"Comparison of Glycemic Response of Whole Wheat Brown Bread and White Bread in Non-Insulin Dependent Diabetics."

BY

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LIST OF FIGURES

LIST OF APPENDICES

APPENDIX

Introduction

I. INTRODUCTION

"A good diet is a perfect way to healthy life". Diet plays an important role in all disease conditions. A well balanced diet should be modified according to the disease condition. Modification may be high or low protein, carbohydrate, fat, minerals and vitamins.

Among the various disease conditions which well respond to dietary modification diabetes is one in which diet has a major role to play. Diabetes mellitus is a chronic inborn error of metabolism occuring due to an absolute or relative insufficiency of insulin or due to ineffectiveness of peripheral action of insulin.

Diabetes mellitus, a disorder of carbohydrate utilization secondary to a relative or absolute deficiency of insulin, is the seventh leading underlying cause of death in the U.S. (NRC, 1989). Sharma (1987) points out that diabetes mellitus is the third commonest diease in the world next to the cardio vascular and oncological disorder, and every fifth person today in the world is suffering directly or indirectly from this disease.

The prevalence of diabetes mellitus has increased to 1.5% in rural population, greater than 3% in large urban

centres, 8% - 22% in immigrant Indians due to altered life style of present society (Raheja,1988). There are about 30 million people in the world affected by this disease (Raghuram, 1988).

Diabetes mellitus is broadly classified as insulin dependent diabetes mellitus, non insulin dependent diabetes mellitus and malnutrition related diabetes mellitus. Insulin dependent diabetes mellitus is most frequently seen in individuals less than 30 years of age and non insulin dependent diabetes mellitus Occurs mainly in the middle aged and elderly.

Diet remains the cornerstone for diabetic patients especially non insulin dependent diabetics. The diet which are rich in fiber content seems to be very effective in reducing the blood sugar level.

Current evidence suggests that high fiber diets, especially of the soluble variety, and soluble fiber supplement may offer some improvement in carbohydrate metabolism.

Trowell (1972) first defined dietary fibre as components of the plant cell wall that resist digestion by secretion of the human alimentary tract.

Life Sciences Research Office (1987) defined dietary fiber as 'the endogenous components of plant materials in the diet which are resistant to digestion by enzymes produced by humans'.

Cereal products represent an important source of dietary fiber and supply about 40% of the entire volume of dietary fiber. Cereal products and baked goods add approximately 9.5 g to the total daily intake of dietary fibre (Becker et al., 1986).

In patients with non-insulin dependent diabetes a modest increase in dietary fiber from wholemeal bread and apple resulted in a lower postprandial glucose respose compared with corresponding low fiber diet (Hagander, 1987).

Breads containing a high proportion of whole cereal grains may be useful in reducing the postprandial blood glucose profile in diabetics because they are more slowly digested (Jenkins et al, 1988).

Bread is a food product which is readymade and does not need much cooking, and is easily available. The consumption of bread and other whole grain cereal

products is increasing day by day throughout the world. In brown bread whole wheat flour is used and the amount of sugar added is minimum. Salt is also avoided in brown bread. Thorburn (1986) says that when salt is added to bread, the peak glucose concentration was significantly higher than that of unsalted bread. A few bakeries in Coimbatore city specially prepared whole wheat brown bread and sold it for diabetic subjects. Hence the investigator planned to evaluate this bread for its effectiveness in lowering the blood glucose levels. The effect of whole wheat brown bread on glycemic response in diabetics is new and interesting. If the effects are scientifically proved that may greatly benefit the non insulin dependent diabetics. In the present study the two varieties of bread namely the whole wheat brown bread and white bread have been selected for testing their glycemic response in the diabetics. The comparative effeciency if the two bread varieties in controlling blood glucose levels was studied.

The following were the specific objectives of the present study:

A. Elicit the socio economic and dietary pattern of selected 100 non insulin dependent diabetics.

B. Select a sub sample of 12 diabetics and find out the mean daily food and nutrient intake of the sub sample.

C. Conduct a feeding trial with whole wheat brown bread and white bread on the sub sample.

D. Evaluate the effect of whole wheat brown bread and white bread on glycemic response of a sub sample.

E. Compare the effect of the two varieties of bread on blood glucose level.

Review of Literature

II. REVIEW OF LITERATURE

The literature pertaining to the study on comparison of the glycemic response of whole wheat brown and white bread in non insulin dependent diabetics are discussed under the following headings:

A. Diabetes mellitus - chronic life long disease.

B. Pre disposing factors of diabetes

C. Role of nutritional factors in etio-pathogenesis of diabetes.

D. Glycemic response of different foods.

A. Diabetes Mellitus - Chronic life long disease

According to Khan (1988), diabetes mellitus is one of the oldest diseases known to man which was recognised by ancient civilization of India, Egypt, China and Greece. It is undoubtedly of ancient origin Aretaus of Cappadocia described it first, probably in the first century A.D. The first name diabetes is derived from greek word meaning 'Flow through and mel ' means honey.

Diabetes mellitus is a chronic metabolic disorder with a strong hereditary basis.

Diabetes mellitus has been rightly defined as a chronic inborn error of carbohydrate metabolism occuring often due to an absolute or relative insufficiency of insulin or due to ineffectiveness of peripheral action of insulin and also resulting in specific micro and macro vascular diseases (Arulraj, 1988 and Moses, 1988).

Deshay (1987) defines diabetes mellitus as an age old disorder from the medical and sociological point of view. In addition to the genetic inheritance, diseases of the internal glands such as pancreas, pituitary and administration of certain drugs may also preceipitate diabetes mellitus.

According to Flack (1988) diabetes mellitus is a chronic disorder caused by insufficient available insulin or inadequate insulin action. It is characterised by disorders in carbohydrate, fat and protein metabolism associated with metabolic changes at the cellular levels and vascular defects.

Melander (1987) states that non-insulin dependent diabetes mellitus (NIDDM) signifies a condition

including both fasting and post prandial hyperglycemia; this probably depends on a gradual impairment of the beta cell capacity to secrete insulin at an appropriate rate and insufficient amounts.

Diabetes is a heterogenous disorder in which environmental factors interact with genetic to precipitate the disease with altered life style of the present day society, its prevalence amongst Indians has increased sharply - 1.5% in rural population, 3.0% in large urban centres, rising alarmingly between 8.0 - 22% in immigrant Indians (Raheja, 1988).

Diabetes recognises no boundries. World wide more than two hundred million people suffer from it and their number increases everyday (Kandar, 1988).

The problem of diabetes in India assumes great significancebecause of vast population of around 800 million. TheICMR conducted a multicentre study is 1975 which showed that the prevalence of diabetes in India was 2.1% among the urban population while it was 1.5% in the rural areas. There would thus be more than 14 million people with diabetes in India. We know that for every known diabetic there could be at least one more

individual with undiagnosed diabetes. This implies that in India there are about 28 million diabetic persons, which is greater than the population of Australia or Yugoslavia (Viswanathan et al. 1988).

According to Giri et al (1987) diabetes is very common in India with an overall prevalence rate of 1.6% amounting to less than 12 million diabetics in the country.

It is of interest that the prevalence of diabetes is very high among migrant Indians in South Africa, Fiji, Singapore, Mauritius, Tanzania and U.K. (Tanhanand and Vannasarng, 1988).

A study conducted in Saudi Arabia include both sexes in the western region which showed an overall prevalance with increase in age and higher income groups. The overall prevalence in women was twice that for men. Obesity occured in 41.2% of the diabetic and 29.3% of the non diabetic subjects, states Fatani (1987).

According to Ahuja (1979) the prevalence of diabetes in South India is significantly higher in subjects whose income is above the mean and prevalence is high among urban Indians.

Diabetes afflicts nearly 3.5 per cent of the

Indian population. Almost 99 per cent of these cases are non-insulin dependents and about half of them could hope to keep their diabetes under control (Dhanya Gopinath, 1990).

According to Shukla (1987), there is a preponderance of male over female diabetes in India, while it is the other way, in the west. There are more than 10 million persons with diabetics in the country. Nine million of these case of diabetes are obesity induced, opines Davis (1983).

In our country males are more prone to diabetis than females. The incidence was found to be 86.87 per cent in males while 13.33 per cent in females (Singh, 1982).

The incidence of diabetes varies from country to country, depending on its civilization, educational level and economic level. Amongst Indians in India there is an average 2-0% diabetes, but these very people migrate to other countries such as South Asia or Africa, the incidence of diabetes rapidly rise upto 7.0%. There are localised groups like the population in Malta who have the incidence of diabetes upto 20%, while in the macronasian population in Naura in the Pacific, the incidence of diabetes is 34% (Zimmet, 1989).

In 1981 the estimated number of deaths from diabetes was 34,750. This corresponds to a mortality rate of 15.2/1,00,000 population and results in its being ranked 7th among the leading causes of death in the U.S. Although mortality from diabetes accounts for only 1.7% of all deaths in the USA, it is implicated as a substantial proportion of deaths from other diseases, particularly those of the cardiovascular renal system and is especially associated with death in the elderly population (Mann and Simpson, 1980).

According to WHO 1980 the diabetics are classified into the followings:

1. Insulin dependent diabetes mellitus (IDDM).
2. Non insulin dependent diabetes mellitus (NIDDM) a) Non-obese b) obese
3. Malnutrition related diabetes mellitus (MRDM)
4. Gestational diabetes mellitus (GDM)
5. Impaired glucose tolerence (IGT)
   a) Non-obese b) Obese
   c) Associated with certain conditions and syndromes.

Another classification by WHO 1985 is as follows:

1. Clinical classes

   a. Insulin dependent type (IDDM)

   b. Non-insulin dependent type

      i. Non-obese ii) obese

      Other types

      i. Pancreatic

      ii. Hormonal

      iii. Drug-induced

      iv. Insulin/receptor abnormalities

      v. Genetic syndrome

      vi. Other associations.

Gestational diabetes (GDM)

Impaired glucose tolerence (IGT)

      i. Non-obese

      ii. Obese.

2. Statistical risk classes.

      Previous abnormality of glucose tolerence

      Potential abnormality of glucose tolerence.

B. Pre-Disposing Factors of Diabetes

1. Age

Diabetes is most likely to be found among those who are over 35 years of age, overweight and blood relations of diabetics (Davis, 1983).

Greatest prevalence of non insulin dependent diabetes patients are above the age of 30 in both the sexes (Viswanathan et al, 1988).

NIDDM represents approximately 98% of all individuals with diabetes over the age of 45 years (Huse et al, 1989).

2. Sex

In our country males are more prone to diabetes than females. The incidence found to be 86.87 percent in males while 13.33 per cent in females in random study conducted by Singh (1982).

According to Shukla (1987), there is a preponderance of male over female diabetics in India, while it is the other way in the other countries.

3. Obesity

Obesity is the most common cause of insulin resistance (Devlin, 1985).

Vague (1986) suggest that increased central body fat is more likely to be associated with the onset of diabetes mellitus.

Nair (1988) states that over eating results in obesity which precipitates insulin resistance and impaired glucose tolerence. Indians who are 20 per cent to 30 per cent over weight are at an increased risk for NIDDM and the risk accelerates with increased body weight, Blood glucose usually return towards normal as weight loss occurs in the obese NIDDM.

Jarrett (1981) says that there is a high degree of corelation between diabetes prevalance and average fatness as obesity increase the size and number of adipocytes and makes them relatively insulin resistant.

The waist to hip ratio was significantly associated with the risk for diabetes although the body mass index was a measure of the total body fat mass was accounted (Ohlson, 1985).

4. Genetic Factors

Family history and obesity were shown to be strong independent risk factors for NIDDM (Morris et al., 1989).

Since 1932, the mode of transmission has been thought to be a menedelian autosomal recessive, subsequent genetic studies have brought this into question. It is now supposed that diabetic predisposition is due to a number of genetic characteristics.

Hereditary in involved in the development of diabetes or its metabolic variations (Pfelffier, 1989).

Genetic studies in special subtypes of type-II diabetics or maturity onset diabetics of the young indicate that inheritance is best explained by antosomal dominant transmission (Eschmege, 1989). There is a link between some molecules of the histocompatibility system (HLA DR 3/DR 4) and diabetes (Le Monde, 1990).

5. Stress

Gulati (1987) opines that mental stress is known to precipitate diabetics in susceptable individuals,

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Contents

TABLE OF CONTENTS

LIST OF TABLES

This is because the mind is intimately related to body function which counteract the available insulin.

Due to the stress or acute myocardial infarction, the temporary excursions in blood sugar have been associated with a bad prognosis even in non diabetics (Seshiah, 1990).

6. Alcoholism

Diabetics are particularly prone to having fatty livers even the slighest sign of liver function is a strict contraindication of alcohol (Mayer, 1981) and (Josylin, 1989).

Diabetes should avoid alcohol consumption. Insulin may aggravate the intoxicating effect of alcohol which in turn stimulates appetite and the whole chain reaction makes the diabetics prone to breaking dietary regimen and the control of the disease will be difficult (Simha, 1981).

7. Minerals and Trace Elements

Many minerals and trace elements have a subtle role in carbohydrate and lipid metabolism. Depletion of potassium as seen after diuretics results in impaired glucose tolerence (Khaw, 1987). Low levels of ionised calcium are

seen in many subjects with NIDDM or hypertention (McCarron, 1982).

Studies in animals indicate that a decrease in glucose tolerence is induced by chromium deficiency and is reversed by the administration of chromium supplement improved glucose tolerence and lowered insulin levels (Anderson, 1986).

8. Additives, Preservatives And Pesticides:

Ingestion of cured, smoked preserved meat by mother at the time of conception may result in the development of insulin dependent diabetes mellitus in the male off spring (Helgason, 1981). Some cases of insulin dependent diabetes mellitus from ingestion of rodenticide, vacor, have been reported (Karam et al, 1980).

9. Under Nutrition and Carbohydrate Intolerence:

Basal normoglycemia or hypoglycemia with carbohydrate intolerence following glucose challenge is a feature of Kwashiorkar. Fatty, infilteration of liver in protein deficiency syndromes could partly account for low fasting blood glucose levels. This may also be to a reduction in the number of cells or to a functional impairment of cells.

The close relationship of malnutrition related diabetes to childhood malnutrition suggest a distinct etiological relation. There is distinct possibility that in some cases impairment of cells, due to protein deprivation over prolonged period in infancy can cause diabetes mellitus. It is reasonable to suggest that malnutrition may also produce alternation in immune mechanism thus increasing the suacceptibility and response to various infections agents (Raheja, 1988).

Role of Nutritional Factors in Etiopathogenesis of Disbetes

"A true physician first finds the cause of the disease and having found that out tries to cure it by food and when food fails then prescribes medicine"

- Sun Semio

Diet is the regimen area with which individuals with diabetes have the greatest difficulty and the area in which improvements could potentially lead to the greatest health benefits (Glasgow, 1989).

Several nutritional factors are known to be associated with carbohydrate intolerence.

A. Casually related

1. Excessive intake of calories: Obesity
2. Excessive alcohol intake: pancreatitis and hepatic cirrhosis
3. Excessive iron intake; hemochromatasis

B. Probably related

1. Negative nitrogen balance; protein under nutrition
2. Conditional deficiency of sulfur containing amino acids, cassava consumption.
3. Negative potassium balance; chlorothiazide and related diuretic therapy.
4. Negative balance of trace minerals, chromium and zinc deficiency states.

C. Possibly related

1. Low level of dietary fiber
2. Excessive consumption of refined carbohydrates
3. Food Toxins affecting cells nitrosamine in foods

(Bajaj, 1982)

Diet is the therapuetic pillar to diminish the impact of obesity and insulin resistance at various sites, improve glucose utilization with the limited amount of available endogenous insulin (Ahuja, 1989).

Chait (1988) says that the marked restriction of carbohydrate content within the frame work of the calorie recommended is of little benefit to the diabetic.

Increased intake of dietary fibre benefits diabetic individuals in both specific and general ways. The specific benefits are decreased insulin requirements, improved glycemic control, greater sensitivity to insulin and less frequent insulin reactions (Anderson, 1986).

Anderson (1980) showed that diabetic subjects fed a diet high in carbohydrate and fiber had reduced blood glucose levels and diminished insulin requirements. Jenkins and colleagues (1982) demonstrated that purified viscous fiber without alteration in the carbohydrate intake reduced postprandial glucose and insulin responses to test meals in both diabetic and mondiabetic volunteers. Addition of purified viscous fiber to metabolic diets resulted in reduced urinary loses of glucose and ketone bodies (Jenkins, 1980).

The scientific status of fiber research suggests that water soluable fibers found in such foods as legumes and oats have the most beneficial effect on plasma glucose, insulin, lipoprotein fractions and triglyceride levels (Tietyen, 1989).

Incremental glucose and insulin response were higher and glucose excretion was significantly greater in response to the low fat, high carbohydrate diet. In addition fasting and post prandial triglyceride levels were increased and high density lipoproteincholesterol concentration were reduced when patients with non-insulin dependent diabetes millitus ate the low fat, high carbohydrate diet (Coulston (1987) and Waslien 1987).

Kerin (1989) says that if high carbohydrate, low fat diets are to be recommended to patients with disbetes, it is essential that the type of carbohydrate recommended be unrefined and high in fiber.

Soluble fibers have shown promise in the treatment of hyperglycemia because they appear to slow down the absorption of nutrients from ingested foods (Melvor, 1989). Jenkins (1988) says that non-insulin dependent diabetes mellitus high fibre diets may offer some improvement in carbohydrate metabolism, lower total cholesterol and LDL cholesterol. Foods should be selected from a wide variety of choices to include both soluble and insoluble types of fiber.

Plant fibre, particularly soluble fibre from pulses, vegetables and fruits lower blood glucose, cholesterol and triglycerides (Carper (1987) and Kushi (1985).

Sucrose does not aggravate hyperglycemia in diets of patients with non-insulin dependent diabetes, but it elevates fasting triglyceride levels in high carbohydrate diets (Abraira (1988) and Forlani (1989).

Consumption of fructose following glucose or starch drinks produced significantly higher levels of plasma insulin, but not plasma glucose, as compared with consumption of corresponding drinks without fructose (Reiser, 1987)., and there is no adverse effects on triglyceridea pyruvate, lactate or uric acid metabolism.

In patients with non-insulin dependent diabetes a modest increase in dietary fibre from wholemeal bread and apple resulted in postprandial glucose response compared with corresponding low fibre meals in non insulin dependent diabetics.

Soy polysaccharide improves the post prandial return of serum glucose toward baseline in healthy subjects. There might be some advantages in using this fiber source as a

means of dietary treatment of diabetes, it is easier to incorporate 10g. soy polysaccharide than fibers such as pectin or guar gum into a meal without greatly effecting the texture and palatability of that meal (Tasi, 1987).

Glycemic response of different foods

Different starchy foods produce different glycemic responses when fed individually. Legumes, pasta, grains such as barley, parboiled rice and bulgar and whole grain breads, such as pumpernickel. Specific incorporation of those foods into diets has been associated with reduction in LDL cholesterol and triglyceride levels in hyperlipidemia and with improved blood glucose control in individuals with insulin dependent distbetes mellitus (Jenkins, 1988).

Uniform glycaemic indices were observed for each food, similar to those reported by others in non-pregnent subjects. Post prandial glucose values reached their peak later after glucose and bread ingestion than after the remaining foods (Lock, 1988).

The glycemic control attained by calorie restriction allows recovery of disproportionate over secretion of pro-insulin in patients with non-insulin dependent diabetes mellitus, presumably decreasing the demand for insulin secretion from β cells (Yoshioka, 1989).

Study conducted by Atchison (1989) says that fructose given alone increased the blood glucose almost as much as a similar amount of glucose. However, the same amount of fructose given with glucose produced no greater glycemic response than did glucose alone. Similarly, galactose contributed only slightly to the glycemic response when given as lactose, whereas protein and fat had no additional glycemic effect. When patients were fed an amount of bread and apple that contained 25 gm, glucose, both challanges produced glycemic responses very similar to the response of 25 gm purified glucose.

Salt may increase the post prandial plasma glucose and insulin responses to lentils and bread by accelerating the digestion of starch by stimulating amylase activity or by accelerating small intentisal absorption of the liberated glucose or both (Thorburn, 1986).

Amylose starch may be ofpotential benefit to carbonydrate sensitive individual or individuals with diabetes (Behall, 1988). Types of pastesmay produce different glycemic responses, but they are not necessarily related to differences in cooking surface area (Wolever, 1986).

Dried beans, because of their high fiber content and low glycemic index, are especially suitable for diabetic diets. Addition of 10 per cent to 20 per cent of total carbohydrate as sucrose would be permissible and without significant disturbance of blood-glucose homeostasis (Vorster, 1987). Mixing the meals significantly increased the insulinemic indexes and introduced a positive correlation between glycemic and insulinemic indexes (Bornet, 1987).

Inclusion of low-glycemic index foods in the diets of patients with diabetes may be an additional meassure that favourably influences carbohydrate metabolism without increasing insulin demand (Jenkins, 1987).

Methodology

III. METHODOLOGY

The procedure followed in conducting the present investigation on "Comparison of glycemic response of whole wheat brown bread and white bread in Non-insulin dependent diabetics" is presented under the following headings.

A. Selection Of Area

B. Selection Of The Samples

C. Development Of Tools For The Study

D. Formulation Of Breakfast Foods

E. Calculation of Daily Mean Food And Nutrient Intake Of The Sub-Sample

F. Conducting The Experiment

G. Evaluation

A. Selection Of Area

The study was carried out in Coimbatore City. Four hospitals namely Sakthi diagnostics, Kikani diagnostics, Kuppusamy Naidu Hospital and Ellen Hospital were selected for the study.

These hospitals were selected because the authorities of these hospitals were willing to co-operate and non-insulin dependent diabetics were available.

B. Selection Of The Samples

According to Booth (1982) in a random sample every individual in the population has an equal chance of being selected. Hence all the non-insulin dependent diabetic adults attending the hospitals were recorded as and when they attended the clinic and included in the study. A total number of 100 subjects were collected for the study. The Socio-economic status, food habits, knowledge and dietary practices of these 100 subjects were elicited. A sub sample of 12 non insulin dependent diabetics were drawn from this 100 subjects, for the feeding trial. Those who were between the age range of 40 - 55 years and willing to cooperate were selected and were divided into two groups, of 4 males and 2 females each.

C. Development Of Tools For The Study

Interview method was selected to elicit information from the subjects on socio-economic status and dietary pattern.

Gupta (1988) states that an interview is two way method which permits an exchange of ideas and information. The information received from an interview schedule is more reliable as the accuracy of statements can be checked by supplementary questions wherever necessary. Interview makes

possible a face to face association and process of instrumentation between the interviewer and interviewee and this helps in securing data not obtainable by methods that do not involve an interpersonal relationship. The investigator formulated a special interview schedule as presented in Appendix I to study the socio economic status and dietary pattern of 100 diabetics.

To evaluate and then compare the effectiveness of the two bread varieties of feeding trial was planned for the sub sample of 12 non-insulin dependent diabetics. Their fasting and post-prandial blood glucose responses were recorded before and after feeding the test food.

D. Formulation Of BreakfastFoods

Eighty grams of whole wheat brown bread, 100g of milk and 100 g of apple formed the breakfast item for the first group referred as Group I and eighty grams of white bread, 100g milk and 100g apple formed the breakfast item for the second group (Group II). Breakfast served are showed in Figure 1 and 2.Whole wheat Brown bread and white bread were specially prepared for including breakfast items for the diabetics. The receipe followed in the preparation of bread is given in Appendix-II. Milk was included to increase the protein content of the diet and also to help in the consumption of bread. Apple was included to increase the energy content of the break-fast, so that 1/3 of the energy requirement could be met by the breakfast. An

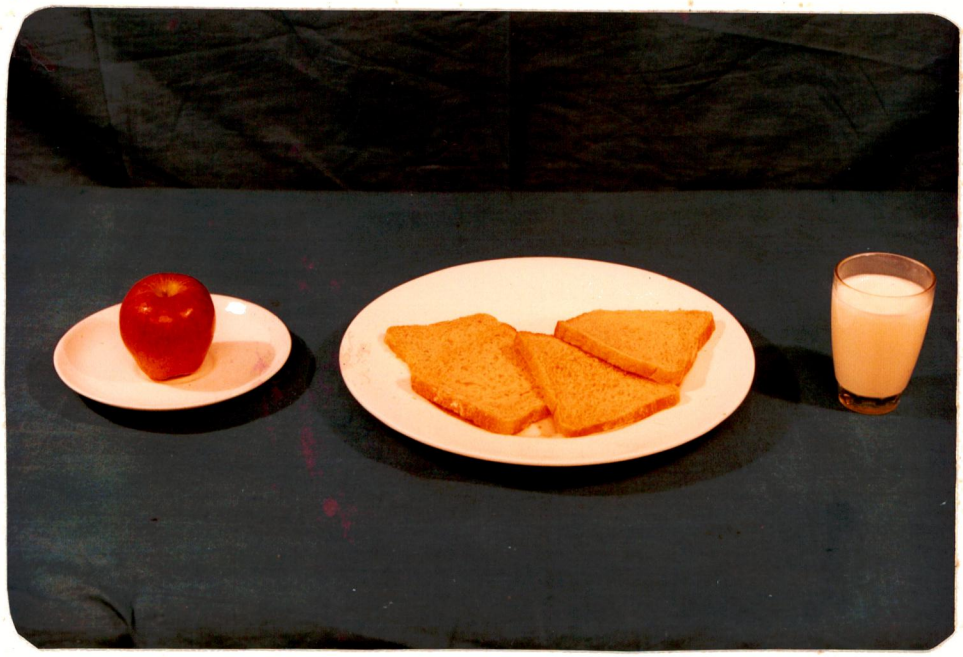


FIGURE-I BREAKFAST SERVED FOR GROUP I
(WHOLE WHEAT BROWN BREAD)

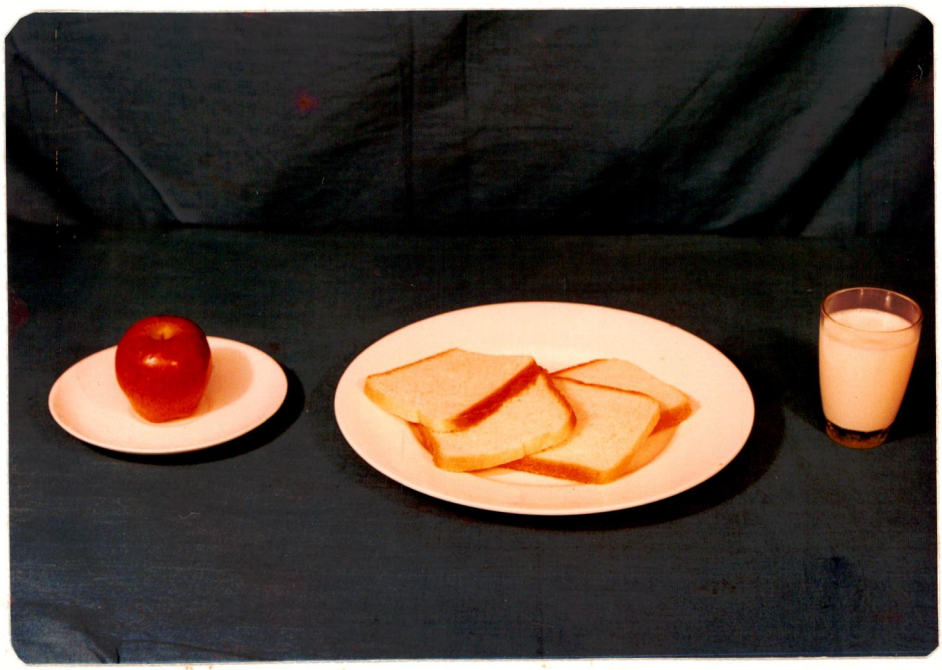


FIGURE-II BREAKFAST SERVED FOR GROUP II
(WHITE BREAD)

evaluation of the daily dietary pattern of the subjects revealed that four slices (20g) each will be sufficient for breakfast. Thus the amount of bread to be given was computed. The nutritive value of the breakfast items was computed from the raw equivalents using the nutritive value of Indian Foods (ICMR, 1984) and are presented in Tables I and II.

TABLE - 1

NUTRITIVE VALUE OF BREAKFAST ITEMS WITH WHOLE WHEAT BROWN BREAD (GROUP I)

	Amount	Energy	Protein	Cho	Fat	Crude fiber
	g	Kcal	g	g	g	g
Brown Bread	80	178	5.9	36.6	2.0	0.71
Milk	100	67	3.2	4.4	4.1	-
Apple	100	59	0.2	13.4	0.5	1.00
Total		304	9.3	54.4	6.6	1.71

TABLE - II

NUTRITIVE VALUE OF BREAKFAST ITEMS WITH WHITE BREAD(GROUP.II)

	Amount g	Energy Kcal	Protein g	CHO g	Fat g	Crude Fiber g
White Bread	80	200	5.5	40.7	1.7	0.15
Milk	100	67	3.2	4.4	4.1	-
Apple	100	59	0.2	13.4	0.5	1.00
Total		326	8.9	58.5	5.6	1.15

E. Calculation Of Daily Mean Food And Nutrient Intake Of The Sub Sample

Pennington (1988) points out that studies that relate to food and nutrient intake to measure health or disease are essential for monitoring dietary status. In the present investigation one day weighment of cooked foods was done to quantify the food intake of the subjects. This was carried out by recording the quantities of all foods eaten during a day and by weighing the cooked food protions, and the raw ingredients used in cooking. From this the daily mean food and nutrient intakes were computed making use of the food tables given by ICMR using the raw equivalents for the cooked foods.

F. Conducting The Experiment

Utilising the interview schedule prepared the investigator assessed the socio-economic and dietary practices of all the 100 selected subjects. This was done by interviewing the subjects when they visited the clinic. From this 12 subjects were selected and included in the feeding trial. All the 12 selected diabetics were collected in one place and they were informed of the importance of their co-operation in the study. Then on the first day after an over night fasting of 12 hours the fasting blood glucose level was recorded and the subjects were allowed to consume their normal breakfast and the post prandial blood glucose level at one hour and two hours after breakfast were recorded. From the next day onwards, the standardised breakfast items of 80g of whole wheat brown bread or white bread with 100g of milk and 100 g of apple were served, at 8.30 a.m for 10 consecutive days. The subjects were requested to assemble in Sakthi diagnostic centre and were served breakfast. They were requested to eat the breakfast completely without wasting. On the tenth day the fasting blood glucose level and the postprandial blood glucose levels at one hour and two hours after the breakfast were estimated. The blood glucose was analysed using the glucose oxidase peroxidase method as given in Appendix - III.

G. Evaluation

Data obtained from the study conducted were tabulated and analysed satistically. Effectiveness of whole wheat brown bread and white bread in maintaining blood glucose level was evaluated by comparing the blood glucose responses before and after feeding the test foods.

Results and Discussion

IV. RESULTS AND DISCUSSION

The results of the present investigation entitled "Comparison of the glycemic response of whole wheat brown bread and white bread in non insulin dependent diabetics" are discussed under the following headings.

A. Socio Economic Profile Of The Selected Diabetic Subjects

B. Height And Weight Of The Selected Diabetic Subjects

C. Dietary Practices Of The Selected Diabetic Subjects

D. Consumption Pattern Of Wheat Products.

E. Mean Daily Food And Nutrient Intake Of Selected Sub Samples

F. Blood Glucose Of The Subjects Before And After Feeding The Test Foods.

A. Socio Economic Profile Of The Selected Diabetic Subjects

The socio economic status of the 100 non-insulin dependent diabeties are discussed in the following:

1. Age

The age - wise distribution of the selected diabetic subjects are presented in Table III and discussed. Figure 3 Pictorially depicts the age-wise distribution of the selected diabetic subjects.

T A B L E - III

AGE-WISE DISTRIBUTION OF THE SELECTED DIABETIC SUBJECTS

(Number of Subjects 100)

Age	Number
20 - 30	2
30 - 40	2
40 - 50	35
50 - 60	33
60 - 70	17
70 - 80	11
Total	100

Table III shows that about 35 subjects were between 40 and 50 years and 33 between 50 and 60 years. Thus, majority of subjects namely 68 were between 40 to 60 years of age. There were 20 subjects above sixty years whereas diabetics below forty years were only four. These results are in tune with the results of Huse et al, (1989) who have indicated that 98 percent of all individuals with diabetics are over the age of 45 years.

2. Sex

The Sex-wise distribution of the selected diabetic subjects are presented in Figure . 4.

FIGURE -3 AGE-WISE DISTRIBUTION OF SELECTED DIABETIC SUBJECTS

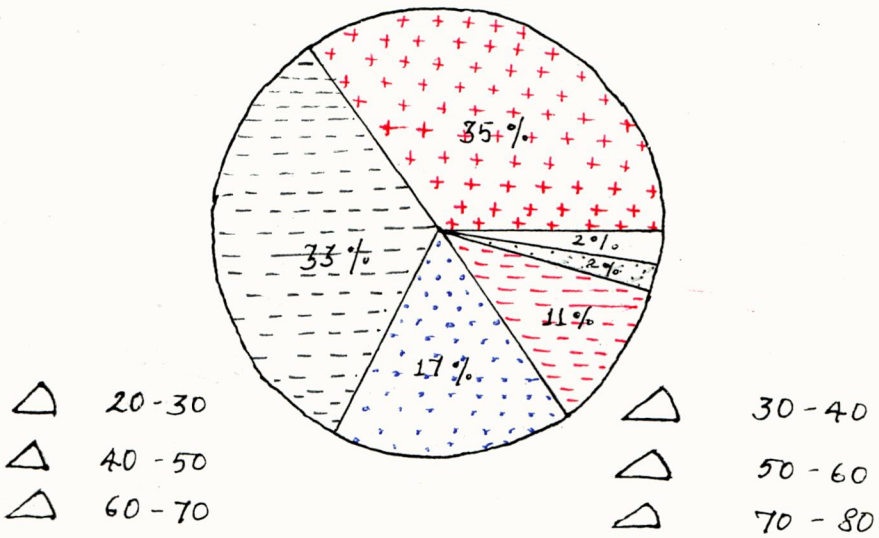
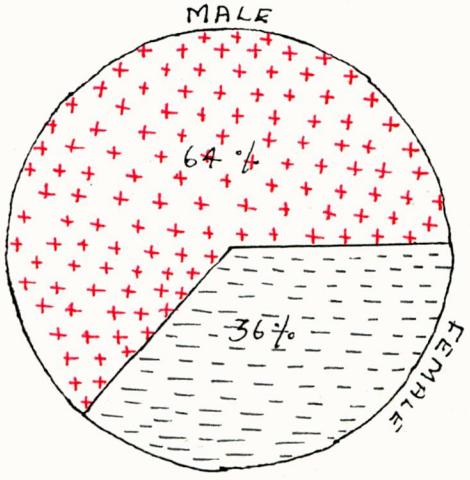


FIGURE -4 SEX-WISE DISTRIBUTION OF SELECTED DIABETIC SUBJECTS.



Sixty four percent of the selected diabetic subjects were males and only 36 percent were females. This trend is in conformity with the results of Singh (1982) who suggests two possibilities for such results.

1. It could be just a coincidence that more males come for treatment purpose when compared to females.
2. It could be that in our country generally the females are more used for doing hard work as compared to males, the result being the working of all organs including pancreas, the solitary factory of insulin production, which remain very active in females thus keeping incidence of diabetes mellitus low in them. The reports of Mohan et al., (1983) also shows similar results.

3. Marital Status

Ninety eight percent of the selected diabetic subject were married. Only 2 subjects were unmarried. These two subjects were in the age group group of 20 - 30 years.

4. Educational Status

Table IV shows the educational status of the selected diabetic subjects.

T A B L E - IV

EDUCATIONAL STATUS OF THE SELECTED DIABETIC SUBJECTS

(No. of Subjects - 100)

Educational Status	Male	Female	Number
Illitrate	3	4	7
Lower primary	-	2	2
Upper primary	5	4	9
Secondary School	22	12	34
Higher Secondary	7	3	10
Graduate	17	10	27
Post Graduate	7	1	8
Diploma	3	-	3
Total	64	36	100

Table IV shows that seven percent of the selected diabetic subjects were illitrates. Fifty five percent had school education and 38 percent had college education. On the whole 93 per cent were illitrate.

5. Income

Table V persents the income classification of the selected diabetic subjects. It is also shown in Figure 5. The income groups are classified into three as follows.

0 - 1500 - low income
1501 - 2500 - Middle income
2501 - and above- High income

T A B L E - V

INCOME LEVEL OF THE SELECTED DIABETIC SUBJECTS

(No. of Subjects - 100)

Income Rs.	Number
1 - 1500	25
1501 - 2500	26
2501 & above	49
Total	100

Majority (49 per cent) of the selected diabetic subjects was from high income group, 26 from middle income group and 25 from low income group. According to Ramachandran et al.,(1988) the pervalence of diabetes was significantly higher in subjects whose income was more.

FIGURE -5 INCOME LEVEL OF SELECTED DIABETIC SUBJECTS

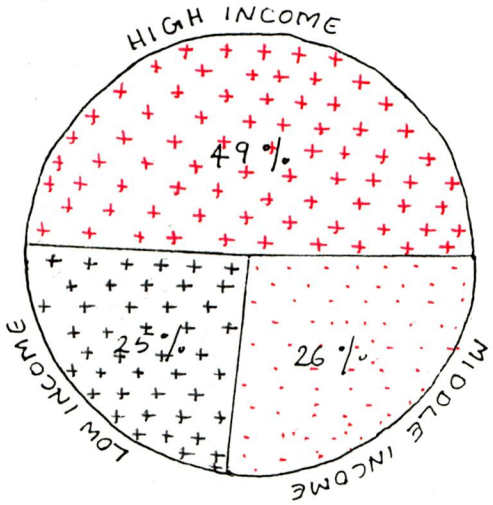
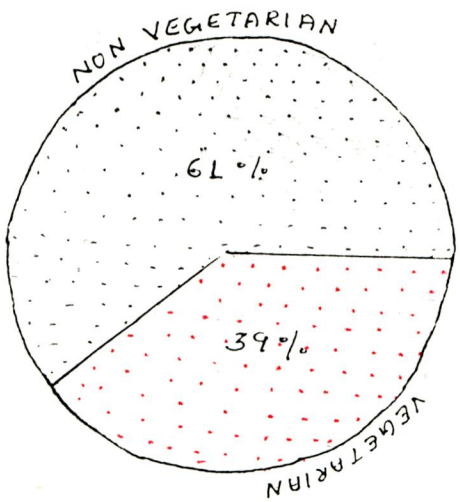


FIGURE 6 TYPE OF FOOD CONSUMED BY SELECTED DIABETIC SUBJECTS



6. Type Of Food Consumed

Food plays an important role in health and it is well to know the type of diet followed. Figure 6 depicts the classification of subjects according to the type of foods consumed.

Majority (61 percent) of the selected diabetic subjects were non-vegetarians whereas only 39 percent were vegetarians. This survey indicates that the incidence of diabetes was more among non-vegetarians. Vegetarian foods contain more fiber than the non-vegetarian food. This may be a factor which has controlled the incidence of diabetes in the vegetarian.

B. Height And Weight Of The Selected Diabetic Subjects

Height and Weight of the selected diabetic subjects is given in Table VI. The height and weight of the subjects as compared with the standards given by L.I.C are discussed in the following. The L.I.C. standards are given in Appendix - IV.

TABLE - VI

HEIGHT AND WEIGHT OF THE SELECTED DIABETIC SUBJECTS
(No. of subjects - 100)

Height in cm	Weight in Kg.							
	40 - 50		50 - 60		60 - 70		Above 70	
	M	F	M	F	M	F	M	F
140 - 150	-	1	-	2	-	1	-	-
150 - 160	2	4	3	10	4	7	1	3
160 - 170	1	-	11	3	12	3	3	1
170 - 180	1	-	4	-	11	-	10	1
180 - 190	-	-	-	-	-	-	1	-
Total	4	5	18	15	27	11	15	5

Table VI shows that three females in the height range of 140 - 150 cms were over weight. In the 150 - 160 Cms height, ten females and five males were over weight. One female and three males were overweight in the 160 - 170 cms height range. One female was over weight in the height range of 170 - 180 cms. On the whole the percentage of over weight subjects in the diabetic subjects studied was 22 percent.

C. Dietary Practices Of Selected Diabetic Subjects

The diet survey of the selected diabetic subjects revealed the fact that only eighty eight percent of the diabetics were aware of the importance of controlling diet whereas 12 percent were not aware of dietary restrictions. The foods specially included, avoided and restricted by the selected diabetic subjects are presented in the following Tables and discussed.

1. Foods Included

Table VII shows the foods specially included by the subjects.

T A B L E VII

FOODS SPECIALLY INCLUDED BY THE SELECTED DIABETIC SUBJECTS

(No. of Subjects - 100)

Foods	Number
Wheat	14
Fenu greek powder	9
Greens	8
Ragi	7
Bitter gourd juice	4
Keerai Juice	2
Increased Milk	2

From Table VII it is evident that 14 subjects specially included wheat in their diet. These subjects indicated that they had previously excluded wheat from their diet. Nine subjects consumed fenu greek powder in the morning and eight started includingmore quantities of greens. Four subjects consumed bittergourd juice and 2 included keerai juice. One or the subjects started consuming frequent small feedings. All diabetics included these items as they believed that they reduce the blood glucose level.

2. Foods Avoided

Table VIII presents the foods avoided by the selected diabetic subjects.

T A B L E VIII

FOODS AVOIDED BY THE SELECTED DIABETIC SUBJECTS

(No. of subjects - 100)

Foods	Number
Sugar	48
Roots & Tubers	24
Potato	12
Fruits	7
Beetroot	6
Rice	3
Milk	3
Egg Yolk	2
Tea	1
Coffee	1
Onion	1
Processed foods	1
Fried foods	1
Pappaya	1
Alcohol	1

Table VIII shows that only 48 percent avoided sugar and sweets from their diet. Twenty four avoided the consumption of roots and tubers potato by 7 diabetics, and beetroot by 6 samples. Milk was avoided by 3 and another 3 avoided rice. Two diabetics avoided egg yolk. Tea, Coffee, Onion, Processed foods, fried foods, pappaya and alcohol were the other foods avoided by diabetics.

3. Foods Restricted

Certain foods were consumed in restricted amounts by diabetics. Table IX presents the foods that were consumed in restricted quantities by the selected diabetic subjects.

T A B L E - IX

FOODS RESTRICTED BY THE SELECTED DIABETIC SUBJECTS

(No. of Subjects - 100)

Foods Restricted	Number
Sugar	44
Calories	10
Rice	9
Potato	8
Oil	5
Non-vegetarian items	4
Salt	2
Not following dietary restrictions	8

Sugar was consumed in restricted amounts by 44 subjects. Ten diabetics restricted the consumption of rice and 8 reduced intake of potato. Oil in the diet was reduced by 5 and intake of fleshy foods was reduced by 4. Two diabetics retricted salt because they had hypertension. Eight subjects did not follow any dietary restrictions.

D. Consumption Pattern Of Wheat Products

1. Frequency Of Consumption Of Wheat By The Selected Diabetic Subjects:

The results of the survey conducted to find out the pattern of consumption of wheat and wheat products by the diabetics is presented in the following.

Table X presents the frequency of inclusion of wheat products in the diet of the selected diabetic subjects.

TABLE X

FREQUENCY OF CONSUMPTION OF WHEAT PRODUCTS BY THE SELECTED DIABETIC SUBJECTS

(No.of subjects - 100)

Frequency Of Consumption	Number
Daily	59
Weekly	38
Monthly	1
Avoided	2
Total	100

Ninety eight percent of the diabetics consumed wheat products and only two subjects avoided wheat. 59 percent of the selected diabetic subjects were consuming wheat products daily and thirty eight subjects consumed wheat weekly. Only one subjects consumed wheat monthly.

2. Method Of Consumption Of Wheat

Table XI shows the frequency of consumption of different wheat preparations.

T A B L E XI

FREQUENCY OF CONSUMPTION OF WHEAT PREPARATIONS BY THE SELECTED DIABETIC SUBJECTS

(No. of Subjects - 100)

Preparation	Daily	Weekly	Monthly	Total
Chapathi	43	39	3	85
White bread	33	45	15	93
Brown bread	23	20	2	45
Uppuma	12	67	3	82
Broken wheat	8	35	9	52
Kali	10	9	5	24
Wheat Dosai	3	7	2	12

Chapathi was the most common way of consuming wheat daily. Totally 85 subjects consumed Chapathi. Forty three consumed chapathi daily, 39 consumed weekly and 3 consumed it monthly. The other preparation that was consumed daily by about 33 per cent of subjects was white bread. White bread was consumed mainly because it is easily available. Forty five were consuming weekly and only 15 consumed it monthly. Twenty three subjects consumed whole wheat brown bread daily, 20 weekly and only 2 consumed monthly. Uppuma was consumed daily by 20 subjects, by 67 weekly and only 3 monthly. Kali was consumed daily by 10 subjects, weekly by 9 and 5 consumed it monthly. The least consumed preparation was wheat Dosai. Three consumed wheat dosai daily, 7 consumed weekly and only 2 consumed monthly.

These results revealed the fact that white bread was the most common preparation consumed by 93 per cent of the subjects. Chapathi(85%) and wheat uppuma (82%) were the other two popular preparations. Brown bread was consumed by 45 percent. Kali and wheat dosai were found to be the less common among the diabetics.

E. Mean Daily Food And Nutrient Intake Of Selected Sub Samples

From the 100 subjects studied two groups of 6 samples each were selected for feeding the bread samples and comparing their effect on the blood glucose values. There were four males and two females in each group. Before feeding the bread varieties, the food and nutrient intake of these 12 subjects were studied through weighment survey and the resultswere Tabulated and discussed. The individual food and nutrient intake data are presented in Appendix V and VI.

1. Mean Daily Food Consumption of Selected Diabetic Subjects

Table XII presents the mean daily food consumption of the selected, male diabetic subjects in the two groups.

T A B L E XII

MEAN DAILY FOOD CONSUMPTION OF SELECTED DIABETIC MALE SUBJECTS
(No. of males - 4)

Food Group	R.D.A	Mean daily food consumption			
		Group - I	Deficit (or) Surplus than R.D.A. %	Group II	Deficit (or) Surplus than R.D.A.%
Cereals	475	332	- 30	340	- 28
Pulses	65	60	- 8	58	- 11
Leafy vegetables	125	96	- 23	80	- 36
Roots and Tubers	75	34	- 55	32	- 57
Other Vegetables	100	83	- 17	86	- 14
Fruits	30	-	-100	-	- 100
Milk	100	337	+ 227	301	+ 201
Fleshyfoods	30	59	+ 96	58	+ 93
Oil and fat	40	43	+ 8	43	+ 8
Sugar and Jaggery	40	-	- 100	-	- 100

The mean daily food consumption of the male subjects in the two groups indicated that except milk fleshy foods and fats and oils, all the other groups of food were consumed in deficit quantities. There was 100 percent deficit in the case of fruits, since all the subjects were found to avoid fruits. The next maximum avoided foods was roots and tubers in both the groups.

In the case of creals there was a deficit of 30 percent in the Ist Group and 28 per cent in the second group. The percentage deficit in the consumption of pulses was very much less 8 per cent in the Ist group and 11 percent in the IInd group. There was a significant reduction (23% and 36% in the two groups respectively) in the consumption of green leafy vegetables. Though a significant number of subjects knew that leafy vegetables are essential this dificit existed. The consumption of other vegetables was also deficient. Sugar and jaggery were avoided by all the subjects in both the groups.

Tables XIII presents the mean daily food consumption of the selected female diabetic subjects in the two groups.

TABLE XIII

MEAN DAILY FOOD CONSUMPTION OF SELECTED DIABETIC FEMALE SUBJECTS

Food Group	R.D.A	Mean Daily Food Consumption			
		Group - I	Deficit of Surplus %	Group II	Deficit or Surplus %
Cereals	350	271	-23	265	- 24
Pulses	35	62	+ 13	52	- 5
Leafy Vegetables	125	112	- 10	72	- 42
Roots and Tubers	75	32	- 57.3	50	- 33
Other vegetables	75	108	+ 44	142	+ 89
Fruits	30	-	- 100	-	- 100
Milk	100	255	+ 155	205	+ 105
Fleshy foods	30	75	+ 150	87	+ 190
Oils and fat	40	40	-	35	- 13
Sugars & Jaggery	30	-	- 100	-	- 100

The mean daily consumption of the female subjects in the two groups indicated that except milk, fleshy foods and other vegetables all other groups of food were consumed in deficient quantities. There was 100 percent deficit in the case of fruits. All the subjects were found to avoid fruits. The next maximum avoided food was roots and tubers in both the groups the percentage deficit being 57 percent and 33. Percent in Group I & II respectively.

In the case of cereals there was a deficit of 23 percent in the Ist group and 24 percent in the second group. Consumption of pulses was more by group I (13 percent) and was deficit in group II (5.4%). There was a slight reduction (10 percent) in the consumption of green leafy vegetables in group I and a significant reduction (42.4%) in the group II In the case of females also though a significant number of subjects indicated that leafy vegetable are essential, this deficit existed. Sugar and Jaggery were avoided by all the subjects in both the groups.

2. Mean Daily Nutrient Intake of Selected Diabetic Subjects

Table XIV presents the mean daily nutrient intake of the selected male diabetic subjects.

TABLE XIV

MEAN DAILY NUTRIENT INTAKE OF THE SELECTED DIABETIC SUBJECTS (MALE)

Nutrients	R.D.A.	Group - I mean daily nutrient intake	% Deficit or Surplus	Group - I mean daily nutrient intake	% Deficit or Surplus
Energy (Kcal)	2800	2290	- 18.2	2278	- 18.64
Carbohydrate (g)	*490	363	- 25.91	352	- 28.16
Protein (g)	55	62	+ 21.8	64	+ 25.45
Fat (g)	**62	63	+ 1.6	63	+ 2
Crude Fiber (g)		5.5		4.4	
Calcium (g)	0.4 - 0.5	0.64	+ 42.22	0.56	+ 24.44
Iron (mg)	20	26.6	+ 33	29.8	+ 99
β - Carotene (ug)	3000	2230	- 25.66	2639	- 12.03
Thiamin	1.4	1.62	+ 20	1.55	+ 19
Ribo flavin	1.6	1.18	- 22	1.24	- 20
Niacin	18	15.37	- 17	17.34	- 6
Vitamin-C (mg)	50	53	+ 6	45.80	- 10

* 70 of per cent of total calories from carbohydrate

** 20 per cent of total calories from fat.

The energy consumption of the two groups met almost about 82 per cent of the requirements. The deficit was only 18 per cent. This can be considered as adequate for the Non-insulin Depedent diabetics as less amount of energy is recommended There was a reduction of about 25 percent in the consumption of carbohydrate in both the groups. But the protein intake was more than the recommended allowance and this may be because of the increased intake of fleshy foods by the two groups of subjects. Fat consumption of both the groups were almost normal, and equal to that of the recommended allowance. There was only 1.6 per cent surplus intake of fat.

Calcium and iron intake was slightly more than the recommended allowances. The increased iron intake may be due to the consumption of liver and other fleshy foods. The intake of B Carotene was less than the recommended allowance. There was a 25 percent deficit in the first group and 12 percent in the second group.

Table XV presents the mean daily nutrient intake of the selected female diabetic subjects.

TABLE XV

MEAN DAILY NUTRIENT INTAKE OF THE SELECTED FEMALE DIABETIC SUBJECTS

Nutrients	R.D.A	Group I mean daily nutrient intake	% Deficit or Surplus	Group II mean daily nutrient intake	% Deficit or Surplus
Energy (Kcal)	2200	1823	- 17.13	1800	- 18.18
Carbohydrate (g)	* 385	283	- 26.49	277	- 28.05
Protein (g)	45	60	+ 33.33	59	+ 31.1
Fat (g)	** 49	57	+ 16.32	45	- 8.1
Crude Fiber (g)		3.6		2.8	
Calcium (g)	0.4 - 0.5	0.45	-	0.42	-
Iron (Mg)	30	21.66	- 27.8	17.9	- 40.3
β-Carotene (Ug)	3000	4027	+ 34.23	3977	+ 32.56
Thiamin	1.1	1.35	+ 22	1.34	+ 23
Ribo flavin	1.3	0.96	- 22	0.91	- 22
Niacin	14	16.4	+ 17	13.16	- 6
Vitamin - C (Mg)	50	45	-10	44	- 12

* 70 per cent of calories from Carbohydrate

** 20 per cent of calories from fat.

The energy consumption of the two groups met almost about 82 per cent of the requirement. The deficit was only 17.13 per cent and 18.18 per cent respectively. There was a reduction of about 26 per cent in the consumption of carbahydrates in both the groups. But the protein intake was more than the recommended allowance and this may be because of the increased intake of fleshy foods, milk and pulses by the groups. Fat consumption of both the groups were higher than the recommended allowance, Calcium intake was within normal range in both the groups. There was a deficit in the intake of iron (34.23%) and 30.3% respectively).

Carotene was higher in both the groups this may be due to increased amount of yellow vegetables in the diet.

F. Blood Glucose Response Of The Subjects Before And After Feeding The Test Foods

The mean blood glucose levels of the subjects estimated before and after feeding whole wheat brown bread (Group I) and white bread (Group II) are presented and discussed under the following headings. The individual values are presented in Appendix VII.

A. Effect of whole wheat brown bread on blood glucose levels.

B. Effect of white bread on blood glucose levels.

C. Comparison of the effect of whole wheat brown bread and white bread on blood glucose levels.

1. Effect Of Whole Wheat Brown Bread On Blood Glucose Levels

Blood glucose levels of subjects before and after feeding whole wheat brown bread are presented in Table XVI, and also in Figure 7.

TABLE XVI

BLOOD GLUCOSE LEVELS OFSUBJECTS BEFORE AND AFTER FEEDING WHOLE WHEAT BROWN BREAD

(GROUP - I)

Blood sample	Normal value	Blood glucose Values before feeding mean ± S.D. (mg/100ml)	Blood glucose values after feeding mean ± S.D. (mg/100ml)	t' values	
Fasting	90	162.16 ± 15.22	151.66 ± 15.96	1.070	NS
1 Hour after breakfast	160	218.66 ± 19.10	203.06 ± 20.99	1.188	NS
2 Hours after breakfast	90	189.83 ± 21.25	177.50 ± 25.72	0.831	NS

N S Not Significant

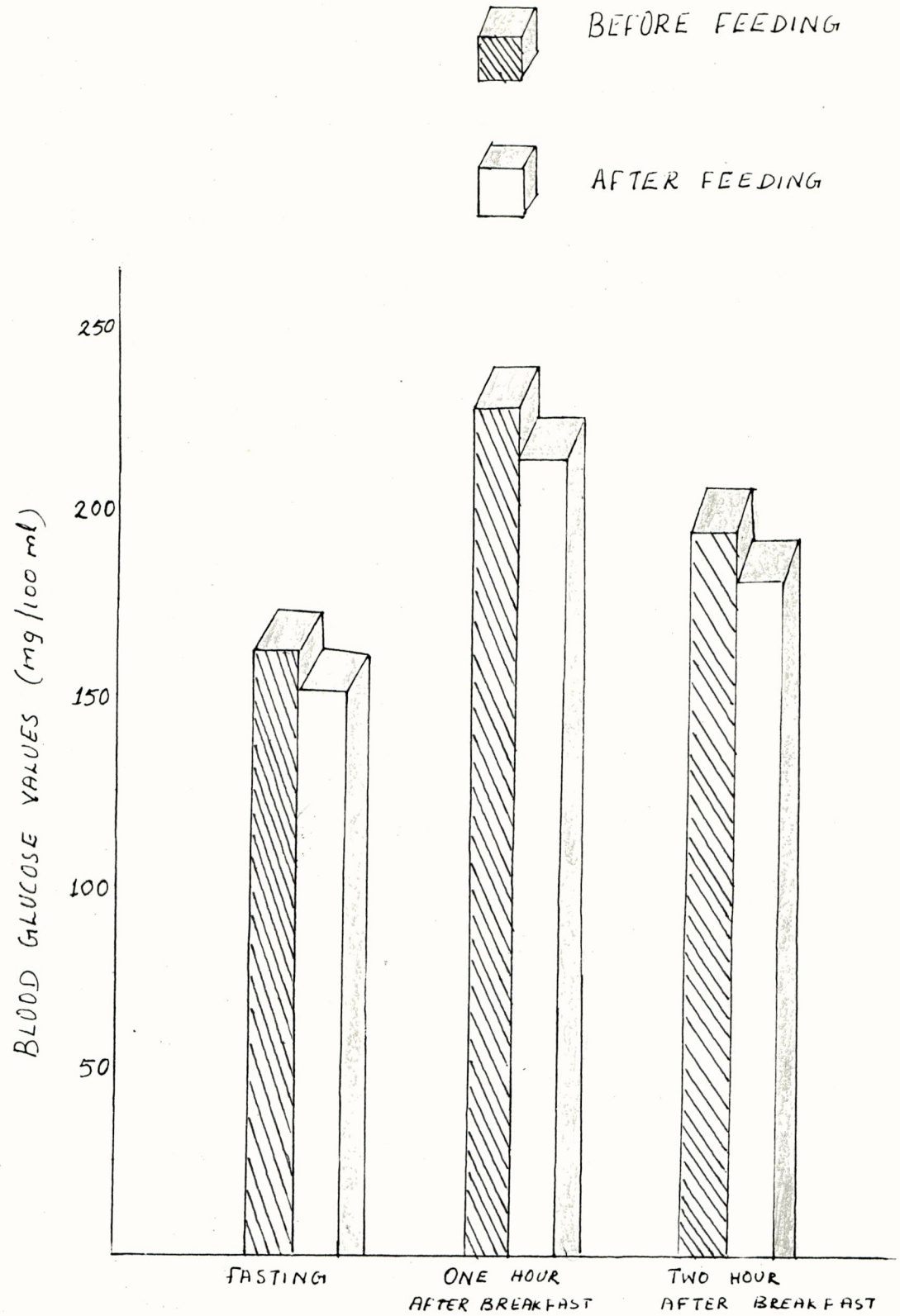


FIGURE-7

BLOOD GLUCOSE LEVELS OF SUBJECTS BEFORE AND AFTER FEEDING WHOLE WHEAT BROWN BREAD

The blood glucose values recorded by the diabetic samples were more than the normal blood glucose values. The fasting blood glucose value before feeding was 162.16 mg/100 ml of blood. After feeding the whole wheat brown bread for a period of 10 days, the fasting blood glucose showed a reduction to 151.66 mg/100 ml. But the statistical analysis showed that the reduction was not significant.

The blood glucose values recorded 1 hour and 2 hours after having break fast also showed higher values when compared to the normal values. But after the administration of the whole wheat brown bread the blood glucose levels decreased. But, the difference between the values before and after feeding were not satisfically significant. Though the reduction was more in the 1 hour blood glucose level it was not significant. After 2 hour also the reduction in the blood glucose level after feeding was not statisfically significant.

These results show that including whole wheat brown bread reduces the blood glucose level though the reduction was not statistically significant.

2. Effect Of White Bread On Blood Glucose Levels

Blood glucose levels of subjects before and after feeding white bread is shown in Tabe XVII and in Figure 8.

TABLE XVII

BLOOD GLUCOSE LEVELS OF SUBJECTS BEFORE AND AFTER FEEDING WHITE BREAD (GROUP II)

Blood Sample	Normal Value	Blood Glucose Values before feeding Mean ± S.D (Mg/100 ml)	Blood Glucose Values after feeding mean ± S.D. (mg/100ml)	Value
Fasting	90	172.00 ± 17.88	168.00 ± 18.10	0.353 NS
1 Hour after break fast	160	226.66 ± 11.43	225.66 ± 9.94	0.148 NS
2 Hour after break fast	90	200.16 ± 20.08	202.5 ± 21.36	0.179 NS

NS Not Significant

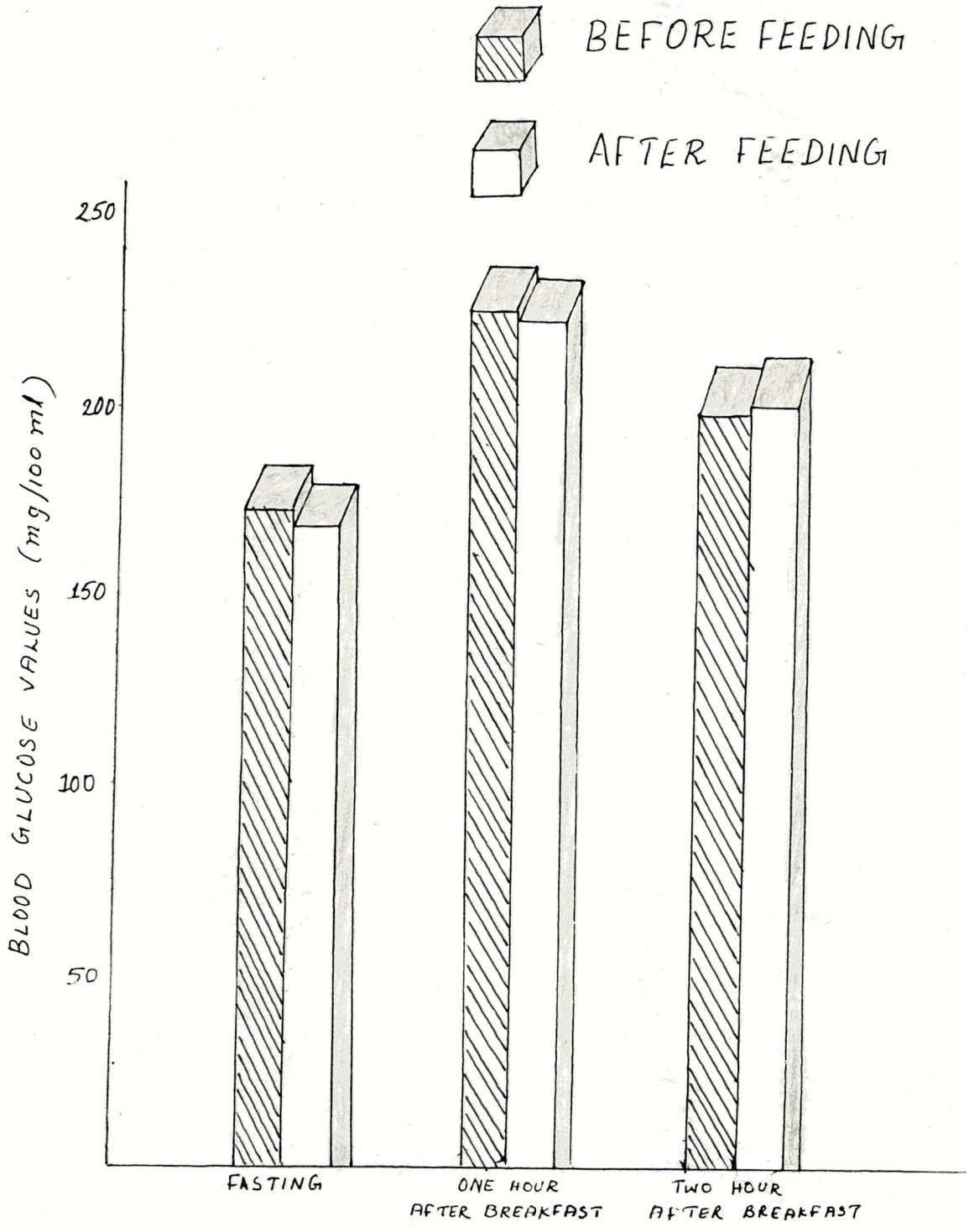


FIGURE-8

BLOOD GLUCOSE OF SUBJECTS BEFORE AND AFTER FEEDING WHITE BREAD.

In the case of the subjects fed white bread also the blood glucose values showed a reduction after feeding. But the reduction was about 1 mg to 2mg only. Since the reduction was very low the difference between the initial and final values were not statistically significant. After 2 hours there was a slight increase in the blood values of the group fed white bread.

3. Comparison Of The Effect OfWhole Wheat Brown Bread And White Bread On Blood Glucose Level

The glycemic responses of whole wheat brown bread and white bread are presented in Table XVIII and Figure 9.

TABLE XVIII

COMPARISION OF THE GLYCEMIC RESPONSE OF THE TWO GROUPS AT ONE HOUR AND TWO HOURS AFTER BREAKFAST

Blood Glucose Values	Group I	Group II	t' Value
One hour after breakfast mean ± S.D	203.66 ± 20.99	225.06 ± 9.94	2.129 NS
1 hour - fasting	52.50 ± 18.65	57.66 ± 17.30	0.4558 NS
Two hour after breakfast mean ± S.D	177.50 ± 25.70	202.5 ± 21.36	1.681 NS
2 hours - fasting	25.83 ± 8.37	34.05 ± 10.43	0.837 NS

NS Not Significant

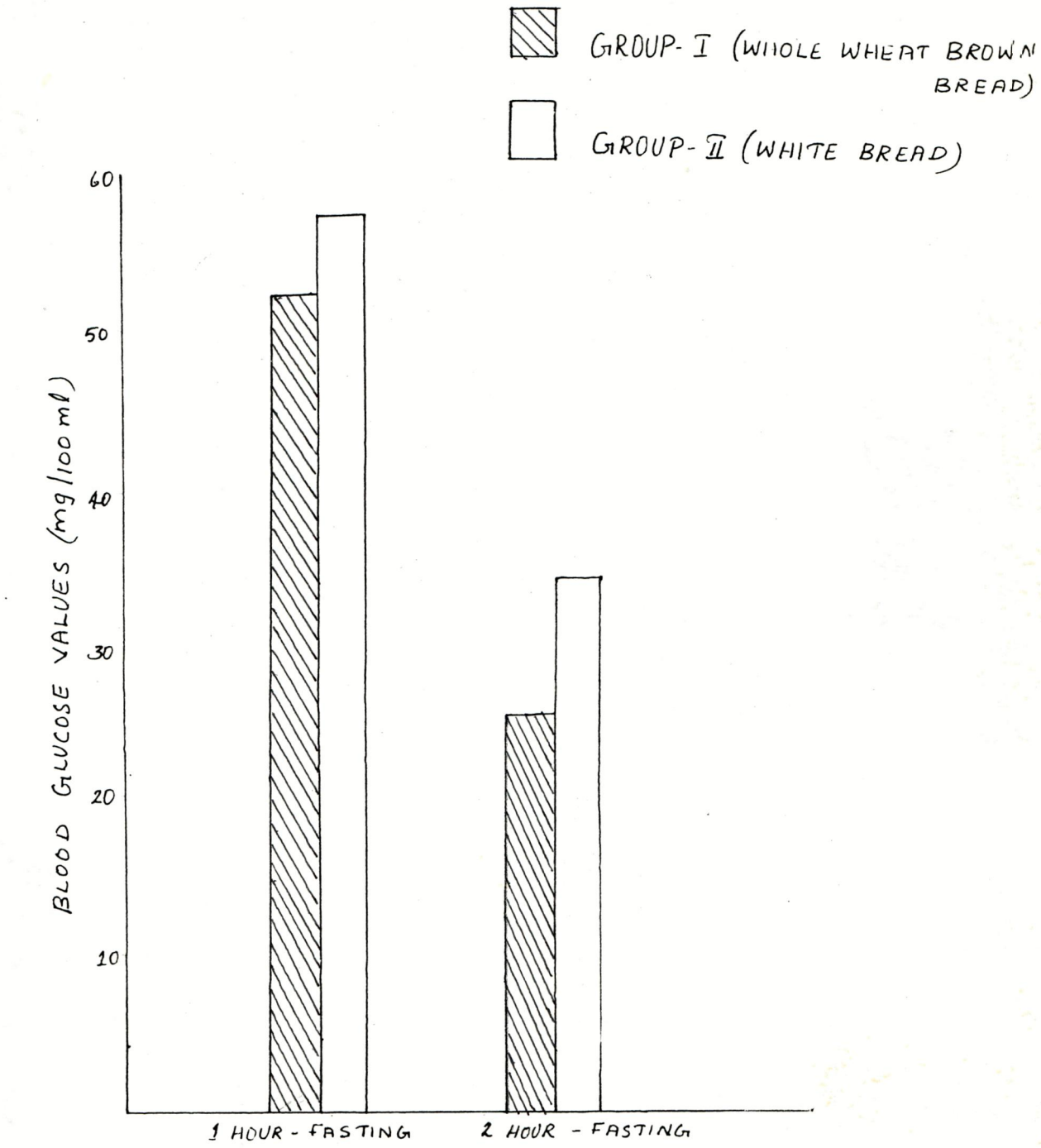


FIGURE-9

COMPARISON OF GLYCEMIC RESPONSE OF THE TWO GROUPS AT ONE HOUR AND TWO HOURS AFTER BREAK FAST

Table XXII represents the blood glucose values recorded by the two groups after one hour and two hours of consuming the two varieties of bread. Since the fasting blood glucose values of the two groups are slightly different the difference between the 1 hour value and fasting value, and the 2 hours value and the fasting values of the two groups are also represented in the Table and compared. Analysis of these values show that the group I, fed whole wheat brown bread has registered a lower blood glucose value the Group II fed white bread. The effect is more after 1 hour of feeding than 2 hrs. But the reduction is not statistically different.

The results of the study indicate that including bread varieties in the breakfast of the diabetic subjects does help in reducing blood glucose values. Among the two varieties of bread samples, the whole wheat brown bread is more efficient in lowering blood glucose level than white bread. This may be because of the higher fiber content of the whole wheat brown bread, which contains more amount of unrefined wheat.

It is recommended that further studies can be conducted on breads developed specially for the diabetics, adding more amount of bran to the bread as bread is preferred by most of the diabetic subjects.

Summary and Conclusion

V. SUMMARY AND CONCLUSION

The present investigation on the "Comparison of glycemic response of whole wheat brown bread and white bread in non-insulin dependent diabetics" was undertaken with the following objectives.

1. Study the socio-economic and dietary pattern of the 100 non insulin dependent diabetics
2. Conduct a feeding trial with whole wheat brown bread and white bread on a sub sample of 12 diabetics.
3. Evaluate the glycemic response of the two varieties of bread and
4. Compare the effect of the two varieties on blood glucose level.

The samples were selected from four hospitals in Coimbatore city. The socio economic status, food habits, knowledge and practices of the 100 subjects were studied. A sub sample of 12 non insulin dependent diabetics who were in the age range of 40 - 55 years and willing to co-operate in the feeding trial were selected and divided into two groups of six subjects each. In each group there were four males

and two females whole wheat brown bread and white bread were specially prepared for including in the feeding trial for the diabetics. Eighty grams of whole wheat brown bread along with 100g of milk and 100g of apple formed the break fast item for the two groups of selected subjects. The formulated breakfast item supplied about 300 kcals of energy, 9 g of protein, and 1.5g of fiber. The fasting blood glucose level and the blood glucose level after one hour and two hours of the normal breakfast were recorded before starting the feeding trial. The standardized breakfast items were served for the two groups of the subjects in one common place for a period of 10 days. At the end of the feeding trial again the fasting blood glucose level and blood glucose levels at one hour and two hours after consuming the break fast items were estimated. The data obtained were satistically analysed and the results were evaluated.

The following are the findings of the study:-

(1) About 68 percent of the subjects were between 40 - 60 years of age. There were only 20 subjects above 60 years and only four below 40 years of age.

(2) There were more males (64 per cent) than females in the selected samples.

(3) 98 per cent of the selected subjects were married.

(4) Seven percent of the selected subjects were illitrates and the rest 93 per cent were litterates. There were more educated males than females.

(5) About 50 per cent of subjects belonged to high income group and the rest were equally distributed between middle income and low income groups.

(6) Incidence of diabetes was more among non-vegetarians than vegetarians.

(7) About 22 percent of selected diabetic subjects were over weight.

(8) Eighty eight per cent of diabeties were diet concious while the rest did not have any dietary restrictions wheat, fenu greek powder, greens, ragi, bitter gourd juice and keerai juice were the foods specially included by the subjects. Sugar, roots and tubers, potato, fruits, beetroot, and rice were the foods avoided by the diabetic subjects.

(9) Sugar, Calories, rice, potato, fats and oils, and fleshy foods were consumed in restricted quantities by the subjects.

(10) The consumption pattern of wheat products by the selected subjects indicated that 98 per cent of diabetics included wheat products. White bread, Chapathi, wheat uppuma boiled broken wheat and brown bread were the wheat preparations consumed by the selected subjects.

(11) The food consumption pattern of the male subjects indicated that except milk, fleshy foods, and fats and oils all the other groups of foods were consumed in the deficient quantities. The consumption pattern of the female subjects revealed a similar trend but the consumption of other vegetables was also adequate by females. Though the subjects knew the importance of green leafy vegetables they did not consume adequate quantities of these foods.

(12) The nutrient intake of subjects indicated that protein, Calcium and iron intakes were adequate. But vitamins consumption was inadequate.

(13) Analysis of blood glucose levels before and after feeding the two bread varieties revealed that the fasting blood glucose levels reduced after feeding.

(14) The blood glucose values recorded one hours and two hours after feeding whole wheat also decreased at the end of the feeding trial. But the reduction was not satistically significant.

(15) Feeding white bread showed only a very little reduction in the blood glucose levels which was also not satistically significant.

(16) When the efficacy of the two bread in lowering the blood glucose levels were compared it was found that whole wheat brown bread was more efficient than

the white bread. Whole wheat brown bread which contains more amount of unrefined wheat flour showed a better effect than the refined white bread in lowering the blood glucose values in non-insulin dependent diabeties.

The study has brought out the fact that inclusion of unrefined cereal products which have more crude fiber could be well incorporated into the diet of non insulin depent diabetics to bringing down the blood glucose level.

Further studies can be conducted on cereals and under exploited millets and products made out of them to evaluate their hypoglycemic effects.

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Appendix

A P P E N D I X- I

SOCIO ECONOMIC AND DIETARY SURVEY OF DIABETICS

1. Name of the Diabetic
2. Age
3. Sex
4. Height
5. Weight
6. Vegetarian/ Non Vegetarian
7. Name and address of the Head of the family
8. Religion
9. Composition of the family

No.	Name of Member	Relation to the head of the family	Marital status	Age	Education	Occupation	Income per month
1.							
2.							
3.							
4.							
5.							
6.							

10. Total family Income

11. Are you aware that diet plays a major role in controlling diabetes

▱ Yes ▱ No

If Yes, what are the alterations made

12. Do you include wheat preparations

▱ Yes ▱ No

If yes, what is the frequency of use

Daily ▱ weekly ▱ Monthly ▱

13. The ways in which wheat products are consumed

	Daily	Weekly	Monthly
1. Chappathi			
2. Uppuma			
3. Broken wheat			
4. Kali			
5. White bread			
6. Brown bread			
7. Others			

14. Details of Food consumption

Foods	Included fully	Included partially	Avoided
CEREALS:			
Rice			
Wheat			
Maida			
Maize			

Ragi

Suji

Vermicelli

Semolina

Other

PULSES

Black gram dhal

Bengal gram dhal

Red gram dhal

Green gram dhal

Cow peas

Soya beans.

WHOLE GRAIN

Bengal grain

Green gram

Horse gram

ROOTS AND TUBERS

Potato

Carrot

Onion

Radish

Yam

Others.

GREEN LEAFY VEGETABLS			
Beans			
Brinjal			
Bitter gourd			
Ladies finger			
Pumpkin			
Tomato			
Others.			
FRUITS			
Plantain			
Guava			
Pappaya			
Grapes			
Others			
NUTS AND OILS			
Coconut Oil			
Gingelly Oil			
Ground nut oil			
Vanaspathy			
Others.			
FLESHY FOODS			
Mutton			
Fish (Fresh)			
Fish (dried)			
Chicken			
Egg			
Beef			
Other.			

MILK AND MILK PRODUCTS

Milk

Curds

Buttermilk

Butter

Ghee

SUGAR AND JAGGERY

Sugar

Jaggery

Honey

BEVERAGES

Tea

Coffee

Others

PREPARED FOODS

Sweets

Biscuits

Cakes

Jam

Jelly

Custard

Sauce

Pickle

Papad

Others

15. MEAL PATTERN

	Early Morning	Breakfast	Mid-Morning	Lunch	Tea	Dinner
I. Day						
II Day						
III Day						

APPENDIX - II

RECIPE FOR THE PREPARATION OF WHOLE WHEAT BROWN BREAD AND WHITE BREAD

I. WHOLE WHEAT BROWN BREAD

Whole wheat flour	-	700 gm
Maida	-	300 gm
Dalda	-	25 gm
Sugar	-	20 gm
Yeast	-	20 gm
Calcium propionate	-	3 gm
Water	-	600 ml.

METHOD

1. Mix yeast thoroughly with little water
2. Add all the ingredients and make a dough
3. Beat the dough to incorporate some air
4. Leave aside the dough in a warm place for 15-20 minutes to allow it to rise.
5. After the dough has acquired full volume, it is baked between 400 - 450° F in the oven.
6. After baking, bread should be released from the mould immediately.

II. WHITE BREAD

Maida	-	1000 gm
Sugar	-	75 gm

Salt	-	20 gm
Dalda	-	20 gm
Yeast	-	12 gm
Calcium propionate	-	3 gm
G.M.S.	-	2.5 gm
Water	-	600 ml.

METHOD

Same as that of whole wheat brown bread.

APPENDIX - III

ESTIMATION OF BLOOD GLUCOSE

1. PRINCIPLE:

Glucose is oxidised by the enzyme glucose Oxidase (GOD) to give D- glucose acid and hygrogen perioxide. Hydrogen perioxide in presence of enzyme Peroxidase (POD) Oxidizes phenol which combines with 4 Aminoantipyrine to produce a red colored quinoneimine dye. The intensify of the color developed is proportional to glucose concentration in the sample.

$$\text{D-glucose} + H_2O + O_2 \xrightarrow{\text{GOD}} \text{D- gluconic acid} + H_2O_2$$

$$H_2O_2 + \text{4 Aminoantipyrine} + \text{Phenol} \xrightarrow{\text{POD}} \text{Red Quinoneimine dye} + H_2O$$

2. REAGENTS PROVIDED:

1.	Enzyme Reagent (Lyophilized)	2 vials
2.	Buffer solution	2 x 125 ml.
3.	Glucose standard 100 mg. %	1 x 2 ml.

3. REAGENT PREPARATION:

Dissolve one vial of the lyophilized Enxyme Reagent (1) in one bottle of Buffer solution (2) Mix gently to dissolve. The prepared working Enzyme Reagent is stable for atleast a month at 2 - 8° C.

4. PROCEDURE:

Pipette into clean dry test tubes labelled blank (B), Standard (S) and Test (T)..

	(B)	(S)	(T)
Working Enzyme Reagent	1.0 ml	1.0 ml.	1.0 ml
Distilled Water	0.01 ml	-	-
Glucose Standard (3)	-	0.01 ml.	-
Serum / Plasma	-	-	0.01 ml.

Mix well and incubate at 37° C for 10 minutes. Then measure the absorbance of Test (T) and Standard (S), against Blank (B) on a photocolorimeter with a green filter or on a spectrophotometer at 505 nm (Hg 546 nm).

5. CALCULATION :

$$\text{Glucose in mg \%} = \frac{\text{A of (T)}}{\text{A of (S)}} \times 100$$

6. NORMAL VALUES:

Fasting level

Whole blood - 60 - 100 mg / 100 ml.

Serum / plasma - 80 - 120 mg / 100 ml.

A P P E N D I X - IV

STANDARD WEIGHT CORRESPONDING TO HEIGHT GIVEN BY L.I.C.

Height in cms.	Weight in Kg.	
	MEN	WOMEN
140 - 150	45.5 - 50.7	44.7 - 50.7
150 - 160	50.7 - 61.7	50.8 - 59.1
160 - 170	61.7 - 68.5	59.1 - 65.3
170 - 180	68.5 - 76.2	65.3 - 71.7
180 - 190	71.2 - 85.7	67.1 - 73.9

APPENDIX - V

MEAN DAILY FOOD INTAKE (Group - I)

	Cereals	Pulses	Greens	Other Vegetables	Roots & Tubers	Fruits	Milk	Fats & oils	Fleshy foods	Sugar
P_1	300	70	100	109	34	-	300	37	-	-
P_2	300	71.6	116.7	95	46.6	-	408	43.3	-	-
P_3	358	50.0	116.7	81.7	23.3	-	234	42.0	62.0	-
P_4	350	58	52	90	45	-	334	40	87	-
P_5	317	60	100	67	20	-	372	47	30	-
P_6	242	54	125	107	30	-	209	42	75	-

MEAN DAILY FOOD INTAKE (Group- II)

	Cereals	Pulses	Greens	Other Vegetables	Roots & Tubers	Fruits	Milk	Fats & Oils	Fleshy Foods	Sugar
P_1	259	72	84	142	54	-	234	35	-	-
P_2	317	60	100	100	20	-	372	45	-	-
P_3	358	57	70	83	20	-	300	45	50	-
P_4	333	63	87	87	52	-	290	42	42	-
P_5	350	50	62	75	33	-	242	38	83	-
P_6	270	32	59	142	47	-	175	34	87	-

APPENDIX - VI

MEAN DAILY NUTRIENT INTAKE (Group-I)

	Protein	Fat	CHO	Energy	Calcium	Iron	Vit. C	Fiber (Crude)	B.Carotene	Thiamine	Riboflavin	Niacin
P_1	57	55	315	1929	0.43	20	38	3.13	4217	1.35	1.07	14.15
P_2	62	70	368	2377	0.77	28.4	51	6.76	699	1.29	1.01	15.05
P_3	61	68	348	2342	0.67	21.2	49	4.83	3373	1.45	1.04	16.09
P_4	56	55	344	2014	0.47	26.9	32	4.63	1542	1.91	1.52	19.2
P_5	66	61	394	2428	0.67	29.9	71	5.9	3308	1.85	1.15	14.45
P_6	63.	60	252	1718	0.5	22.0	52	4.1	3838	1.35	0.85	16.6

MEAN DAILY NUTRIENT (Group - II)

	Protein	Fat	CHO	Energy	Calcium	Iron	Vit. C	Fiber (Crude)	B.Carotene	Thiamine	Riboflavin	Niacin
P_1	68	51	256	1717	0.47	19.8	50	2.26	2064	1.39	0.84	12.1
P_2	61	67	390	2563	0.76	28.4	30	6.4	2608	1.34	1.17	16.1
P_3	56	64	353	2224	0.43	44.5	39	4.3	1230	1.85	1.53	19.7
P_4	71	58	337	21 /5	0.39	29.23	49	3.63	3539	1.53	1.27	19.2
P_5	67	63	325	2154	0.67	17.3	38	3.5	3181	1.48	1.01	14.34
P_6	48	39	297	1883	0.37	15.9	37.	3.33	5889	1.3	0.99	14.22

APPENDIX - VII

BLOOD GLUCOSE LEVELS OF SUBJECTS BEFORE AND AFTER FEEDING (Group - I)

	BEFORE SUPPLEMENTATION			AFTER SUPPLEMENTATION		
	Fasting	One hour after break-fast	2 Hour after break-fast	Fasting	One hour after break-fast	2 Hour after break-fast
P_1	160	215	180	155	225	190
P_2	173	235	205	165	205	180
P_3	140	180	159	130	160	145
P_4	180	219	210	170	220	205
P_5	145	230	180	130	210	160
P_6	175	235	205	160	200	185

BLOOD GLUCOSE LEVELS OF SUBJECTS BEFORE AND AFTER FEEDING (Group - II)

	BEFORE SUPPLEMENTATION			AFTER SUPPLEMENTATION		
	Fasting	One hour after break-fast	2 Hour after break-fast	Fasting	One hour after break-fast	2 Hour after break-fast
P_1	170	250	200	160	235	200
P_2	190	225	200	180	220	200
P_3	182	220	210	176	220	205
P_4	160	215	180	150	210	175
P_5	140	220	175	145	230	190
P_6	190	230	236	193	239	245