EFFECT OF HIGH FIBROUS MEAL BISCUITS ON THE BLOOD GLUCOSE LEVELS OF SIXTY INSULIN DEPENDENT DIABETICS

By

S. SELVAMEENAKARI

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INTRODUCTION

Diabetes mellitus is a disturbing health problem in India with an overall prevalence of twelve million (1.9%) of the total population. In India, epidemiological studies show a predominance on the male with a sex ratio of 2.2 : 1.5 and a greater prevalence in the urban area (Ahuja, 1979).

World Health Organization expert Committee on Diabetes Mellitus, 1980 (Who (1980) defines. "Diabetes mellitus" is a state of chronic hyperglycaemia which may arise from many environmental and genetic factors. The major effects of diabetes include characteristic symptoms keto acidosis (diabetic coma) the progressive development of the disease of the capillaries, of the kidney and retina, damage to the peripheral nerves and excessive artero sclerosis.

Diabetes mellitus has been classified into two types, growth onset and maturity onset, diabetes. Classically, growth onset diabetes is characterised by sudden onset, occuring in children and young adults who are insulin dependent. Juvenile diabetes in west is approximately 5 percent of the diabetic population.

White, (1960). Indian figures are much lower 0.5 percent reported at Bombay by Udani et al., (1968) and 0.8 percent by Vaishnava (1977), Delhi.

The World Health Organisation (W.H.O.) Expert Committee (1965) classified all diabetics with onset between 25 and 64 years as adult onset diabetics. Tattersal and Fajans (1975) considered the age 30 years as the upper limit for Juvenile onset diabetes. Ahuja (1973) and Vaishnava et al included subjects upto 40 years of age in the description of young diabetics, Viswanathan et al., (1966), Hosea (1971) and Janet et al (1978) upto age 30.

The factors influencing diabetes - The high risk individuals include, Those who are blood relatives of diabetics, Those over 40 years of age, Those who are obese, Women who have some carbohydrate intolerance during pregnancy, and Women who give birth to babies weighing nine pounds or more, (Robinson, 1977).

Most of the symptoms of diabetes are present in Juvenile diabetes and some in adult onset diabetes. They are oly uren, frequent urination and abnormally large volume of urine, polydipsia (or) excessive thirst,

polyphagia increased appetite, ketosis the accumulation of lower fatty acids in the blood which leads to the excretion of ketones in the urine.

The importance of diet in the management of diabetes mellitus has been recognised for many centuries. In India as early as 2,500 years ago, Sushruta and Charaka realised the importance of diet restriction in the treatment of diabetes mellitus. With the advent of insulin and drugs, diet was less emphasised for some time. Today however, based on several recent studies, the pendulum has swing back and the importance has been established all over the world, Viswanathan et al (1979).

Till recently, the fundamental principle in the diabetic diet was to restrict the carbohydrate intake. The typical diabetic diet of India at that time was similar to the diet followed in the Western countries as recommended by the Special Report of Committee on Food and Nutrition (1967) and consisted of about 55% carbohydrate, 17% protein, 30% fat, much different to habitual diet of an average Indian where carbohydrate contributed to 70 - 80% of total calories.

This resulted in an anti carbohydrate attitude in

the minds of diabetics, where no distinction was made between refined and unrefined carbohydrate in the diet. In refined carbohydrate in the diet, as Visvanathan (1979) aptly points out reduces not only the post prandial rise in blood glucose, but also the fasting blood glucose.

Sheldon and Bette (1979) refer to dietary fiber as that part of a food which is not digested in the human gastro intestinal tract. It includes cellulose, hemicellulose, pectic substances, gums and other non indigestible carbohydrates. "Crude fiber" is the material remaining after vigorous treatment of a food sample with acid and alkali. Dietary crude fiber ratio may vary from as high as 7:1.

Unrefined carbohydrate might favourably influence blood glucose in several ways: larger particles may be less digestible: it may slow the absorption. Non absorbable carbohydrates may retain otherwise the absorbable carbohydrates. The unrefined fiber fills the stomach, adds satiety and so the caloric intake is reduced and it helps in reducing the weight of the body. This also helps in releasing the muscle bound insulin (Anderson and Ceiling, (1981).

Trowell (1973) suggested that a deficiency of fiber may be involved in the aetiology of diabetes, initiating several studies on fiber and diabetic management. However, there are not many studies conducted in India on the effect of fiber, hence this study has been undertaken with wheat bran as the main source of fiber with the following objectives:-

- To plan dietaries with an additional 5.2g crude fiber suitable for the diabetics.
- To formulate high fibrous bran biscuits to add fiber in the above dietaries.
- To study the effect of high fibrous bran biscuits on the blood glucose levels of the selected 20 diabetic patients - 10 juvenile and 10 adult onset diabetics.

II. REVIEW OF LITERATURE

The literature regarding the study. The effect of high fibrous bran biscuits on the blood glucose levels of twenty insulin dependent diabetic patients from Coimbatore Medical College Hospital is dealt under.

A. Diabetes, a Major Public Health Problem.
B. Approaches in Treatment Regimen
C. Diet an Integral Part of Treatment
D. Role of Dietary Fiber as a Therapeutic agent

A. Diabetes a Major Public Health Problem

1. Incidence of diabetes mellitus

The incidence of Juvenile diabetes is 5% of the total diabetic population in West, (White, 1960). In India 0.5% reported by Mani et al (1968) and 0.8% of the total diabetics by Vaishnava et al, (1977) Chakravarthi et al (1971) gave a figure of 0.7% and Chirwani et al (1971) gave 0.96% as the prevalence. Gangali et al (1964) reported an incidence of 2.3%.

2. Predisposing factors

Etiology of diabetes is complicated that there is no single cause for this condition. Several factors can be suggested. These include age, sex, body weight, heredity, parity and other factors. Maximum incidence in India is observed between third and fifth decades, Ahuja, (1979). Diabetes mellitus is more common in the second half of life, very rare in childhood, uncommon in early childhood, Goodhart et al, (1980). In majority of diabetics above 45 years body weight, is a contributory factor. In many with weight reduction diabetes is controlled, Goodhart et al, (1980). In United States and Western European countries, female to male prevalence is 3:1. In India female to male (Rural) 1.3 : 1.3 and (Urban) 1.8 : 2.6 Ahuja (1979). Diabetes is believed to be inherited as a mendelian recessive factor. If both the parents are diabetic the children will develop diabetes (Ahuja, 1979). Pyke and Please (1957) established a strong association between parity and susceptibility of diabetes. Indian Council of Medical Research (ICMR) study (1978) brought out that 5+ parity significantly increased the risk of diabetes, stress and strain situation like infection, pregnancy and shock may bring about a light diabetic syndrome which can be reverted (Goodhart et al, 1980).

2. Approaches in Treatment Regimen

There are three methods of treatment and each involves an obligation for the patient to adhere to a dietary regimen for the rest of his life.

1. Diet.

In 1971 The University group diabetes programme (UGDP) reported the results of the multicenter study and concluded that 'diet alone' may be more effective in prolonging the life of the diabetic than the other therapeutic agents. In addition in 1975, the National Commission on diabetes noted that the chance of diabetes mellitus doubles for every 20% of excessive weight. Hence the strong implication that 'diet' may play a role on the pathogenesis of diabetes mellitus, Arky (1978).

2. Oral Hypoglycaemic Agents:

A number of compounds reduce hyperglycaemia in patients who would otherwise require insulin. The sulphonyl urea compounds tolbutamide and chlorpropamide and to a lesser extent the biguanides, metformin and phenformin, have a place in the management of 30% of diabetic patients. Although their mechanism of action is different, the action of both groups depends upon a supply of endogenous insulin and it is dangerous to attempt to control juvenile diabetes with these

compounds, (Davidson and Passmore, 1975).

3. Insulin:

Unfortunately no method of insulin has yet been found that will maintain the blood glucose level within the physiological range throughout the 24 hours without undue risk of hypoglycaemia. Two main forms of insulin are available, namely soluble and depot and these vary in rate of onset and duration of their effect. One unit of insulin will metabolise 1.5 to 2g of glucose. (Proudfit and Robinson, 1980).

C. Diet as Integral Part of the Treatment Programme.

Specific objectives of dietary treatment are based on the type of diabetes. Generally in diabetes, the first objective is to prevent the acute complications of hyper and hypoglycaemia. This is accomplished through the careful balance and timing of food, insulin and exercise. The other objectives are to provide normal growth in children and to maintain desirable body weight in adults (Schwarts, 1979).

1. Energy:

The single most important objective in dietary treatment of diabetes is control of the total energy

intake to attain or maintain ideal body weight (West, 1977). Weight loss in obese diabetics lowers fasting blood glucose levels and improves glucose tolerance. Furthermore weight loss has been shown to increase the number of insulin receptors and to gradually diminish the insulin resistance associated with obesity. Schwartz, (1979). Maintenance of desired body weight involves the calorie restriction of the diet.

2. Carbohydrate.

It is generally assumed that diabetic control cannot be achieved without dietary restriction of carbohydrate (Trowell et al, 1975). But now diabetics are given diets containing 70-80% of carbohydrate with no apparent ill effect. (Patel et al, 1969). Experimental studies have confirmed the epidemiological observation that diets containing a high proportions of carbohydrate is mediated not by insulin secretion but by increased peripheral sensitivity to insulin and enhanced activity of the glycolytic path ways (Biermann and Nelson, 1979).

3. Protein.

Floyed et al (1976) found a synergistic effect exerted on insulin secretion. Einstein and Strachs

study on rats indicated that a high protein diet stimulate glucagon secretion. Protein should supply approximately 12-20% of total energy intake or an amount equal to 1g per Kg body weight, Robinson, Davidson (1975), Schwarts (1978).

4. Fat.

After the protein and carbohydrate levels have been established the fat allowance makes up the remaining calories. Though dietary fat does not have an immediate effect on blood glucose, it is a concentrated energy and it should be limited to 30-35% of energy, Schwarts, (1978).

5. Vitamins and Minerals.

In diabetics the conversion of Beta carotene to vitamin A is impaired. The need for B complex vitamin increases with the use of the drugs. Calcium, Iron and Potassium should also be supplemented.

6. Fiber - The Unrefined Carbohydrate in the Food.

Trowell (1975) defined dietary fiber as that part of plant material taken in our diet which is resistant to digestion by the secretion of the human gastro intestinal tract. It comprises of a heterogeneous

group of carbohydrate components including cellulose, hemicellulose and a non carbohydrate substance lignin, Briggs, (1976), Southgate and Bingham (1979), Richard (1980), and Anderson, (1981).

According to Kritchevsky (1978), Crude fiber is the component of the food included in most of the food composition tables, it is the material remaining after vigorous treatment of the food sample with acid and alkali. Therefore, dietary and crude fiber ratio may vary from as high as 7:1. Trowell (1972), Spiller and Amen (1975), Leville (1976) conclude the definition of dietary fiber as that part of plant material which is resistant to digestion by the secretions of human gastro intestinal tract.

The components of dietary fiber, as summarized by Levin and Horwitz, (1979), is given in Table-1.

TABLE 1.

COMPONENTS OF DIETARY FIBER

Principal Dietary Sources	Description	Nomenclature
Structural materials of the plant cell wall.	Structural polysaccharides Noncarbohydrate constituents	Cellulose Hemi cellulose, Pectic substances, Lignin.
Non Structural material either found naturally (or) used as food additives.	Poly saccharides from a variety of sources	Minor components of pectin substances, mucilages, gums.

D. Uses of Fiber As a Therapeutic Agent.

The value of adding fiber to the diet was reported as early as 400 B.C. by Hippocrates when they identified that bran is a laxative, Trowell, (1977). Burkitt (1970), Pal and Ghosh, (1976) discussed a hypothesis that the low fiber diets in the country may be related to a higher incidence of constipation, ulcerative colitis, venous thrombosis, diverticulosis, varicose veins and the cancer of the colon.

1. Relief of Constipation.

The increase in stool weight is largely responsible for the prevention and relief of constipation. The consumption 10-15g of extra dietary fiber will prevent constipation. The indigestible carbohydrate in the form of fiber absorbs the water and increases the stool weight and excretes the bacteria (Weininger and Briggs, 1976).

Andersen and Hailing (1980) showed the effect of high carbohydrate high fiber diets on glucose and lipid metabolism in twelve diabetic patients. The patients were fed an isocaloric diet with 70% of energy as carbohydrate and 65g of plant fiber. The

insulin doses on high fiber diet was reduced to an average of 3.1 ± 1.9 units/day. Average fasting plasma glucose levels declined from 160 mg/dl to 132 mg/dl on high fiber diet.

Heaton et al (1977) studied ten normal subjects fed test meals based on apples contributing 60g carbohydrate and a fiber free juice. There was a striking rebound fall of plasma glucose after apples and the least after juice. Monnier et al (1975) cited by Viswanathan et al, (1979) studied the differences between various types of indigestible fibers where oral glucose (45g) was given to diabetics by itself or with pectin or cellulose phosphate. All these substances reduced the rate of rise in glucose.

Viswanathan et al (1979) formulated a diet which was high in carbohydrate 67%, and high in fiber, 50g. There was a significant reduction in the plasma glucose levels (Fig.1). There was a significant reduction in immune reactive insulin levels. Addition of guar gum to carbohydrate containing meal results in a decrease of post prandial hyperglycaemia and insulinaemia in normal subjects, Jenkins et al, 1976 and diabetic subjects, (Jenkins et al, 1977).

Studies of Jennifer et al, 1979 indicate that non absorbable carbohydrate and the non carbohydrate lignin together lead to an improvement in the management of diabetes. It reduces not only post prandial blood glucose values but also fasting glucose values. Beyer and Margret (1977) found the effect of low fiber diet (1g crude fiber) and high fiber diet (9g crude fiber) diets on blood glucose levels of diabetic patients, which resulted in a significant fall in the post prandial blood glucose levels.

Simpson et al, 1981 conducted a study in which 18 insulin independent and 9 insulin dependent diabetic patients who were put under a high carbohydrate diet 60% and high fiber content 64% for six weeks. The mean two hour post prandial blood glucose were significantly lower on the high carbohydrate high fiber diet.

A study by Rivellese et al 1980 where diabetic patients were given high fibrous diet (54g) for 10 days revealed that the high fiber diet reduced the post prandial glucose levels significantly. Keihn et al (1976) fed 13 diabetic patients a diet rich in carbohydrate (75% of calories) and 14.2 g of crude fiber. A significant fall in plasma glucose was seen in 4 patients who were

under sulfonyl ureas and less than 30 units of insulin. Insulin could be discontinued for 5 patients.

Hiramia and Horwits (1976) studied eight insulin dependent diabetic patients on two different diets of 3g and 20g crude fiber. Mean plasma glucose throughout the day on the high fiber diet was significantly ($P < 0.01$) lower on the high fiber diet (120.8 ± 10.1 mg per al) than on the low fiber diet, (169.4 ± 11.7 mg/dl) (Fig.1), (Table.I).

Nunes et al (1978) showed that the glucose tolerance improved greatly in healthy subjects maintained for 30 days on diets to which corn bran (32.1% fiber) and Soy bean hulls (36.7%) fiber) was added.

Jenkins et al, 1977 examined the effects of adding guar flour to test meal in both normal and diabetic patients. Reductions in post prandial blood glucose levels were seen in all subjects.

III. METHODOLOGY

The effect of high fibrous bran biscuits on controlling the blood glucose levels of insulin dependent adult onset and juvenile diabetic patients has been studied with twenty patients from the out patient department of Coimbatore Medical College Hospital.

The aspects of the study were:-

A. Selection of the Patients.
B. Method of Assessing the blood glucose level.
C. Formulation of high fibrous bran biscuits.
D. Quantification of nutrient intake of the selected patients.
E. Administration of the high fibrous bran biscuits.

A. Selection of the Patients

Ten insulin dependent juvenile and ten adult onset diabetic patients without any complications were selected based on the cooperation extended. Only three were male patients, since male patients could not spare three hours continuously to test the post prandial glucose level. All the patients belonged to low socio economic group.

B. Method of Assessing Blood Glucose Level

The blood glucose level was estimated using the Dyetone reflectance colorimeter, which utilises an electro-optical system for measuring the degree of color development on the dextrostix reagent strips in reaction to the glucose concentration of a drop of whole blood. Since no patient was willing to give the venous blood every half an hour, capillary blood glucose was analysed using the Dyetone colorimeter. According to Lily Research laboratories, 1980, when Polin wu method is used to estimate the blood glucose level about 20 mg per 100 ml should be substracted inorder to convert the value into 'true glucose' level. There are differences in the glucose level of capillary and venous blood. Therefore when capillary blood is collected by finger prick, 30 mg per 100ml should be deducted to convert the value into 'true glucose' level. Appendix-I.

C. Formulation of the High Fibrous Bran Biscuits:

The bran biscuits were selected to increase the fiber content of the patients' diet. The reason for the selection of this biscuit was it was easy to prepare, reasonable cost and it was easy for administration.

1. Recipe of the Biscuit: 40 Biscuits (520g).

Wheat bran biscuits were prepared in two proportions of wheat bran and refined wheat flour (i.e) 1:1 and 3:1.

INGREDIENTS	WEIGHT IN GRAMS	
	BISCUIT-I	BISCUIT-II
Wheat bran	150	100
Refined wheat flour	50	100
Vanaspathy	125	100
Salt	5	5
Ammonium bi carbonate	10	10

Method.

Vanaspathy and sugar were made into a cream consistency. Refined wheat flour, wheat bran, salt and ammonium bi carbonate were sifted and then added to the cream. The dough was rolled and cut with the biscuit cutter the biscuits were baked at 350°F for about 15 minutes.

2. Palatability Test

The biscuits prepared in two different proportions of bran were scored for palatability by the expert panel of 25 Judges among the faculty members and

students. The biscuit I got a high score of 22 eventhough the bran was more in it whereas the Biscuit II got only 18. The Score card used is given in Appendix-II.

3. Acceptability Test

The biscuit-I was exhibited in the Second World Congress on Diabetes held at the Tamilnadu Agricultural University, Coimbatore, and it was distributed to 200 patients who visited the exhibition and it was found acceptable by every body.

D. Quantification of the Nutrient intake of the selected Patients

The energy, Carbohydrate, Protein, fat and Fiber content of the diet of the patients was assessed by the three day recall method of dietary survey.

E. Administration of the Bran Biscuits

Before administering the biscuits the investigator as unselled the patients about the importance and benefits of consuming the biscuits and convinced them.

The Post prandial blood glucose levels of the patients after half an hour, one hour, one and a half

hour, two hours and three hours were estimated and recorded as the initial reading. Then they were given eight biscuits (104g) a day of 32g wheat bran, and asked to eat two in the morning, two in the afternoon, two in the evening and two in the night for five consequitive days. On the fifth day again the post prandial levels after the consumption of the same amount of breakfast was estimated after half, one, one and a half, two and three hours and recorded as the final reading.

RESULT AND DISCUSSION

The result of the study, the effect of high fibrous bran biscuit on the blood glucose levels of twenty insulin dependent diabetic patients is interpreted under the following headings.

A. Background Information
B. Post Prandial Blood Glucose Levels
C. Mean Daily Nutrient Intake Before and After the Administration of the Bran Biscuits
D. Impact of the Bran Biscuits on the Blood Glucose Levels.

A. Background Information

The sex, age, weight, the onset of diabetes in years and the insulin units of the selected ten juvenile diabetic patients is given in the Table.II.

TABLE II.

[illegible] OF THE [illegible] IN THE JUVENILE ADULT PATIENTS

Patient Number	Sex	Age (Years)	Onset of Diabetes (Years)	Weight Kgs.	Insulin Units given
1	M	16	13	32.0	150
2	F	17	8	50.5	56
3	F	17	16	2[illegible].0	90
4	F	18	15	34.5	80
5	F	19	11	32.0	90
6	F	19	16	42.0	110
7	F	20	18	35.0	96
8	F	25	22	37.5	48
9	F	27	22	39.0	60
10	F	27	25	41.0	56

The weight of the patients as seen from Table.IV is below the normal weight. Thus it indicates that they were under nourished. According to Goodhart (1980) insulin dependent diabetes usually, but not always, arises during childhood or puberty, it is abrupt in onset and symptomatic, occurs usually in under nourished patients. Sharky (1965) points out that all Juvenile diabetics are under nourished.

The sex, age, onset of diabetes, weight and insulin units of ten selected adult onset diabetic patients is given in Table.III.

TABLE.III

BACKGROUND INFORMATION OF THE ADULT ONSET DIABETIC PATIENTS

Patient Number	Sex	Age (years)	Onset of Diabetes (years)	Weight Kgs	Insulin Units given
1	F	56	52	49.0	20
2	F	42	37	56.0	70
3	F	45	43	58.0	24
4	F	45	41	62.5	56
5	M	45	40	61.5	30
6	F	52	50	55.5	20
7	F	45	40	66.0	40
8	M	52	35	71.0	40
9	F	53	46	60.0	28
10	F	59	56	65.5	40

With reference to the I.C.M.R. reference tables (1971), almost all the adult onset diabetic patients were overweight.

B. [redacted]

The Post Prandial blood glucose levels of the selected ten Juvenile diabetic patients before the administration of the biscuits is given in Table-IV. The instrument used to find out the blood glucose level was Zycotone colorimeter and the limitation of using the instrument is, it does not read the levels beyond 400 mg. But for quick and easy estimation and since no patient was willing to give venous blood every half an hour, this instrument was used.

TABLE IV

POST PRANDIAL BLOOD GLUCOSE LEVELS IN THE JUVENILE DIABETIC PATIENTS.

Patient Number	Time in hours				
	½	1	1½	2	3
1	180	220	260	260	200
2	-	380	360	360	300
3	< 400	< 400	< 400	< 400	< 400
4	400	< 400	< 400	< 400	380
5	380	< 400	< 400	< 400	360
6	< 400	< 400	< 400	< 400	< 400
7	-	280	320	300	240
8	400	< 400	< 400	< 400	380
9	-	< 400	< 400	< 400	< 400
10	400	< 400	< 400	< 400	380

* Since these patients could not come to the experimental spot after half an hour of the breakfast, these levels could not be estimated.

The post prandial blood glucose levels of the selected adult onset diabetic patients before the administration of the bran biscuits is given in the table-V.

TABLE.V

THE POST PRANDIAL BLOOD GLUCOSE LEVELS OF THE ADULT ONSET DIABETIC PATIENTS

Patient Number	Time in hours				
	1/2	1	1/2	2	3
1	200	220	240	240	220
2	*	380	400	380	360
3	260	280	240	240	220
4	280	300	320	300	280
5	320	340	360	360	300
6	*	220	240	220	180
7	320	340	320	320	300
8	300	320	340	360	320
9	300	340	340	360	320
10	300	320	320	340	320

* Since these patients could not come to the experimental spot within half an hour after breakfast this level could not be estimated.

The blood glucose levels of the adult onset diabetics is lower than the Juvenile diabetic patients.

C. Mean daily Nutrient Intake of the Patients before and after the Administration of the Bran Biscuits

The mean energy, carbohydrate, protein, fat and fiber intake of the Juvenile diabetic patients before the administration of the biscuits is given in the Table.VI and of adult onset diabetics in Table.VII.

TABLE.VI

MEAN DAILY ENERGY CARBOHYDRATE, PROTEIN, FAT AND FIBER INTAKE OF THE JUVENILE DIABETIC PATIENTS.

Patient Number	Energy Calories	Carbo-hydrate g	Protein g	Fat g	Fiber g
1	1370	215	42	38	4.5
2	1151	152	52	35	5.2
3	1155	147	35	40	5.6
4	1408	215	47	40	6.0
5	1450	209	51	46	5.8
6	1340	189	38	48	4.2
7	1440	249	30	36	3.4
8	1419	221	46	39	4.8
9	1508	232	43	32	5.1
10	1144	189	32	26	4.8

It may be noted from table.VI that the intake of calories, carbohydrate, fat and protein are low.

TABLE.VII

MEAN DAILY ENERGY, CARBOHYDRATE, PROTEIN, FAT AND FIBER INTAKE OF THE ADULT MALE INDIAN PATIENT.

Patient Number	Energy Calories	Carbo-hydrates g	Pro-tein g	Fat g	Fiber g
1	1375	211	45	39	3.6
2	1241	187	40	37	5.1
3	1370	193	48	46	4.6
4	1054	150	32	25	4.0
5	1280	217	31	32	4.7
6	1479	218	37	51	4.5
7	1461	231	51	37	4.4
8	1425	255	32	31	5.1
9	1529	246	44	41	5.9
10	1490	216	53	46	5.1

From the dietary pattern of the patients it was noted that they include rice in only one meal and the other meals comprises of ragi (or) wheat because they think that they should not eat rice much.

It is clear that the intake of the calorie, protein, fat and carbohydrate is lower than the daily recommended allowances. Compared to the intake of Juvenile diabetics intake, the intake of adult onset diabetics is better.

Each biscuit supplied about 10 calories of energy and 0.65g crude fiber. The patients were given in addition to their diet eight biscuits a day which supplied 80 calories of energy and 5.20g of crude fiber through 32g of wheat bran.

D. <u>Impact of the High Fibrous Bran Biscuits on the Blood Glucose Levels of the selected Patients.</u>

The impact of the bran biscuits on the post prandial blood glucose levels of the selected Juvenile diabetic patients is presented in Table-X.

TABLE VIII

IMPACT OF THE HIGH FIBROUS BRAN BISCUITS ON THE BLOOD GLUCOSE LEVELS OF THE DIABETIC PATIENTS

Patient Number	Time in hours									
	½		1		1½		2		3	
	B.A	A.A	B.A	A.A	B.A	A.A	B.A	A.A	B.A	A.A
1	180	140	220	200	260	240	260	200	200	180
2	-	-	300	320	360	340	360	340	340	300
3	< 400	360	< 400	380	< 400	400	< 400	360	< 400	340
4	400	300	< 400	320	< 400	340	< 400	340	380	300
5	380	300	< 400	320	< 400	340	< 400	340	360	300
6	< 400	320	< 400	340	< 400	340	< 400	360	< 400	300
7	-	-	280	180	320	240	300	240	240	180
8	400	320	< 400	340	< 400	340	< 400	360	380	300
9	380	320	< 400	340	< 400	340	< 400	340	360	300
10	400	320	< 400	340	< 400	340	< 400	340	380	300

B.A. - Before Administration of the biscuit.
A.A. - After Administration of the biscuit.

It is clear that the post prandial levels were reduced after the consumption of the bran biscuits. It is felt by the investigator that if the number of biscuits could be increased, much more reduction could be achieved.

The impact of the bran biscuits on the blood glucose levels of the selected adult onset diabetic, patients to presented in Table.IX.

TABLE IX

IMPACT OF THE HIGH FIBROUS B AN BISCUITS ON THE BLOOD GLUCOSE LEVELS OF THE ADULT ONSET DIABETIC PATIENTS

Patient Number	Time in hours									
	1/2		1		1 1/2		2		3	
	Administration of the Biscuit									
	Before	After	Before	After	Before	After	Before	After	Before	After
1	200	160	220	180	240	200	240	220	220	180
2	*	-	380	300	400	320	380	320	360	300
3	260	200	280	220	240	240	240	220	220	200
4	280	200	300	280	320	300	290	260	280	220
5	320	260	340	280	360	300	360	280	300	260
6	-	-	220	130	240	140	220	130	180	100
7	320	200	240	240	320	260	320	300	300	240
8	300	220	320	280	340	280	360	260	340	220
9	300	220	340	240	340	260	360	300	320	240
10	300	240	320	260	320	260	340	280	320	320

* Since the patient could not come to the spot after half an hour of the breakfast this level could not be taken.

It is noted that there was a decrease in the post prandial blood glucose level after the consumption of the bran biscuits in the adult onset diabetic patients. The final levels of the blood glucose were taken after the consumption of the same calorie breakfast by the patient.

The impact of the high fibrous bran biscuits on the blood glucose levels of the diabetic patients closely resembles the study on the effect of high fibrous diet on the blood glucose levels of diabetics by Viswanathan et al, (1979) where the study resulted in a good control of the blood glucose level, the and study of Miranda and Horwits 1978, the effect of high fibrous bread on the blood glucose levels of the diabetics, which resulted in a significant reduction in the blood glucose levels. Table.3 and Figure.1 indicates the results of the Miranda and Horwits study (1978) and Figure.2 gives the picture of the results of Viswanathan et al study (1979).

TABLE X

[redacted]

[redacted]

PLASMA GLUCOSE LEVEL mg/100 ml.

Subject	Low fiber diet 5.11g/day	High fiber diet 19.87g/day	% difference in plasma glucose level
1	279.6	121.4	-57
2	223.3	145.8	-35
3	75.7	85.7	-13
4	198.0	135.7	-31
5	248.0	99.3	-60
6	103.8	83.8	-14
7	121.4	98.5	-19
8	105.3	91.2	-13

MEAN PLASMA GLUCOSE LEVELS ON HIGH AND LOW FIBER DIETS FROM MIRANDA AND HORWITZ STUDY, 1978.

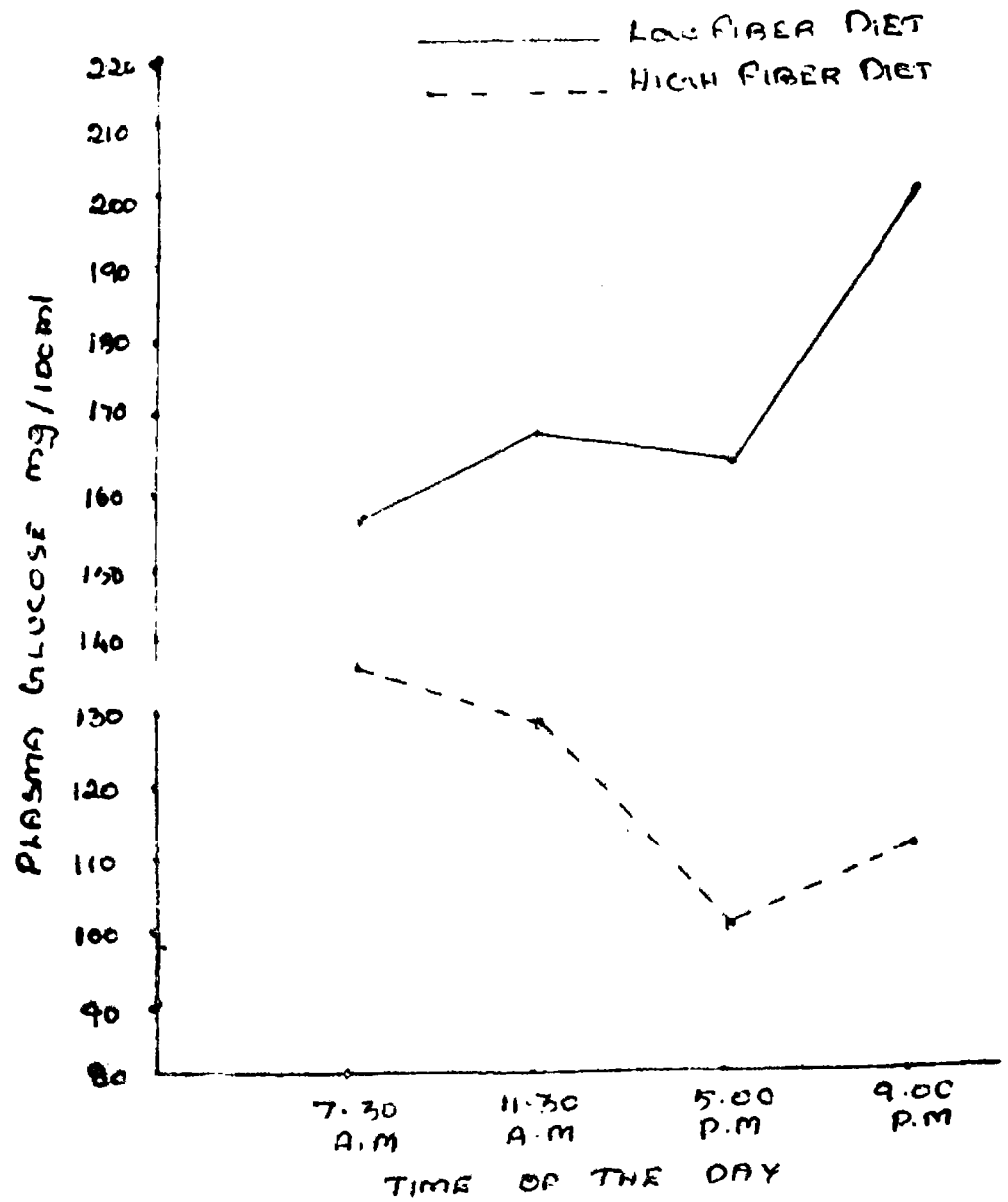
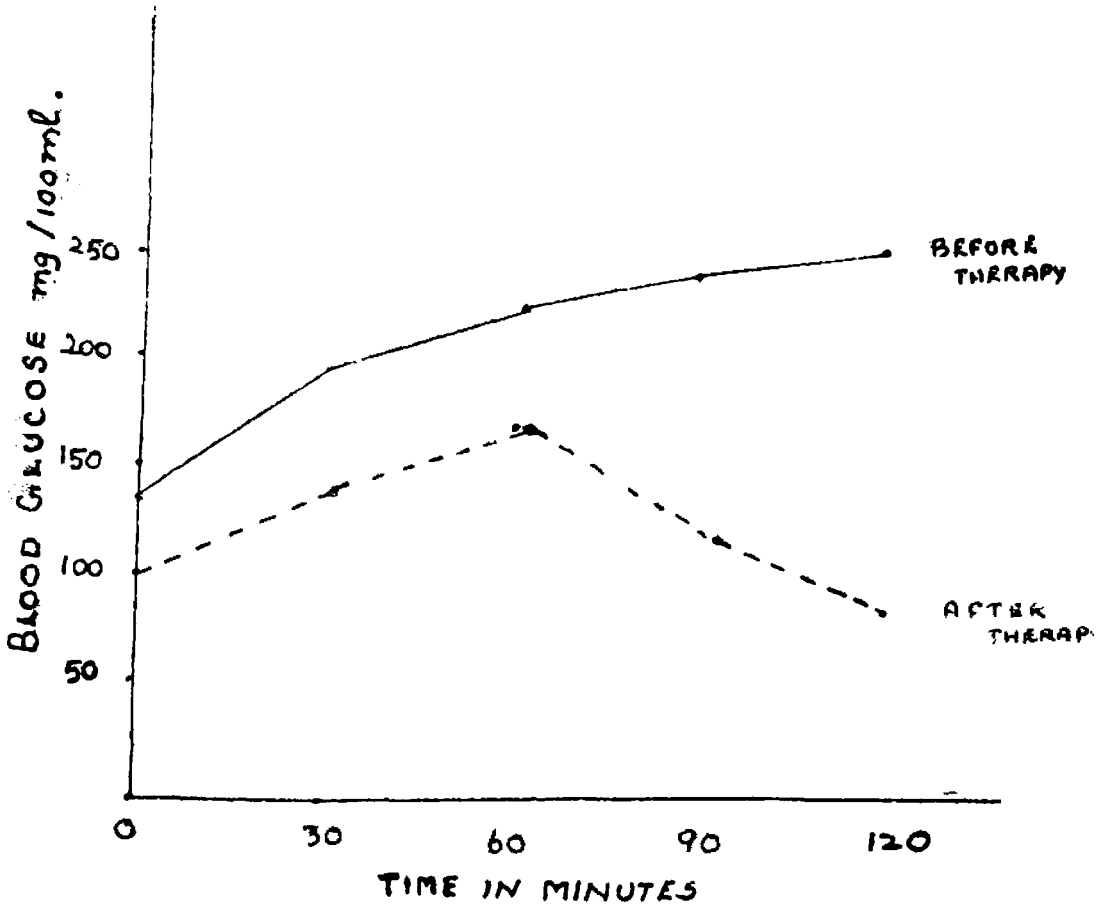


FIGURE -

RESULTS OF ORAL GLUCOSE TOLERANCE TEST IN PATIENTS BEFORE AND AFTER HIGH CARBOHYDRATE HIGH FIBER THERAPY, VISWANATHAN et al, 1979.



SUMMARY AND CONCLUSION

To evaluate the effect of the addition of 5.2g of crude fiber in the form of bran biscuits on the blood glucose levels of ten juvenile and ten adult onset diabetic patients, the post prandial blood glucose levels were estimated soon after selecting them for the study. Then they were fed eight bran biscuits (104g) a day which supplied 5.2g of crude fiber and 80 calories a day through 32g of wheat bran for five consecutive days. On the fifth day again their postprandial blood glucose levels were estimated and there was a considerable decrease in the blood glucose levels after the consumption of these biscuits.

RECOMMENDATIONS

These biscuits were very easy to prepare and each biscuit costs only 15 paise. These biscuits were preferred by all the patients and they did not have any discomfort after eating these biscuits, rather they felt a high degree of satiety. They were eager to know the method of preparation and the source of availability of these biscuits. So it is felt that if these biscuits are prepared and sold by the co-operative societies, all the diabetic patients will be benefited.

Longterm studies need to be conducted with the same bran biscuit to indicate whether the insulin dosage could be reduced. Similar fiber rich foods should be included in every days diet. Fiber should not be thought as a medicine. An increased consumption of fiber through whole grains, legumes, nuts, greens, fruits and vegetables will provide not only a variety of fibers but also make a positive contribution to the overall nutritional value of the diet.

Even though this study revealed a marked decrease in the blood glucose level after the consumption of these biscuits in the diabetic patients, longterm studies are needed to confirm the fact further.

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APPENDIX - I

[illegible] CALIBRATION TO ESTIMATE BLOOD ALCOHOL LEVEL

1. Keep the instrument on a flat surface.
2. Switch it in the on position. Check to see that the pilot lamp is lit.
3. Leave the instrument turned on for 30 minutes.
4. Adjust the thumb wheel on the right side of the instrument until the white mark is in the middle of the visible area.
5. CALIBRATION.
   a. Remove the Set - 1 Reference strip and insert into the strip guide with the colored area toward the meter scale.
   b. Press and hold the instrument lid of the instrument until the meter needle stops at the position set-1 on the meter scale.
   c. Remove the set - 1 - strip and insert the set-2 strip and turn set - 2 adjustment until the meter needle stops at set - 2 position on the meter scale.
6. STANDARDIZATION.

Standardization of the instrument should be done only after caliberation.

a. Shake the 130 mg all standard solution to mix well.

b. Freely apply a large drop of 130mg/dl standard solution sufficient enough to cover the entire reagent area of the dextrostix reagent strip.

c. Using a stop watch, time the reaction exactly sixty seconds.

d. At the end of the 60 seconds timing period quickly (within 1 or 2 seconds) wash of the standard solution from the reagent area with a sharp stream of water using an Asco water bottle.

e. Quickly blot the reagent area of the strip on a lint free paper towel.

f. Quickly insert the reagent strip into the strip guide.

g. Press and hold the instrument lid in the centre and verify that the meter needle stops at 130mg/dl.

h. If it does not stop adjust the thumb wheel so that the meter scale stops at 130mg/dl.

7. <u>FINDING THE BLOOD GLUCOSE LEVEL</u>

Only after Caliberation and standardisations the apparatus can be used to find out the blood glucose level.

a. Take a dextrostix reagent strip and keep it near the Eyetone meter.

b. Freely apply a large drop of the blood on the reagent strip sufficient enough to cover the entire area.

c. Using a stop watch, time the reaction, exactly 60 seconds.

d. At the end of the 60 seconds quickly wash of the blood from the reagent area with a sharp stream of water.

e. Quickly blot the reagent area with a lint-free paper towel.

f. Quickly insert the strip into the strip guide, press on the lid in the centre and note down the reading of the meter scale.

The meter scale readings starts from 0 and ends at 400.

APPENDIX - II

SCORE CARD USED TO EVALUATE THE BEAN BISCUITS OF TWO DIFFERENT FORMULATIONS OF BEAN.

Serial Number	Criteria	Score	Sample I	Sample II
1.	COLOUR			
	a. Attractive	3		
	b. Light	2		
	c. Dark	1		
2.	TEXTURE			
	a. Crisp	3		
	b. Crumby	2		
	c. Soggy	1		
3.	FLAVOUR			
	a. Pleasant	3		
	b. Lacks flavour	2		
	c. Strong flavour	1		
4.	TASTE			
	a. Good	3		
	b. Salty	2		
	c. Insipid	1		
	TOTAL			

DATE AND SIGNATURE