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Research Article

IMPACT OF MEAL REPLACEMENT ON THE HEALTH STATUS OF TYPE II DIABETES

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ABSTRACT

Diabetes mellitus is one of the pandemic disorder affecting approximately 347 million people in world. The WHO identified and announced India as the capital of Diabetes. Food products that can induce a slow release of glucose are the demand for managing diabetes. Hence researchers are accelerated to bring into focus the same; so we planned to prepare a low glycemic roti for the management of diabetes which is low cost, high in fiber, low glycemic index and glycemic load value. The glycemic index and glycemic load of the product was assessed by monitoring the rises in blood glucose after a 50g of portion was fed to 15 healthy subjects. The glycemic index of hypoglycemic roti is 53%. The impact of formulated roti was assessed at 1% significance among all diabetic individuals.

Keywords: II Diabetes,

INTRODUCTION

As per the **Glycemic Research Institute**, "glycemic index provides a measure of how quickly blood sugar levels rise after eating particular types of foods. The effects that different foods have on blood sugar levels vary considerably. The glycemic index estimates how much each gram of available carbohydrate in a foods raises a person's blood glucose levels following consumption of the foods, relative to consumption of pure glucose. Glucose has a glycemic index of 100." In a nutshell, GI measures the way each food's carbohydrates are processed by body. Foods with a high GI score contain rapidly digested carbohydrates, which promote a rapid rise and fall in your blood glucose level. Foods ranked lower on the glycaemic index score contain carbohydrates that are more slowly digested. The result is a gradual and lower rise in blood glucose level. Eating foods lower on the glycemic index makes it easier for body to maintain a normal blood glucose level. This is because the sugars are processed more slowly, and over a longer period of time, rather than creating a sharp spike that requires large amounts of insulin**. – (International diabetes foundation, 2012)**

Lower GI implies slower digestion which results into proper absorption of carbohydrates. This also results into a much lower demand of insulin. Foods with high GI temporarily create a large increase in blood sugar levels. Usually, low GI foods are considered better for health. Low GI foods are found to minimize the risk of diabetes and cardiovascular diseases. Since high GI foods create an immediate rise and fall in blood sugar level, the person feels drained and hungry and tends to eat more even though the body does not need it. This makes the person overweight over a period of time. Low GI foods prevent abnormalities in energy metabolism. Fiber rich foods generally have a low glycemic index (GI), although not all foods with a low GI necessarily have high fiber content. Several benefits effects of low –GI, high fiber diets have been shown, including lower postprandial glucose and insulin responses, an improved lipid profile, and possibly, reduced insulin resistance.– **(Gabriele, 2008)**

MATERIALS AND METHODS

Soya Beans, Oats, Bengal Gram, Barley and Bajra are chosen as the main ingredient of low glycemic index based food. These ingredients were mixed in various proportions with standard wheat based flour and kneaded to prepare dough. From this dough, Indian bread (Rotis) is prepared.

Formulation of Roti

The following five variations of Rotis were prepared. These variations of rotis were subjected to organoleptic evaluation for appearance, flavour, taste and texture to check out the overall acceptability. It was carried out by using score card method. Below are the proportions of the various ingredients in the five variations.

Variation 1 (100g)	Variation 2 (100g)	Variation 3 (100g)	Variation 4 (100g)	Variation 5 (100g)
• Wheat Flour 40g	• Wheat 40g	• Wheat 40g	• Wheat 40g	• Wheat 40g
• Barley 10g	• Barley 10g	• Barley 10g	• **Barley 20g**	• Barley 10g
• Oats 10g	• Oats 10g	• **Oats 20g**	• Oats 10g	• Oats 10g
• Bajra 10g	• Bajra 10g	• Bajra 10g	• Bajra 10g	• **Bajra 20g**
• Bengal Gram 10g	• **Bengal Gram 20g**	• Bengal Gram 10g	• Bengal Gram 10g	• Bengal Gram 10g
• **Soyabean 20g**	• Soyabean 10g	• Soyabean 10g	• Soyabean 10g	• Soyabean 10g

Fig. 1: Proportion of ingredients in different variations

Based on the calculation on the overall acceptability variation 5 was selected from the five variations.

Below is the nutrient analysis of 100 gm of Roti (Variation 5)

Table 1: Nutrient Analysis of Roti (Variation 5)

Fiber (g)	Protein (g)	Fat (g)	Carbohydrate (g)	Energy (kcal)
15.18	15.7	5.05	62.68	358.8

Calculation of Glycemic Index

Ten healthy subjects were chosen to calculate the glycemic index of the formulated roti.

On a day, a subject's blood sugar after 12 hours of overnight fasting was taken. Then the subject was made to eat 3 formulated rotis which contained 50g of carbohydrate. Further four blood sugar levels were noted with an interval of 30 minutes.

On the next day, the same steps were repeated on the same subject but with 3.5 slices of white bread which contained 50g of carbohydrate.

Following are the blood glucose level when subjects ate rotis and white bread.

Table 2: Blood Glucose Level with Roti

				Blood glucose level (ROTI)		S. No.
120 min	**90 min**	**60 min**	**30 min**	**0 min**	**Subject**	
107	129	119	142	100	Sundeep	1.
112	115	138	116	98	Diksha	2.
110	116	122	115	101	Ratanamma	3.
105	115	112	113	98	Soundarya	4.
90	102	106	106	87	Pushpa	5.
110	114	120	113	99	Pratibha	6.
105	132	121	144	102	Arjun	7.
107	115	126	136	100	Manoj	8.
103	118	134	120	90	Padma	9.
100	116	128	119	99	Mukta	10.

Table 3: Blood Glucose Level with White Bread

				Blood glucose level (white bread)		S. No.
120 min	**90 min**	**60 min**	**30 min**	**0 min**	**Subject**	
113	120	151	125	95	Sundeep	1.
118	125	140	120	96	Diksha	2.
117	122	129	138	111	Ratanamma	3.
105	110	118	125	101	Soundarya	4.
95	110	120	115	90	Pushpa	5.
95	110	120	115	90	Pratibha	6.
122	130	140	126	97	Arjun	7.
110	121	128	134	97	Manoj	8.
123	132	138	126	97	Padma	9.
103	121	128	123	96	Mukta	10.

Glycemic index is defined as the incremental area under the blood glucose curve of a 50 g carbohydrate portion of a test food as expressed as a percentage of the response to 50 g carbohydrate of a reference food taken by the same subject on reference food taken by the same subject on a different day. The average GI value is calculated from data collected in 10 human subjects. (Brand, 2005).

$$= \frac{*\ 100}{\quad}$$

The GI is a ranking of foods based on how quickly they raise blood glucose levels. The reference foods such as glucose have a GI of 100.

The foods with GI of 55 or less are low glycemic food, a GI of 56-69 is medium and food with GI of 70 or more is high glycemic index food.

The glycemic index of formulated Roti is **53**. It shows low glycemic index.

Calculation of Glycemic Index

The blood glucose level of individual subjects was averaged at each of the 0, 30, 60, 90 and 120 minutes to yield an average value. These values are shown below. Individual value of blood glucose is attached in **Appendix-I**

White bread has been used a reference food to calculate the glycemic index of roti.

Table 4: Average Blood Glucose Level for Roti and White Bread

AUC*	Blood glucose level					Subject
	120 min	**90 min**	**60 min**	**30 min**	**0 min**	
2281.098	104.9	117.2	122.6	122.4	97.4	Roti
3003.098	120.1	120.1	131.2	124.7	97	White Bread

* AUC = Area under Curve

The above data for Roti and White Bread is represented below graphically.

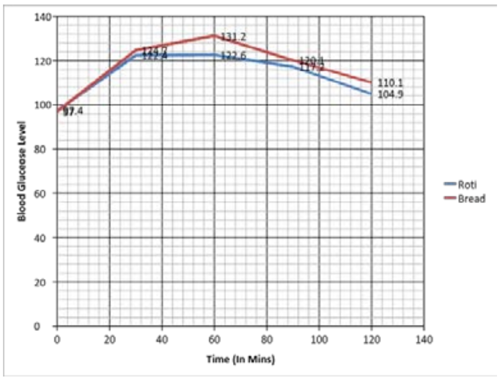

Fig. 2: Graphical Representation of blood glucose levels

The glycemic index of white bread is 70. Thus, in order to calculate glycemic of test food with white bread a reference food, the glycemic index need to be adjusted with respect to glucose whose glycemic index is 100. Hence, the calculated glycemic index should be divided by 100/70 or 1.43 to calculate the final glycemic index.

$$= \frac{* \; 100}{\quad}$$

$$= \frac{* \; 100}{\quad}$$

$$= \frac{2281.098 * 100}{3003.098 * 1.43}$$

$$= 53.11$$

RESULTS AND DISCUSSION

A total of 30 diabetic patients were selected. Out of these 15 patients were considered for the control group and the remaining 15 for the experimental group. The patients of the experimental group were prescribed the formulated roti (20% bajra, 10% oats, 10% barley, 10% soyabean, 10% bengal gram and 40% wheat) for 3 months. The patients were requested to consume 100 g (or 3 rotis equivalent) in a day.

At the beginning of the study, the fasting blood glucose level, post-prandial blood glucose level and HbA1C tests were conducted for both the experimental and control groups. At the end of the 3 months, the same tests were repeated. Statistical tests were conducted to identify if the results were statistically different. Following section describes the impact of the result.

The student's 'T' test was conducted on the Initial and Final data for the Experimental and Control Groups. It was conducted at a significance level of 1%.

Impact of mean fasting blood glucose level

Following table is the result of the Student's T-test at 1% significance level.

N=15

Table 5: Mean Fasting Blood Glucose Level

p-value*	t-value*	Fasting Blood Glucose (mg/100 ml)		Group
		Final	Initial	
0.00000012	2.7787	151±45.31	206.53±34.33	Experimental(N=15)
0.2668	2.7787	168.27±51.37	178.26±69.71	Control(N=15)

* 1% significance

The mean initial fasting blood glucose level of the subjects in experimental group and control group were found to be 206.53±34.33 mg/100 ml and 178.26±69.71mg/100 ml respectively. By the end of three months supplementation the fasting blood glucose level was noted in the experimental group and control group were 151±45.31 mg/100 ml and 168.27±51.37 mg/100 ml.

For the experimental group, the p-value in the above table is 0.00000012 which is much lower than 0.01 at 1% significance level, and hence the values in the final dataset are an effect of the supplementation. In other words, there is enough statistical evidence that supplementation has had a positive effect on the blood glucose level of the participants.

Supplementation was not provided to the control group. The initial and final blood glucose level was recorded for all the subjects. "T-test" was conducted for the control group at 1% significance level. The p-value resulted in 0.2668, which is much higher than 0.01. Hence, both the initial and final blood glucose levels are not statistically significant. In other words, there is not enough statistical evidence that the blood glucose level is significantly lower in the control group.

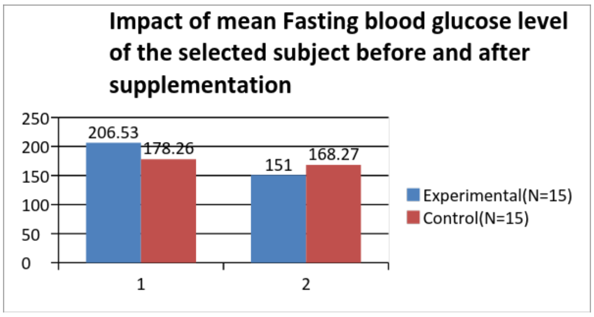

Fig. 3: Fasting Blood Glucose level

Impact of mean post prandial blood glucose level

Following table is the result of the Student's T-test at 1% significance level.

N=15

Table 6: Mean Post Prandial Blood Glucose Level

p-value*	t-value*	Post Prandial Blood Glucose (mg/100 ml)		Group
		Final	Initial	
0.00000088	2.7787	222.13±68.16	298.48±60.13	Experimental(N=15)
0.6569	2.7787	289.2±35.63	291.8±33.24	Control(N=15)

* 1% significance

The mean Post Prandial initial blood glucose level of the subjects in experimental group and control group were found to be 298.48±60.13 and 291.8±33.24 mg/100 ml respectively. By the end of three months supplementation the post prandial blood glucose level was noted in the experimental group and control group were 222.13±68.16 mg/100 ml and 289.2±35.63 mg/100 ml.

For the experimental group, the p-value in the above table is 0.00000088 which is much lower than 0.01 (at 1% significance level), and hence the values in the final dataset are an effect of the supplementation. In other words, there is enough statistical evidence that supplementation has had a positive effect on the blood glucose level of the participants.

Supplementation was not provided to the control group. The initial and final blood glucose level was recorded for all the subjects. "T-test" was conducted for the control group at 1% significance level. The p-value resulted in 0.6569, which is much higher than 0.01. Hence, both the initial and final blood glucose levels are not statistically significant. In other words, there is not enough statistical evidence that the blood glucose level is significantly lower in the control group.

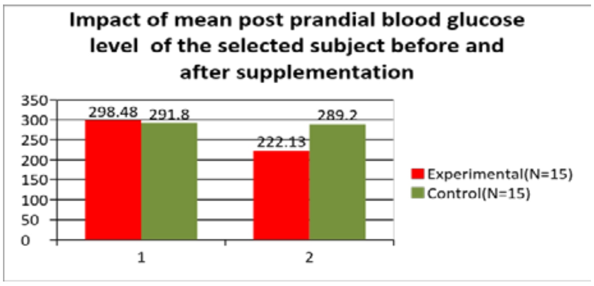

Fig. 4: Average Post Prandial Blood Glucose level

Impact of mean glycosylated haemoglobin

Following table is the result of the Student's T-test at 1% significance level.

N=15

Table 7: Mean Glycosylated Haemoglobin Level

p-value*	t-value*	HBA1C %		Group
		Final	Initial	
0.00000065	0.27787	7.17 ±1.43	9.44±2.21	Experimental(N=15)
0.3529	0.27787	9.54±2.76	9.98±2.82	Control(N=15)

* 1% significance

The mean glycosylated haemoglobin initial of the subjects in experimental group and control group were found to be 9.44±2.21 and 9.98±2.82 % respectively. By the end of three months supplementation the HBA1C was noted in the experimental group and control group were 7.17±1.43and 9.54±2.76%

For the experimental group, the p-value in the above table is 0. 00000065 which is much lower than 0.01 (at 1% significance level), and hence the values in the final dataset are an effect of the supplementation. In other words, there is enough statistical evidence that supplementation has had a positive effect on the blood glucose level of the participants.

Supplementation was not provided to the control group. The initial and final blood glucose level was recorded for all the subjects. "T-test" was conducted for the control group at 1% significance level. The p-value resulted in 0.3529, which is much higher than 0.01. Hence, both the initial and final blood glucose levels are not statistically significant. In other words, there is not enough statistical evidence that the blood glucose level is significantly lower in the control group.

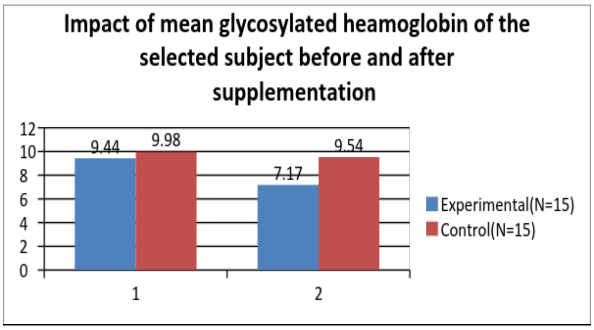

Fig. 5: Average Glycosylated Haemoglobin Levels

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