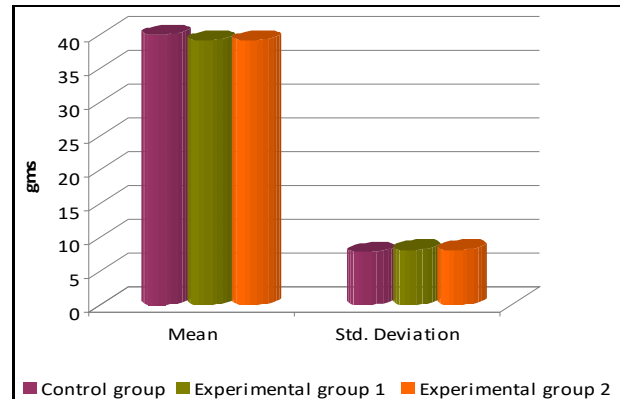
Source	Type III Sum of Squares	df	Mean Square	F	Remark
Group	1224.029	2	612.014	1.583	$p > 0.05$
Error	56452.515	146	386.661		
Total	10405376.950	150			
Corrected Total	189053.868	149			

The statistical analysis indicates that the F value for group being 1.583 is non-significant with $df = 2/146$. It means that the adjusted mean scores of Carbohydrate intake among subjects under three conditions: no fiber, 5 g fiber and 10 g fiber in the breakfast while considering the baseline of carbohydrate Intake as a covariate, do not differ significantly. Therefore the null hypothesis “There is no significant difference in the adjusted mean scores of carbohydrate intake of subjects when the subjects are not given fiber; when they are treated with test diet I (5 g fiber in the breakfast) and when they are treated with test diet II (10 g fiber in the breakfast)” is accepted. This outcome reveals that including fiber rich diet like oatmeal in breakfast may not affect the carbohydrate intake of individuals.

It is understood in a different fashion. Subjects had a piece of realization that they shall reduce their weight by increasing their protein intake but they might not be aware of the complex carbohydrate which shall help in reducing their GI. This is because of ignorance of dietary details and their mechanisms or maybe they were satisfied in having their nutritious breakfast provided and hadn’t changed their normal routine or style of eating their lunch and dinner.

Table 12: Table presents the descriptive statistics like Mean, Standard deviation of post scores of Fat Intake among subjects categorized into three conditions based on fiber intake at breakfast: no fiber, 5 g fiber and 10 g fiber

Group	Mean	Std. Deviation	N
Control group	39.9140	7.73795	50
Experimental group 1	39.1180	8.12581	50
Experimental group 2	39.0880	8.13442	50
	39.3733	7.95691	150



Graph 4: The graph illustrates the descriptive statistics like Mean, Standard deviation of post scores of Fat Intake among subjects categorized into three conditions based on fiber intake at breakfast: no fiber, 5 g fiber and 10 g fiber.

Table 13: Table provides a concise summary of the statistical analysis using one way ANCOVA of post scores of Fat Intake among subjects categorized into three conditions based on fiber intake at breakfast: no fiber, 5 g fiber and 10 g fiber.

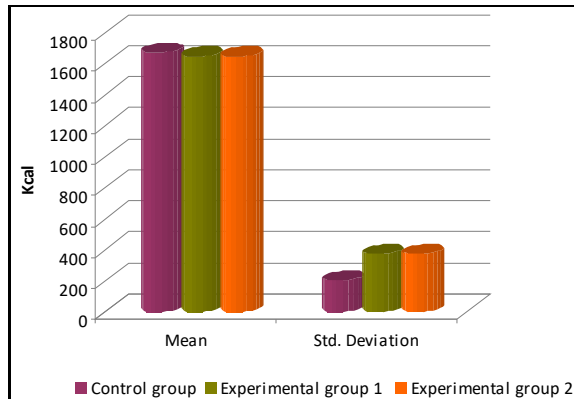
Source	Type III Sum of Squares	df	Mean Square	F	Remark
Group	10.771	2	5.386	.297	$p > 0.05$
Error	2644.083	146	18.110		
Total	241972.460	150			
Corrected Total	9433.553	149			

The statistical analysis reveals a non significant F value for group being 0.297 with $df = 2/146$. It ensures that the adjusted mean scores of Fat Intake among subjects under three conditions: no fiber; 5 g fiber and 10 g fiber in the breakfast while considering the baseline of fat Intake as a covariate, do not differ significantly so the null hypothesis “There is no significant difference in the adjusted mean scores of fat Intake of subjects when the subjects are not given fiber; when they are treated with test diet I (5 g fiber in the breakfast) and when they are treated with test diet II (10 g fiber in the breakfast)” is accepted. This result provides evidence that oatmeal which is rich in fiber may not influence the fat Intake of subjects.

As mentioned already, subjects realized that they shall reduce their weight by increasing their protein intake but they were not aware of proper carbohydrate or the fat intake. Hence there was no significant difference in their fat intake or perhaps they were satisfied in having their nutritious breakfast provided and hadn’t changed their normal routine or style of eating their lunch and dinner.

Table 14: Table presents the descriptive statistics like Mean, Standard deviation of post scores of Calorie Intake (Kcal) among subjects categorized into three conditions based on fiber intake at breakfast: no fiber, 5 g fiber and 10 g fiber

Group	Mean	Std. Deviation	N
Control group	1670.3600	202.84062	50
Experimental group 1	1647.3040	372.75675	50
Experimental group 2	1644.4840	373.26893	50
	1654.0493	324.31456	150



Graph 5: The graph illustrates the descriptive statistics like Mean, Standard deviation of post scores of Calorie Intake (Kcal) among subjects into three conditions based on fiber intake at breakfast: no fiber; 5 g fiber and 10 g fiber.

Table 15: Table provides a concise summary of the statistical analysis using one way ANCOVA of post scores of Calorie Intake among subjects categorized into three conditions based on fiber intake at breakfast: no fiber, 5 g fiber and 10 g fiber

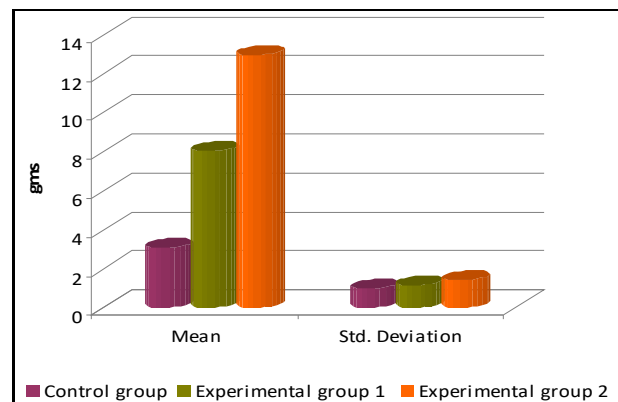
Source	Type III Sum of Squares	df	Mean Square	F	Remark
Group	6583.322	2	3291.661	.105	$p > 0.05$
Error	4559731.638	146	31231.039		
Total	426053690.000	150			
Corrected Total	15671810.435	149			

The statistical analysis displays a non significant F value for group being 0.105 with $df = 2/146$. It ensures that the adjusted mean scores of Calorie Intake among subjects under three conditions: no fiber, 5 g fiber and 10 g fiber in the breakfast while considering the baseline of calorie intake as a covariate, do not differ significantly. Therefore the null hypothesis “There is no significant difference in the adjusted mean scores of Calorie Intake of subjects when the subjects

are not given fiber; when they are treated with test diet I (5 g fiber in the breakfast) and when they are treated with test diet II (10 g fiber in the breakfast)” is accepted. This proves evidently that fiber rich diet like oatmeal in breakfast may not influence the Calorie Intake of subjects. This is obvious that the subjects had no control over the fat intake and nor in the carbohydrate intake. Hence there was a non-significant effect also found in the calories intake.

Table 16: Table provides the descriptive statistics like Mean, Standard deviation of post scores of Fiber Intake (g) among subjects categorized into three conditions based on fiber intake at breakfast: no fiber, 5 g fiber and 10 g fiber

Group	Mean	Std. Deviation	N
Control group	3.0740	.97991	50
Experimental group 1	8.0300	1.16711	50
Experimental group 2	12.9300	1.41093	50
	8.0113	4.20920	150



Graph 6: The graph illustrates the descriptive statistics like Mean, Standard deviation of post scores of Fiber Intake (g) among subjects categorized into three conditions based on fiber intake at breakfast: no fiber; 5 g fiber and 10 g fiber.

Table 17: Table provides a concise summary of the one way ANCOVA of post scores of Fiber Intake among subjects categorized into three conditions based on fiber intake at breakfast: no fiber, 5 g fiber and 10 g fiber.

Source	Type III Sum of Squares	df	Mean Square	F	Remark
Group	719.379	2	359.690	669.011	$p < 0.05$
Error	78.496	146	.538		
Total	12267.105	150			
Corrected Total	2639.886	149			

The statistical assessment indicates a significant F value for group being 669.011 with $df = 2/146$. It confirms that the adjusted mean scores of Fiber Intake among subjects under three conditions: no fiber, 5 g fiber and 10 g fiber in the breakfast while considering the baseline of fiber intake as a covariate, differ significantly. Therefore the null hypothesis “There is no significant difference in the adjusted mean scores of fiber intake of the subjects when they are not given fiber; when they are treated with test diet I (5 g fiber in the breakfast) and when they are treated with test diet II (10 g fiber in the breakfast)” is rejected. This result evidently proves that fiber rich diet like oatmeal in breakfast creates an influential effect in increasing fiber intake and thereby reducing weight creating an impact in the BMI of the individuals.

From the adjusted mean scores of ANCOVA it is obvious that test diet II group subjects showed the greatest fiber intake and test diet II group subjects showed a greater score

of fiber intake than the subjects of control group. This refers to the fact that simply by creating a minor change in the breakfast in terms of fiber shall induce the fiber intake of the day of the individuals.

Conclusion

This study was aimed to investigate the therapeutic benefits of dietary fiber specifically in managing diabetes mellitus. It is already well-established that fiber plays a crucial role in regulating blood sugar level. Through this study an attempt has been made to determine the optimal amount of fiber that should be incorporated in the diet for therapeutic benefits. It was also observed that fiber is a very influential component in reducing clinical symptoms associated with Type II diabetes mellitus. This suggests that a fiber rich diet could alleviate common health issues in regard of the disease.

Further it was also concluded that the fiber has benefits in increasing protein and fiber intake. It did not affect the management of carbohydrate, calorie and fat intake of the subject.

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