Glycemic Response of Selected Vegetables in Non-Insulin Dependent Diabetics

BY

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Introduction

I INTRODUCTION

Diabetes mellitus is one of the most common, chronic disease which continue to burden the modern society. The diabetic of today can hope to lead almost a normal life, provided he is conversant with the bare essentials of its management, consumes only recommended food and regular in taking medicines.

Diabetes is a serious disorder of the glands of pancreas. It is a heredity metabolic disorder characterised by an inadequate supply of effective insulin which under victims unable to regulate blood glucose level within the normal ranges (Aronson, 1990).

Every year approximately 5,00,000 new cases are diagnosed. Many of these people are adults middle aged who see physician for other reasons. It is estimated that 80 per cent of all diagnosed diabetics have atleast one (or) other chronic conditions (National Diabetes Data Group, 1985).

The prevalence rate of diabetes in India is over 10 million (Giri et al.,1987). Sharma (1987) indicate that about 2.3 per cent of the Indian population suffer from this disease of which 1.5 per cent in rural, 3.0 per cent in urban and 8.22 per cent in immigrant Indians.

Diabetes mellitus is classified into Type I - Insulin Dependent Diabetes Mellitus, Type II - Non-Insulin Dependent Diabetes Mellitus, IGT - Impaired Glucose Tolerance, GDM - Gestational Diabetes Mellitus and diabetes associated with other conditions (or) syndromes.

Diabetes is a disease leading to complications. Nerve, eye and kidney failures are common dangers of health and life. Twenty five per cent of the mortality in diabetics is caused by advanced kidney diseases and around 50 per cent deaths result from infection (Beebe, 1987). A study conducted by (Patel, 1985) showed that 18.1 per cent diabetics were affected by renal problems as against 4.2 per cent with neuropathy and 4.3 per cent retinopathy.

A measured diet and insulin dosage are carefully regulated so that the blood sugar is kept within normal limits and the urine is free (or) nearly free of sugar at all times. Such control is believed to reduce the incidence and severity of degenerative complications. Scientists should explore the ways and means through which a better control can be achieved.

Metabolic studies indicate that soluble forms of dietary fibre (e.g. Guar and Pectin) may curtail the

glycemic response (Glucose levels reached in response to ingestion of a particular food) in people with overt diabetes (Jenkins et al., 1976, 1978, 1979; Monnier et al., 1978; Morgon et al., 1979, LSRO, 1987 and Poynard et al., 1980).

Slavin (1987) defines dietary fibre as the source of polysaccharides and lignin not digested by the endogenous secretion of the human gastro-intestinal tract.

High fibre diets prolong eating time, enhance satiety, dampen post-prandial glycemia, increase insulin sensitivity and decrease energy value.

A high intake of dietary fibre makes the Gastro-intestinal content more gelatinous and slows down the absorption of sugar and keeps the blood sugar from reaching either very low or very high levels.

Different individual foods containing iso-caloric amounts of carbohydrates may elicit widely different plasma glucose response. These responses are quantified as 'Glycemic Index'.

Jenkins (1988) defines glycemic index as the proportion of the incremental blood glucose area of the reference food to the test food in percentage.

Many factors contribute to the glycemic response of food and these include food-form, degree of cooking and protein enrichment (Wolever et al., 1986); other considerations include mastigation (Read et al.,1986), the individual variation in absorption and ethinic and racial differences.

Knowledge of the glycemic index of foods can be useful in choosing foods to eat under specific circumstances (e.g. exercise, treatment of hypoglycemia, controlling blood glucose etc.). It is also possible that the fluctuations in blood glucose reported by some diabetic patients, when they implement exchanges in carbohydrates (when all other factors remain unchanged) are due to the different glycemia indices of the foods consumed.

Studies on the glycemic response of many of the Indian foods is scare especially in South India. Analysis of glycemic response of all the commonly consumed foods will be valuable in the development of therapeutic science and help very much in a better control of diabetes mellitus.

Hence the present study has been undertaken with this goal, having the fact in mind that fibre components from vegetables and fruits have a blood glucose lowering effect in diabetics.

Stasse et al., (1980) have pointed out that fibre components from vegetables and fruits in contrast with bran have a favourable effect on the concentration of serumglucose and cholesterol.

The present study was undertaken to find out the effect of selected vegetables on blood glucose level and to compare their efficiency in lowering blood glucose level. Three commonly consumed vegetables namely Cluster beans (Cynmopsis tetragonoloba), cow pea pods (Vigna catjang) and Field beans (Dolichos Lab lab) whose glycemic responses have not yet been evaluated were selected for the study. Since the dietary fibre contents could not be calculated, the crude fibre content of the foods were used in the study.

Non-insulin dependent diabetics who were controlling diabetes with diet alone were included for feeding and evaluating the glycemic response.

Thus the present study was formulated with the following objectives:

1. Selection of three vegetables which have high fibre.
2. Identification of non-insulin dependent diabetic subjects along with matched normal controls

3. Formulation of a suitable recipe with the selected vegetables

4. Administration of the selected vegetable preparations to the diabetics

5. Study the glycemic response of the subjects before and after administration of the selected vegetables and

6. Compare the blood glucose lowering capacity of the three vegetables

Review of Literature

II REVIEW OF LITERATURE

The review of literature pertaining to the present study on "Glycemic Response of Selected Vegetables in Non-insulin Dependent Diabetics " is presented under the following headings:

A. Meaning of Diabetes Mellitus

B. Classification and Causes of Diabetes

C. Dietary Management of Diabetes Mellitus

D. Glucose Response of Foods

E. Dietary Fibre - The New Wave

A. Meaning of Diabetes Mellitus

Diabetes has been defined in various ways. According to Susan (1987) diabetes mellitus is a disease for which treatment is a life long diet, controlling total carbohydrate, protein, fat energy intake and monitoring insulin needs. It is a complex disease involving many factors for this. According to American Diabetic Association (1987) diabetes mellitus is a metabolic disorder characterised byhigh blood glucose level and defective carbohydrate utilisation due to a relative (or) absolute deficiency of insulin.

Diabetes mellitus is a clinical syndrome characterised by hyperglycemia, due to deficiency (or) diminished effectiveness of insulin, Sridhar et al, 1990). Lewis (1986) states

that diabetes mellitus is a chronic, systemic disorder involving the endocrine system, particularly the islets of langerhans of the pancreas. The heterogenous nature of the disorder has led some authorities to conclude that the disorder represents a number of different diseases characterised by an abnormally high circulating blood glucose level.

According to Robinson (1986) diabetes mellitus has been defined as a genetically and clinically heterogenous group of disorders all of which show glucose intolerance. It is characterised by partial (or) total lack of functioning insulin and alternation in carbohydrate, protein and fat metabolism.

Even though definitions are varied, the main point from which the definitions are formulated (increase of blood glucose leading to the passage of sugar in the urpneand dearrangement in carbohydrate, protein an fat metabolism).

B. Classification and Causes of Diabetes Mellitus

1. Classification of Diabetes Mellitus

According to (WHO 1985) diabetes is classified into the following:

A. Type I - Insulin dependent diabetes mellitus

B. Type II - Non insulin dependent diabetes mellitus

C. Impaired glucose tolerance

D. Gestational diabetes

E. Malnutrition related diabetes mellitus

Kanwar (1986) states that another type of diabetes is brittle diabetes which occurs in children (or) adults, which does not respond well to the usual methods of treatment (ie) diet, insulin, exercise. The WHO study group on diabetes mellitus (1985) included malnutrition related diabetes mellitus as a major class ranking with insulin dependent diabetes mellitus and non-insulin dependent diabetes mellitus. Fibro Calculous Pancreatic diabetes (FCPD) and protein Deficient Diabetes mellitus (PDDM) were added as sub groups.

According to Bajaj and Subba Rao (1988) the onset of pancreatic disease in most cases is during childhood with recurrent abdominal pain. Peak onset of symptoms of diabetes occurs between the age of 15 and 30 years and both sexes are affected. Mohan (1990) describes protein - deficient diabetes mellitues (PDDM) as J type, K type or M type of diabetes mellitues.

2. Causes of Diabetes Mellitus

At least 2 per cent of the world's population suffer from diabetes and the main causes are genetic, endocrine and others are age, sex heredity, obesity, virus infections, emotional stress and glandular disorders (Raheena Begum, 1989).

a. Age:

Raheena Begum (1989) states that half of all cases

occur in the age group of 50-60 years, only 5 per cent of diabetic all under ten years of age. NIDDM typically has its onset in the adult years (Banham, 1985).

b. Sex:

Though the disease affects both the sexes in younger age group, more boys develop diabetes. In the middle age, women are more often affected (Dorothy, et al., 1983). In our country males are more prone to diabetes than females (Ahuja, 1979). According to Shukla (1987) there is a preponderance of male over female diabetics in India.

C. Heredity:

Krause (1979) and Khan (1988) say that diabetes mellitus is a chronic metabolic disorder with a strong hereditary basis. (Altman, 1982) states that there is considerable genetic variation between type I and type II diabetes, genetic, environmental and life-style factors can place a person at increased risk for developing NIDDM. The very high concordance of the incidence of NIDDM in many identical twin pairs (Barnett et al., 1981) suggest that genes play a very important role in this disease.

According to Davis (1988) diabetes is most likely to be found among those who are over 35 years of age, overweight, blood relatives of diabetic women, mother's who gave birth to babied that weighted nine pounds or more at birth and

women who have shown carbohydrate intolerance during pregnancy.

d. Virus infections:

It is known that virus infections place a strain on the body and makes controlling diabetes in the diagnosed patient more difficult - but do they actually cause the disorder itself. The possibility that there are individuals who can quickly develop antibodies destroy disease making agents and others who can't produce antibodies get the disease (Johnyudkin, 1989). Several viruses including mumps, rubella and coxsackie are being investigated. The frequency of any coxsackieviral antibody was significantly higher in young Ketosis Resistant Diabetics (YKRD) 80% and Young Ketosis Prone Diabetics (YKPD) 65% (Singh et al., 1980).

e. Obesity:

The only factor that has been consistently related to the prevalence of diabetes mellitus is relative body weight (West 1978). Glueck (1979) and Jarrett (1981) show a high degree of correlation between diabetes prevalence and average fatness as obesity increases the size and number of adipocytes and makes them relatively insulin resistant.

The percentage of obese people developing diabetes is greater than a normal person. According to NRC (1989)

central distribution of body fat (ie) high waist-to-hip ratio is strongly associated with a higher risk of NDDM.

Alexander (1987) opines that over eating throws an excessive strain on the pancreas, a strain that in the end causes its failure. It may be however, that those who become obese and consitently overeat are rpone to diabetes through inheritance any way.

Lee et al.,(1981) found that there is an inverse relationship between Sugar intake and either obesity (or) diabetes. This inverse relationship between sugar intake and obestiy as well as decreased glucose tolerance was confirmed by keen et al., (1979) in Britain.

f. Emotional Stress:

According to Alexander (1987) emotional set backs like worry, strain, rundown feeling, listlessness, contribute to the physiological upsets in the body. Some evidences links the excessive release of adrenaline and cortisone the stress hormones with the occurence of diabetes at a latter date. Again however the real cause and effect relationship in unclear.

g. Trace elements:

Chromium deficiency in animals and in man causes imparied glucose tolerance (Drury, 1979).

In hyperglycemic humans, chromium supplementation imrpoved glucose tolerance and lowered insulin levels. (Anderson, 1986; Riabes and Alhrinik, 1981; Simonoff, 1984). Suggesting that ehromium deficiency may be a contributing factor to disease onset.

Zinc another trace metal is abundant in pancreas. It has a special affinity with insulin and may have a role in the storage of insulin (Drury, 1979). Diabetics excrete increased amounts of zinc in their urine and that their plasma leucocyte and erthycocyte levels are reduced (Krause, 1984).

h. Glandular Disorders:

Damage to tumors in pancreas, pancreatitis, and hemocheamatosis and disorders of glands like acormegaly, cushings syndromw cause diabetes (Alexander, 1987). According to Roheena Begum (1989) disorders in other hormone producing glands like pitutary which secreates growth hormones, over secretion of growth hormone may over stretch the pancreas ability to cope with the rapidly increasing size in the body.

i. Alcohol:

In large population studies, alchohol intake has been correlated with hyperglycemia. There is no ready explanation

for this except for alcoholics who develop insulin deficiency as a result of chronic pancreatitis. It was suspected that ethanol per se impaired glucose tolerance (Gerard et al., 1977). Yki - Jarriven and Nikkila (1985) reported that insulin resistance results from excessive alcohol intake by other wise healthy adults in the united states.

C. Dietary Management of Diabetes Mellitus

Dietary modification is the only treatment that could be offered to an individual with diabeted mellitus, before the availability of insulin and effective oral hypoglycemic drugs were used (Robinson et al., 1986). Regulation of the type and quantity of food ingested is the basis of treatment for all patients with diabetes (Krall et al., 1985).

American Diabetes Association (1986) has given in the following diet Recommendations:

Carbohydrates:

The diet should provide 50-60 per cent of total caloric intake. Emphasize complex corbohydrates (grains, Vegetables, legumes). Restrict simple carbohy drates (Pure Sugar and foods high in added sugar).

Protein:

The diet should provide 12-20 per cent of total

caloric intake. Emphasize sources that are low in fat, low in saturated fat and cholesterol.

Fat:

Restrict to 30 per cent - 38 per cent of total calories. Limit saturated fats and cholesterol; slightly increase poly unsaturated fats.

Fiber:

Increase the fibre intake by substituting high fiber foods for highly refined carbohydrates that are low in fibre.

Among simple carbohydrates (Sugars) and complex carbohydrates (Starches), the former are absorbed rapidly and cause large rises in bloof glucose after ingestion. The latter are absorbed more slowly and produce flat blood glucose responses (Jenkins et al., 1986).

The serum glucose response and insulin responses were higher for fructose than sucrose (Annemarie, 1989).

Some studies show wide variation in the glucose response to simple sugar and to foods containing complex carbohydrates (Crapo, 1985; Crapo et al., 1981; Jenkins et al., 1981).

D. Glucose response of Foods

A new concept in the diabetic treatment of diabetes mellitus has emerged in recent years. Foods were first considered from the point of view of this carbyhydrate content. Not it is suggested that glycemic response also be taken into account. This is mainly because equivalent amounts of carbohydrate give a different response depending on the kind of food consumed. This food with carbohydrate content have been classified according to their glycemic Index (GI)

$$GI = \frac{\text{Area under the curve of food glycemic response}}{\text{Area under the curve of same amount of glucose}} \times 100$$

Hooever et al.,(1987) state that blood glucose response to meals containing grapes, honey dew, orange (or) straw berries was slightly higher than to meal containing apple, banana (or) no fruit.

According to colaquire et al., (1986) the glucose response to isocaloric break fast may vary in NIDDM subjects due to different in processing, decreased availability of starch to enzymes due to higher content of sucrose, lactose, and fructose.

Krezowski et al.,(1987) studied that the insulin rise was greater than normal for oatmeal, lentils, kidney-bean and high amylose muffins.

Jenkins et al., (1983) found that the blood glucose rises after white and whole meals bread identical but the response for spaghetti was markedly less than white and whole meal bread.

E. Dietary Fibre - The new Wave

Dietary fibre has been defined as that part of the plant material in our diet which is resistant to digestion. This term included all indigestable polysaccharoides, lignins, pectins, gums (Guargum) and mucilages, cellulose, hemicellulose and even bacterial degradation products, indigestable poly saccharide be recovered in the feces (Anita, 1989).

According to Ulrich (1987) Dietary fibre may be seperated into 2 types; Insoluble which includes cellulose, hemicellulose, and lignin and soluble including perctin and gums.

According to Aebi et al., (1979) the various physiological effects to dietary fibre are:

1. Increased weight and Volume of feces
2. Decreased transit time through colon
3. Binding of bile acids and lowering of bile cholesterol
4. Decreased blood glucose level and insulin response after carbohydrate meals
5. Decreased mineral absorption

According to strain et al., (1989(dietary fibre may be useful in the management of hypertension and obesity.

The fiber in our diet comes only from plant sources and does not include the tough (or) fibrous portions of some meats. It is composed of complex carbohydrates, such as cellulose and other substances which constitute the cellwalls and structural parts in plants. Some foods which are major contribution to fiber are whole grain flour, cereals, potatoes, fresh-fruits and vegetables, legumes, nuts and seeds (popular Science, 1987).

Total dietary fibre in fresh Vegetables was often around 5 g/100 g; fruits contain 1-2 g/ 100g; root Vegetables provide 1-2.5g/ 100g; Leafy Vegetables 2.5-3.5 g/ 100g and the highest amount by whole grains 11-14 g/ 100g (chandran, 1985).

Some approximation of desirable dietary fibre intakes have been presented and range from 25-50g of dietary fibre a day according to stephen (1981).

1. Effect of High Fibre Diet in Diabetes Mellitus:

Anderson et al ., (1987) believe that dietary fibre has important therapeutic implications for certain conditions such as diabetes and hyperlipidemia and may have preventive implications for others as Blood pressure, cardiovascular disease.

According to Chetty (1986) complex carbohydrates associated with fibre as a major contribution in achieving euglycemia and normalising lipid profile.

Simpson (1981) Anderson (1974) and Jenkins (1986) found out that high fibre and high liberal carbohydrates are of great value in diabetic patients.

Fibre supplementation appears to be beneficial only if given with a diet comprising atleast 50% of calories as carbohydrates (ADA, 1987).

In 1989 Mann and his colleagues demonstrated that the fibre from legumes produce an improving glucose levels throughout the day in IDDM and NIDDM.

Chronic ingestion of high carbohydrates (60%) and high fibre (25 g/1000 Kcal) also reduces the requirements of oral hypoglycemic drugs and dosage of insulin (Sridhar, et al., 1990).

Diets that are lower in fat and higher in fibre were found to be useful in weight loss protools because it allows patients to eat similar quantities of food that are calorically more dilute (Strain, et al., 1989).

2. Effect of Fibre on Insulin and Glucose Metabolism:

Fiber may cause the reduction of post-prandial glucose

and insulin level and even fasting blood glucose levels.

(Bosello (1980) and Brodribb (1976) demonstrate the long term improvement in glucose tolerance and metabolism with high fibre supplemented diets.

According to Mancini et al, (1980), normal carbohydrate fibre rich diet gives better blood glucose control in diabetic than a low carbohydrate diet.

According to Dunai Schnervan (1981) the lower blood glucose levels observed after the consumption of dietary fibre have been associated with low serum insulin level.

Finley et al., (1985) indicate that increasing dietary bran and whole apple in a palatable form increase glucose metabolism in Non-obese non insulin dependent diabetic patients.

According to Anderson (1985) High fiber diets lower insulin requirments, provides better control of blood glucose and reduces serum lipids.

Sharma (1987) observed a significant improvement in plasma glucose response, reduction in insulin level and the symptoms of diabeties like polyuria, polydyspia and polyphagia were under control. The beneficial effects of fenugreekseeds might be due to the presence of guargum.

The fengreek seeds contain 7.2 g fiber per 100 gms.

It also contains trigonellene an alkaloid known to have an effect on glycosuria. Treatment with decotion of fenugreek seeds improve diabetes and suppress glycosuria in mild diabetics and bring about improvement in severe diabetics (Sharma, 1987).

Vorster et al., (1986) found out that multifibre preparations (or) a maize fibre tablet reduced both serum cholesterol, TGA and blood glucose levels.

Jenkins and co-workers (1988) show that both mean peak rise in blood glucose and total area under the glucose curve were at least 45% less than normal in volunteers consumed grains, cereals and tubers (or) vegetables.

Value of high carbohydrate diets is probably due to high fiber content. It delays absorption of glucose high intake increases insulin senstivity, improves carbohydrate tolerance, blood lipids and glucagon (Anderson, et al., 1989).

3. Effect of Gaurgum on Diabetics:

Souble fibers such as pectin mucilage and guar are partly digested and absorb water in the Gastro-intestinal tract, forming a bulky gel. This gel slows the emptying time of the stomach contents, delaying the absorption of carbohydrates which aids in preventing the rapid reflux of sugar into the blood stream (Michalak, 1987).

Tarunk et al., (1983) state that addition of fibre reduced urinary excretion of glucose from 30.5 ± 6 to 8.3 ± 2g/24hr. Fasting blood glucose concentration from 301 ± 24 to 193 ± 9 mg/dl and no significant changes in the patients weight and serum concentration of TGL,HDL, FFA and insulin.

Viswanathan et al., (1980) and Kay et al., (1981) show that an isocaloric diet with 25 g of dietary fibre from guargum (60% carbohydrate, 20% fat and 20% protein) decreased blood glucose values in both IDDM and NIDDM.

According to Spiller et al., (1983) certain fibre containing foods after the metabolic response to meals containing glucose and other carbohydrates. The presence of water soluble fiber guargum alters the response to glucose solution administration. High fiber diets appear to enhance senstivity to insulin given to diabetic patients and permanetly significant decrease in insulin dosage.

Micheal et al., (1988) state that the soluble viscous fibres such as guargum are most effective in normalising carbohydrate intolerance in patients. Guargum brought down the blood sugar and it did not cause any exchange in hemotologic hepatic (or) renal function.

Jenkins and colleagues (1987) report 50% reduction in glycaemia, less insulin requirement and serum lipids were lowered.

Experimental Procedure

III EXPERIMENTAL PROCEDURE

The methodology adopted for conducting this study on 'Glycemic Response of selected vegetables in Non-Insulin Dependent Diabeties' consisted of the following:

A. Selection of the Area

B. Selection of the subjects

C. Study of the background information of the diabetics

D. Selection of the test foods

E. Formulation and administration of the test foods

and F. Recording the blood glucose levels of the subjects

A. Selection of the area

The study was conducted in Coimbatore city. Three hospitals namely Sri Ramakrishna Mission Hospital, Kuppuswamy Naidu Memorial Hospital and Muki clinic were selected for the study. These hospital were selected because of the availability of adequate number of NIDD subjects and the cooperation extended by the authorities of the hospital.

B. Selection of subjects

A total number of 50 diabetics were randomly selected from the above hospitals. From the 50 selected diabetics a total number of 18 subjects (9 males and 9 females) were

selected for the feeding trial. They were between the age group of 40-50 years and comparable in all respects. These 18 diabetics were divided into three groups of six each for receiving the three vegetable supplements. Each group had three males and three females.

Another group of 3 normal subjects comparable in age and sex were selected for comparisons. This group of normal subjects were kept as control group. The control group was not given any supplement.

C. Study of the back-ground information of the diabetics

To study the background information of the diabetics, an interview schedule was used. For this purpose the investigator specially constructed an interview schedule (Appendix I) which collected information on family back-ground, age, sex, height, weight, educational status, family history of diabetes, nature of diabetes, exercise, Foods included and avoided, normal number of meals/day and the knowledge about fibre content of foods. With this schedule the investigator collected the required data from all the 50 diabetics.

To study the specific meal pattern and food habits of the selected sub-sample of 18 diabetics, a weighment survey of Raw cooked foods was conducted. The weightment survey formused in the survey is given in Appendix II.

D. Selection of Test Foods

Fibre rich foods are widely recommended for non-insulin dependent diabetics. Vegetables are good sources of fibre. Since the dietary fibre contents of vegetables were not available the crude fibre content of the vegetables given by ICMR, (1984) were studied and three vegetables were selected. The vegetables thus selected were cluster beans (cyamopsis tetragonoloba), cowpea pods (vigna catjang) and field beans (dolichos Lab-Lab). These vegetables were selected because they are commonly consumed, low cost and locally available. They also contained significant amounts of fibre.

E. Formulation and Administration of Test Meals

1. Evolving the recipe with the selected vegetables
2. Formulation of the meal for the selected subjects
3. Administration of the meals

1. Evolving the recipe with the selected vegetables

It was decided to supplement the experimental foods in the form of porriyal. Thus field beans poriyal(A), cluster beans poriyal(B), Cowpeapods poriyal(C) were prepared in the laboratory and the recipes were standardised. The standardised recipes are presented in the Appendix III, They are also shown in Figure 1.

FIGURE 1 STANDARISED RECIPES WITH THE SELECTED VEGETABLES

2. Formulation of the meal for the selected subjects

An isocarbohydrate breakfast of 4 iddlis and tomato chutney were gives along with the selected vegetables. The breakfast that was given is presented in Figure 2, 3 and 4. The composition and Nutritive value of the breakfast items are presented in Table I, II and III. To make the whole days energy consumption of all the subjects equal the subjects were asked to consume the measured amounts of food during their meals of the day. 1 cup of rice, 1 cup of sambar, any vegetable and 1 cup of buttermilk during lunch; Tea or coffee with 2 salt biscuits for tea and 4 iddlis or 4 chappathies with chutney and one fruit for dinner.

Thus the energy intake of the other meals of the day were also made isocaloric. The whole days energy intake of all the subjects came upto approximately 200 Kcalories.

FIGURE 2 BREAKFAST ITEMS SERVED TO GROUP A FIELD BEANS

FIGURE 3 BREAKFAST ITEMS SERVED TO GROUP B (CLUSTER BEANS)

FIGURE 4 BREAKFAST ITEMS SERVED TO GROUP C (COW PEA PODS)

TABLE I

NUTRITIVE VALUE OF TEST DIET - A (FIELDBEANS)

S.No	Name of the Ingredients	Quantity (g)	Energy Kcal	CHO (g)	Protein (g)	Fat (g)	crude Fibre (g)
1.	Rice	50	173	39.5	3.2	0.2	0.1
2.	Blackgramdhal	12	42	7.1	2.8	0.1	0.1
3.	Tomato	50	10	1.8	0.45	0.1	0.4
4.	Onion	25	25	2.7	0.3	0.02	0.1
5.	Fieldbeans	100	48	6.7	3.8	0.7	1.8
6.	Oil	5	45	-	-	5	-
	TOTAL		345	58	10.7	6.12	2.7

TABLE III.

NUTRITIVE VALUE OF TEST DIET - C (COW PEA PODS)

S.No	Name of the Ingredients	Quantity (g)	Energy (Kcal)	Carbohydrates (g)	Protein (g)	Fat (g)	crude Fibre (g)
1.	Rice	50	173	39.5	3.2	0.2	0.1
2.	Blackgramdhal	12	42	7.1	2.8	0.1	0.1
3.	Tomato	50	10	1.8	0.45	0.1	0.4
4.	Onion	25	25	2.7	0.3	0.02	0.1
5.	Cowpeapods	100	48	8.1	3.5	0.2	2.0
6.	Oil	5	45	-	-	5	-
	TOTAL		343	59.2	10.2	5.6	2.7

3. Administration of the meals

The selected subjects were divided into three groups of 6 in each group. To one group field beans poriyal was given for a duration of 15 days. Similarly for the other two groups cowpea pods poriyal and cluster beans poriyal were given. They were asked to eat the test food (poriyal) along with the iso-caloric breakfast of 4 iddlis and tomato chutney formulated by the investigator. The subjects consumed the breakfast under the supervision of the investigator.

E. Recording the blood glucose levels of the subjects

Blood glucose values were recorded before starting the supplementation. The fasting blood glucose and blood glucose at 1½ hour and 2 hours after consuming the breakfast were also analysed. At the end of the feeding trial again the blood glucose values were estimated. For the normal control subjects glucose - Tolerance test was done. The control group was not given any supplement.

The blood samples collected were analysed by using Glucose - oxidase peroxidase method is given in Appendix IV.

The results are statistically analysed and presented in the following chapter.

Results and Discussion

IV RESULTS AND DISCUSSION

The present study was undertaken to determine the "Glycemic Response of selected Vegetables in Non - Insulin Dependent Diabetics". The results obtained are presented under the following headings and discussed.

A. Background information of the selected diabetics

B. Food and nutrient consumption of the selected diabetics

   1. Mean daily food intake of the selected diabetics

   2. Mean daily nutrient intake of the selected diabetics

C. Impact of the selected vegetables on the blood glucose levels

   1. Glycemic response of diabetics administered field beans

   2. Glycemic response of diabetics administered cluster beans

   3. Glycemic response of diabetics administered cowpea pods

   4. Comparison of the efficiency of the three selected vegetables in reducing blood glucose levels

A. Background information of the selected diabetics

A total number of 50 diabetics were selected for the study. The background information of these diabetics are discussed in the following.

1. Age and sex

The age and sex distribution of the 50 diabetic subjects studied are given in Table IV.

TABLE IV

AGE AND SEX DISTRIBUTION OF DIABETIC SUBJECTS

Sex/age in years	Male		Female		Total	
	No.	%	No.	%	No.	%
31-40	3	6	2	4	5	10
41-50	13	26	10	20	23	46
51-60	6	12	5	10	11	22
61-70	6	12	5	10	11	22
Total	28		22		50	

From the Table IV it is evident that there were more diabetic males than females. The percentage of prevalence in all age groups was high in males. The incidence was high in the age range of 40-50 years. According to Viswanathan (1987) diabetes is much higher among men than women, the ratio being 2:1 and Raheena Begum (1989) opines that it occurs mainly in the age group of 40-60 years. The results of the present investigation are in line with these findings.

2. Income level

The income levels of the diabetic subjects studied are presented in Table V.

TABLE V

DISTRIBUTION OF FAMILIES ACCORDING TO INCOME LEVEL

Income/month in Rs.	Number
0-1500	16
1501-2500	16
2501 and above	18
Total	50

Hudco (1984) classifies a income range of 0-1500 as low income , 1501-2500 as middle income and above 2501 as high income. Table V depicts and various income levels and it was found that 16 of the families had a monthly income of 0-1500 and belonged to low income group; 16 of the families of diabetics had an income of 1501-2500 and belonged to middle income and majority 18 of the families had an income of 2501 and above and belonged to high income group.

3. Educational status

The educational status of the selected diabetics are presented in Table VI.

TABLE VI

EDUCATIONAL STATUS OF THE SELECTED DIABETICS

Educational status	Number
Illiterates	4
Primary school	12
Middle school	4
High school	18
Graduates	9
Post-Graduates	1
Diploma holders	4
Total	50

Four diabetics were illiterates; 12 had completed their primary school; four middle and 18 had completed their high school. Maximum number of diabetics were educated till high school level. Nine of them were graduates, four subjects were diploma holders and only one was a post-graduate.

4. Level of activity

Ten subjects were engaged in sedentary activity. Majority (38) of the subjects were doing moderate activity. Only two subjects did heavy work. They were engaged in handling heavy machines in a workshop.

5. Family size

Thirty two per cent of the families of the diabetics had 1-3 members; 58 per cent of the families had a family size of 4-6 and only ten per cent had a family size of seven and more than seven members. The majority of the families of diabetics had 4-6 members. Most of the families had a minimum of 2 children thus making the total members four.

6. Family history of diabetes

The incidence of diabetes in the families of diabetics are presented in Table VII.

TABLE VII

INCIDENCE OF DIABETES IN THE FAMILIES OF OF THE SUBJECTS

Family history	Number
Grand father	Nil
Grand mother	1
Father	9
Mother	15
Father and mother	13
Others	
Brother	3
Wife	2
Son	1
None	8

Table VII shows that the incidence was high in the first blood relatives (i.e.) mother and father than the 2nd blood relatives (i.e.) grand father and grand mother. Nine had diabetic fathers; 15 had diabetic mothers and 13 had both diabetic mother and father. Brothers were diabetic for three of the diabetic; two of the diabetics wife were also diabetic and one of the diabetics had diabetic sons. Eight had no family history of diabetes. These results confirm the fact that when both father and mother are diabetic the chances for incidence of diabetes in their children is high.

7. Obesity

According to Talwalkar (1989) non-Insulin dependent diabete mellitus usually develops in middle age and obesity increases the chances of getting diabetes. In obese people, an "insulin steal" occurs; the fat steals the insulin from other cells, setting the stage for diabetes. Table VIII shows the distribution of patients according to their body weight for height sex wise as per the norms prescribed by LIC (1986). The LIC norms are presented in Appendix V.

TABLE VIII

DISTRIBUTION OF PATIENTS ACCORDING TO THEIR BODY WEIGHT

Weight	Sex		Total
	Male	Female	
Ideal weight	8	7	15
Under weight	4	1	5
Over weight	4	5	9
Obese	12	9	21
Total	28	22	50

Table VIII shows that eight males had ideal body weight and four males had their body weight ten per cent more than the ideal body weight; four males were under weight and 12 were obese with body weight twenty five per cent more than ideal body weight.

In females seven had ideal body weight and only one was under weight; five females were over weight and nine were obese. On the whole over weight and obese subjects represented about sixty per cent of the total samples.

8. Duration of diabetes

The number of years the subjects were diabetic are presented in Table IX.

TABLE IX

DISTRIBUTION OF DIABETICS ACCORDING TO THEIR DURATION OF DIABETES

Duration	Sex		Total
	Male	Female	
Below 1½ years	4	10	14
1½ - 3 years	10	6	16
Above 3 years	14	6	20
Total	28	22	50

From the Table IX it is revealed that 14 males and six females were suffering from diabetes for more than three years; ten males and six females were suffering from 1½ - 3 years. Four males and ten females were neo-diabetics having diabetes for only below 1½ years.

9. Severity of diabetes

The subjects with diabtes were classified into three groups according to their blood glucose levels as mild (blood sugar level upto 180mg/dl), moderate (180-250mg/dl) and severe (greater than 250mg/dl). The classification of the diabetics according to their fasting blood glucose level is given in Table X.

TABLE X

SEVERITY OF DIABETES IN THE SELECTED DIABETICS

Severity	Sex		Total
	Male	Female	
Mild	28	12	35
Moderate	5	10	15
Severe	Nil	Nil	Nil
Total	28	22	50

From the Table X it is clear that most of the subjects (28 males and 12 females were mild diabetics, whose blood sugar level was below 180mg/dl; five males and ten females had a moderate level of 180-250mg/dl and none of the subjects were severe diabetes.

10. Excercise

The exercise undertaken by the diabetic is represented in Table XI.

TABLE XI

TYPE OF EXCERCISE UNDERTAKEN BY THE DIABETICS

Type of exercise	Number
Walking	28
Jogging	2
Cycling	4
Yoga	6
None	10
Total	50

Table XI indicates that 28 did walking and two went for jogging. Cycling was done by four diabetics and six did yoya and ten of the diabetics did not do any excercise.

Regular excercise increases caloric expenditure and may be of value in achieving weight loss in over weight diabetics (Vranic et al., 1979). According to Gulati (1987), the best excercise for an average person would be brisk walking. Yoga which is also growing interest in the treatment of diabetes can cure diabetes, says Ramiah (1988).

Majority (40) of the subjects studied did one type or other of excercise. This may be because ofthe advice given by their doctors.

11. Foods included

The foods that were specially included by the diabetics to bring down their blood sugar was surveyed and are presented in Table XII.

TABLE XII

FOODS INCLUDED BY THE SELECTED DIABETICS

Foods included	Number
Fenu - greek	5
Fenu greek leaves	1
Ragi	8
Wheat	14
Plantainstem	1
Bitter gourd	19
Cholam	3
Greens	4
Neemleaves	1
Beans	1
Peas	1
Total	50

Table XII shows that fenugreek, fenugreek leaves, cereals like ragi, wheat and cholam, greens, plantain stem

neem leaves beans, peas and bitter gourd were consumed by the subjects to keep their blood glucose under control. Majority (36 per cent) 36 of the diabetics consumed bitter gourd and 28 per cent consumed wheat products to keep the blood glucose under control. 16 per cent consumed ragi, ten per cent fenugreek and eight per cent consumed greens. The subjects mentioned that they included these foods daily.

12. Foods avoided

The foods that specifically avoided by the diabetics are given in Table XIII.

TABLE XIII

FOODS AVOIDED BY THE SELECTED DIABETICS

Foods avoided	Number
Potato	15
Other roots and tubers exceptionion	20
All fruits	2
Plantain	1
Ghee	4
Butter	3
Coffee and tea	2
Sugar and sweets	50

All the diabetics studied omitted sugar and other preparations and 20 diabetics omitted roots and tubers except onion; all fruits were omitted by two; butter and ghee were omitted by four and three per cent respectively.

Only two diabetics avoided coffee and tea.

13. Other food habits

It was found out from the survey that in 46 per cent of the families the meal planning was done in advance and 54 per cent of the families did not plan menus in advance.

All of the diabetics consumed 3 main meals per day. In between snacks such as bonda, bajji, vadai and biscuits were consumed by 32 per cent of the diabetics.

52 per cent of the families prepared meals separately for the diabetics and 48 per cent of the diabetics consumed the family meals.

14. Knowledge of dietary fibre

The awareness of the diabetics of dietary fibre was studied. The results indicated that only about 21 diabetics were aware of dietary fibre and majority (29) did not know about dietary fibre. This shows the poor knowledge of the diabetics of the recent developments and need for disseminating the results of research findings to the public. The foods that were indicated as rich in fibre by the selected diabetics fibre are listed in Table XIV.

TABLE XIV

LIST OF FOODS MENTIONED BY THE SUBJECTS AS RICH IN FIBRE

Foods	Number
Plantain stem	9
Beans	9
Peas	4
Ragi	3
Field beans	3
Pulses	2
Greens	2
Tapioca	1
Bitter gourd	1
Sweet potato	1
Radish	1
Cucumber	1
Carrot	1

From the Table XIV it is observed that nine of the diabetics had a knowledge that plantain stem and beans are good sources of dietary fibre; three diabetics indicated that ragi and field beans and two diabetics said that greens and pulses are good sources of fibre. Bitter gourd, radish, cucumber, tapioca, carrot and sweet potato were mentioned as good sources of fibre by one diabetic each.

15. Life style

Some of the diabetics in the study had habits such as intake of alcoholic beverages, tobacco chewing and smoking. Table XV presents the diabetic subjects according to life style.

TABLE XV

LIFE STYLE OF THE SELECTED DIABETICS

Habits studied	Occasionally	Regularly
	Number	Number
Consumption of alcoholic beverages	7	3
Tobacco chewing	26	7
Smoking	3	7
None of the habits	14	

Seven of the diabetics took alcohol occasionally and three regularly. 26 of the diabetics had the habit of taking tobacco occasionally and seven regularly. Three had occasional habit of smoking and seven had regular smoking habit. It can be observed that 14 diabetics did not have any of these habits.

B. Food and nutrient consumption of selected diabetics

The results of the weighment survey conducted for the 18 diabetics of the three experimental groups namely Field Bean (Group A), cluster bean (Group B) and Cow pea pods (Group C) are presented in the following and discussed.

1. Mean daily food intake of the selected diabetics

The mean daily food intake of the three groups of subjects are depicted in Table XVI. The individual values are given in Appendix VI.

TABLE XVI

MEAN DAILY FOOD INTAKE OF THE SELECTED SUBJECTS

Foods	Male				Female			
	A	B	C	RDA	A	B	C	RDA
Cereals (g)	346	341	297	520	236	235	250	440
Pulses (g)	64	56	49	50	54	51	64	45
Green leagy vegetable (g)	45	24	12	40	40	34	54	100
Other vegetables (g)	47	69	54	70	28	67	39	40
Roots and Tubers (g)	39	83	60	60	57	67	55	50
Fruits (g)	129	179	114	30	140	122	87	30
Milk and Milk products (g)	130	189	192	200	144	145	122	150
Fats and oils (g)	26	31	27	45	26	27	21	25
Fleshy foods (g)	17	22	39	60	58	30	11	60
Sugar and Jaggery (g)	-	-	-	-	-	-	-	20

Food consumption of males

Table XVI indicates that in the case of males the consumption of cereals was only 1/3 of the recommended dietary allowance in all the three groups. The consumption of pulses was more than the recommended dietary allowance in Group A (Field bean group) and pulse consumption was nearly equal to the recommended allowance in the other two groups of males in all the groups. Green leafy vegetables consumption was more in Group A (Field beans) whereas it is less than the recommended allowance in Group B (Cluster beans) and Group C (Cow pea pods).

The consumption of other vegetables was low in all three groups and it did not meet the recommended allowances. though some of the subjects indicated vegetables as fibre rich the results do not indicate excess consumption of other vegetables. The consumption of roots and tubers as more than the recommended allowances in all the groups. Fruit consumption was four times greater than the allowance, in all the three groups. The fruit consumption increased mainly because of plantain consumption. The consumption of fats and oils were within the limit of the recommended allowance in all the three groups. The consumption of fleshy foods and milk consumption were within the recommended allowances in all the three groups. Sugar and jaggery were completely avoided by all the groups.

Food consumption of females

In the case of females the consumption of cereals was only about 1/2 of the recommended allowance. Pulse consumption was high among all the three groups. The consumption of greenleafy vegetables is poor by Group A and B and only 1/2 of the allowance was met by Group C. Other vegetables consumption was higher than recommended allowances in Group B and it did not meet the allowance in Group A and C. Roots and tubers were also consumed in more quantities by all the three groups. Fruits consumption was greater than the allowances in all the three groups, similar to the consumption of males.

The consumption of fats and oil was higher than the recommended allowance in Group A, and B and in C it was little below the allowance. The fleshy foods consumption was low and one of the groups met the Recommended Dietary Allowances. The milk consumption of Group A and B exactly met the allowance whereas it was lower than the allowance in C Group. The subjects in all the groups consumed adequate qualities of milk. Sugar and jaggery was omitted by all the three groups.

2. Mean Daily Nutrient intake of selected diabetics

The mean daily nutrient intake of the subjects along with the Recommended Dietary allowances of ICMR (1984) are

presented in Table XVII the individual values are presented in Appendix VII.

TABLE XVII

MEAN DAILY NUTRIENT INTAKE OF SELECTED DIABETICS

Nutrients	Male				Female			
	A	B	C	RDA	A	B	C	RDA
Calories (kcal)	2044	2085	2036	2860	1672	1822	1489	2200
Proteins (g)	58	58	54	55	45	43	46	45
Fat (g)	53	62	39	15	43	46	33	15
Fibre (g)	6.4	7.4	6.4	-	5.4	6.2	5	-
Carbohydrates(g)	372	327	259	-	259	298	253	-
Calcium	722	709	634	400-500	496	594	1116	400-500
Iron (mg)	36.3	38.9	35.6	24	25.2	26.2	34.1	32
B Casotene(ug)	1846	2009	1224	3000	1487	1471	2219	3000
Thiamine (mg)	1.7	1.7	1.7	1.4	1.1	1.3	1.3	1.1
Riboflavin (mg)	0.9	0.9	1	1.7	3.5	1.2	0.8	1.3
Niacin (mg)	17	17	11.48	19	11.1	11.58	11.1	15
Vitamin C(mg)	69	91	40	40	59	6481	6444	40

Nutrient intake in males

Table XVII reveals that the caloric intake among males in all the three group met 3/4 of the recommended allowance. The nutrient protein was found to be little

higher than the RDA in Group A and B due to increased consumption of pulses, milk and fleshy food, the protein intake of Group C was less due to low intake of pulses in their diet. The fat consumption was high in Group A, B, C due to more intake of oils and fats. The fibre intake of the three groups ranged between 6.4 - 7.4 g/100g. The carbohydrate intake of Group A was more due to more consumption of cereals. The calcium intake was also high than the recommended allowance due to inclusion of greens rich in calcium and milk in their menu. The iron intake was also more than the recommended allowance due to intake of foods rich in iron like greens, and liver. The vitamin A allowance was not met by all the three groups since vitamin A rich food like carrot was omitted by them. The vitamin B namely thiamine allowance was met by all the three groups. The riboflavin and niacin allowances were not met by any of the groups due to poor intake of foods rich in riboflavin and niacin. The consumption of fruits was double in Group A and B and the vitamin A intake was also more.

Nutrient intake in females

The caloric intake among the three groups was only one third of the recommended allowance. The protein intake in Group A and C met the allowance, where as it in Group B

the intake of pulse was less and did not met the allowance. The fat intake was more than the recommended allowance in all the three groups due to intake of more oil. The fibre intake among the three groups ranged between 5 - 6.2g/100g. The three groups met the carbohydrate level due to intake of cereals. The calcium intake was more in Group B and C due to intake of more milk and green leafy vegetables rich in calcium. All the three groups met the allowance of iron due to intake of adequate of more iron rich foods like green leafy vegetables. The vitamin A content was not by any of the groups due to avoidence of roots and tubers. The thiamine allowance was met by the three groups; whereas the other B complex vitamins namely niacin and riboflavin was not met by the groups due to poor intake of other vegetables. The vitamin C content of the groups met the allowance due to intake of fruits daily in their diet and fresh vegetables.

C. Impact of the selected vegetables on the blood glucose levels

1. Glycemic response of diabetics administered field beans

The individual glycemic responses of all the six subjects given field beans were studied at fasting, 1½ hours after breakfast and 2 hours after breakfast and given in Appendix VIII. The individual glood glucose

glucose values registered by the control group is also given in Appendix VIII. The mean blood glucose values were computed and are depicted in Table XVIII and Fig.5.

TABLE XVIII

MEAN GLYCEMIC RESPONSE OF DIABETICS FED FIELD BEANS

	Blood glucose levels(mg/100ml) Mean ± S.D.	Groups compared	't' value
Fasting			
Before supplementation (BS)	135 ± 17.26	BS vs AS	1.336^{NS}
After supplementation (AS)	122 ± 13.41	BS vs C	4.774**
Control (C)	94.5± 80.9	AS vs C	1.248^{NS}
1½ hrs after breakfast			
Before supplementation (BS)	265.16± 28.28	BS vs AS	0.6733^{NS}
After supplementation (AS)	227.83± 27.44	BS vs C	10.36**
Control (C)	121.5 ± 13.11	AS vs C	7.858**
2 hrs after breakfast			
Before supplementation (BS)	223.66± 31.22	BS vs AS	1.097^{NS}
After supplementation (AS)	204.5 ± 23.80	BS vs C	8.428**
Control (C)	103.3 ± 7.5	AS vs C	2.883*

NS - Not significant
* - Significant at 5% level
** - Significant at 1% level

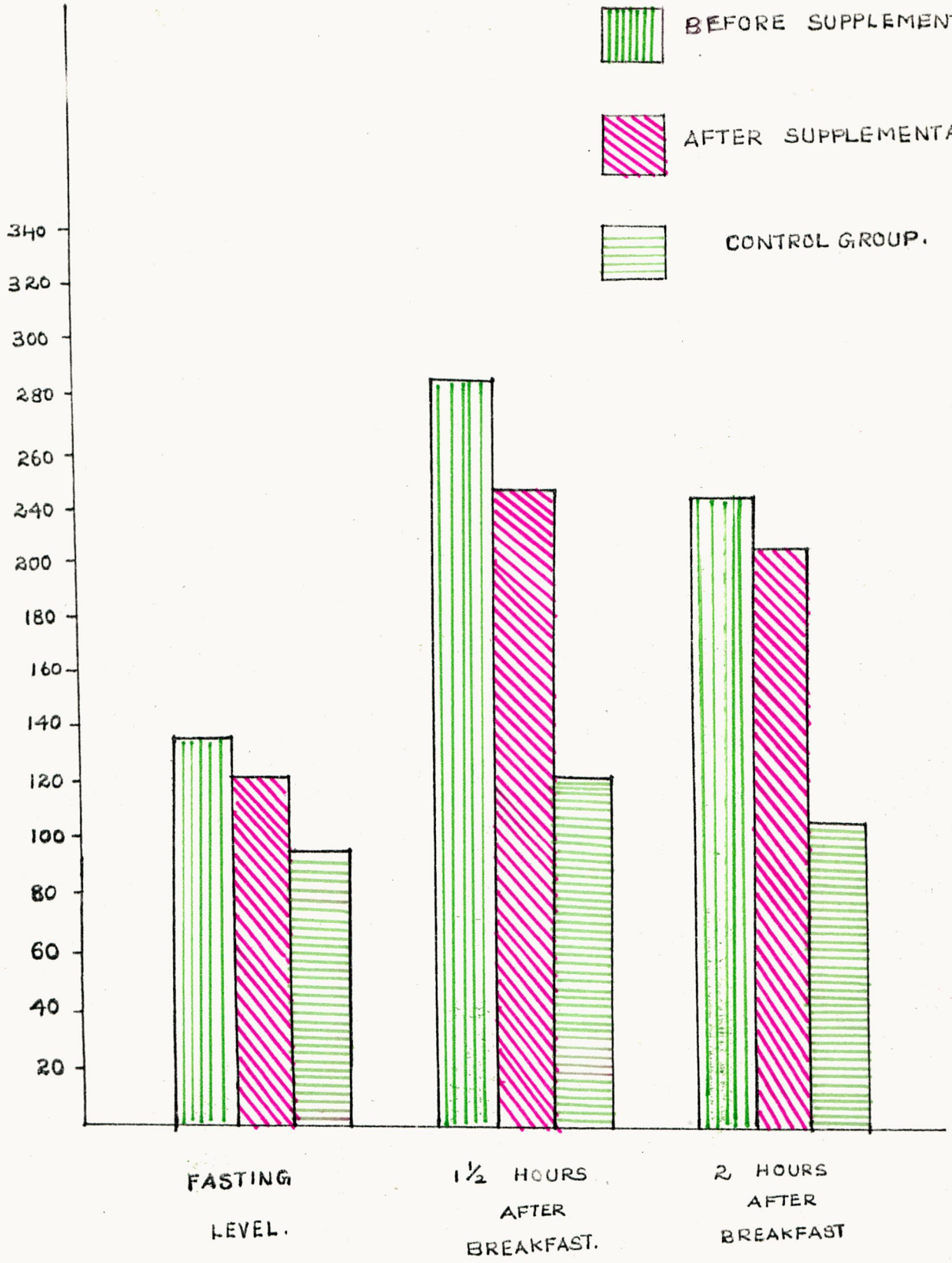

FIGURE - 5 MEAN GLYCEMIC RESPONSE OF DIABETICS FED FIELD BEANS

The analysis of the blood glucose values of the diabetic subjects and the normal control subjects indicated that the values registered by the diabetics were very much higher than the values of the normal subjects.

Analysis of the fasting blood glucose levels before and after feeding field bean showed a reduction after feeding. These values were also compared with the values of the control and the differences in the means were statistically analysed. These results show that the values registered before and after feeding were not significant. But there value registered before feeding when compared with that the control was significant at one per cent level, whereas after feeding the difference was not significant.

The blood glucose values registered 1½ hours and 2 hours after feeding field bean showed similar trends i.e. though values registered after feeding, was lower than the values before feeding, the differences were not significant.

When the values before supplementation (1½ hours and 2 hours after breakfast) were compared with the control values, the difference was highly significant at 1 per cent level. But after supplementation the difference value was low, between the control value and field bean fed group

and it was significant only at 5 per cent level. These results indicate that field bean has produced some impact in lowering blood glucose levels and the beneficial effect of field bean is brought out well.

2. Glycemic response of diabetics administered cluster beans

The individual glycemic responses of all the six subjects given cluster beans were studied at fasting, 1½ hours after breakfast and 2 hours after breakfast and given in Appendix IX. The mean blood glucose values were computed and are depicted in Table XIX and Figure 6.

TABLE XIX

MEAN GLYCEMIC RESPONSE OF DIABETICS FED CLUSTER BEANS

	Bloos glucose levels (mg/100ml) Mean ± S.D.	Groups compared	't' value
Fasting			
Before supplementation (BS)	160.83 ± 27.14	BS vs AS	1.744^{NS}
After supplementation (AS)	130.00 ± 29.01	BS vs C	5.264**
Control supplementation (C)	94.5 ± 8.09	AS vs C	2.649*
1½ hours after breakfast			
Before supplementation (BS)	232.83 ± 21.45	BS vs AS	3.878**
After supplementation (AS)	191.33 ± 10.90	BS vs C	9.957**
Control (C)	121.5 ± 13.11	AS vs C	9.205**
2 hrs after breakfast			
Before supplementation (BS)	213.10 ± 21.02	BS vs AS	0.837^{NS}
After supplementation (AS)	183.83 ± 14.20	BS vs C	11.057**
Control (C)	103.3 ± 7.5	AS vs C	10.986**

NS - Not significant
* - significant at 5% level
** - Significant at 1% level

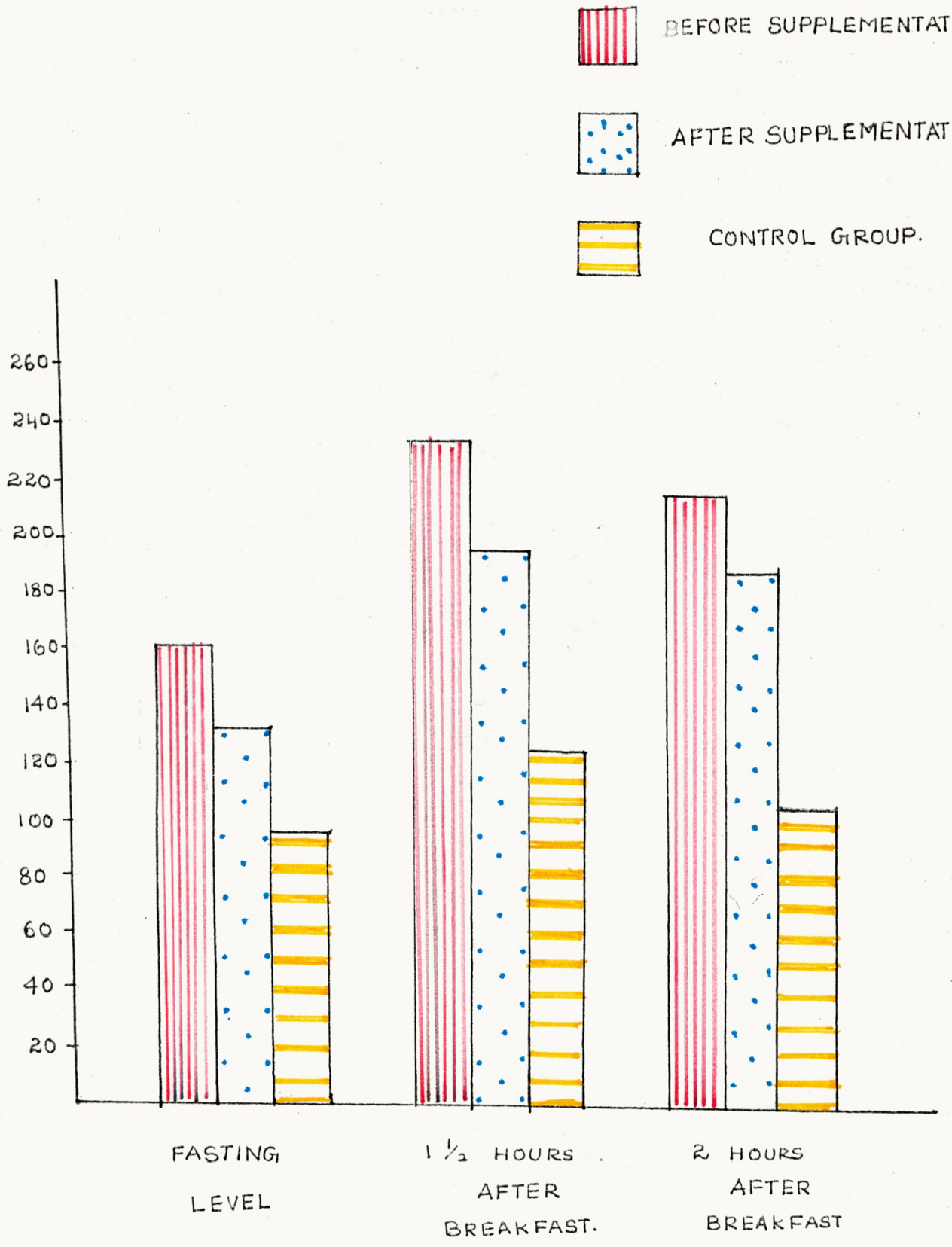

FIGURE-6 MEAN GLYCEMIC RESPONSE OF DIABETICS FED CLUSTER BEANS.

The group fed with cluster beans also showed a similar trend as field beans. The supplementation of cluster beans reduced the blood glucose values after 1½ hours and 2 hours of feeding. But the reduction was not statistically significant. When the values recorded at fasting, 1½ hours and 2 hours after administering cluster beans were compared with that of the respective control values the differences were highly significant at one per cent level. Only the fasting value after supplementation was significant at five per cent level. The results indicate that though administration of cluster beans reduced the blood glucose level it could neither come near the values of the control group nor the reduction was significant.

3. Glycemic response of diabetics administered cow pea pods

The individual glycemic responses of all the six subjects given cow pea pods were studied at fasting, 1½ hours after breakfast and 2 hours after breakfast and given in Appendix X. The mean blood glucose values were computed and are depicted in Table XX and Figure 7.

TABLE XX

MEAN GLYCEMIC RESPONSE OF DIABETICS FED COW PEA PODS

	Blood glucose levels (mg/100ml) Mean ± S.D.	Groups compared	't' value
Fasting			
Before supplementation (BS)	214.66 ± 17.69	BS vs AS	0.704^{NS}
After supplementation (AS)	206.33 ± 19.84	BS vs C	13.891**
Control (C)	94.5 ± 8.09	AS vs C	11.771**
1½ hours after supplementation			
Before supplementation (BS)	298.5 ± 40.47	BS vs AS	0.699^{NS}
After supplementation (AS)	282.00± 34.31	BS vs C	9.335**
Control (C)	121.5 ± 13.11	AS vs C	9.846**
2 hours after supplementation			
Before supplementation (BS)	299.00± 30.60	BS vs AS	1.526^{NS}
After supplementation (AS)	273.66±21.68	BS vs C	13.968**
Control (C)	103.3 ± 7.5	AS vs C	16.701**

NS - Not significant
** - Significant at 1% level

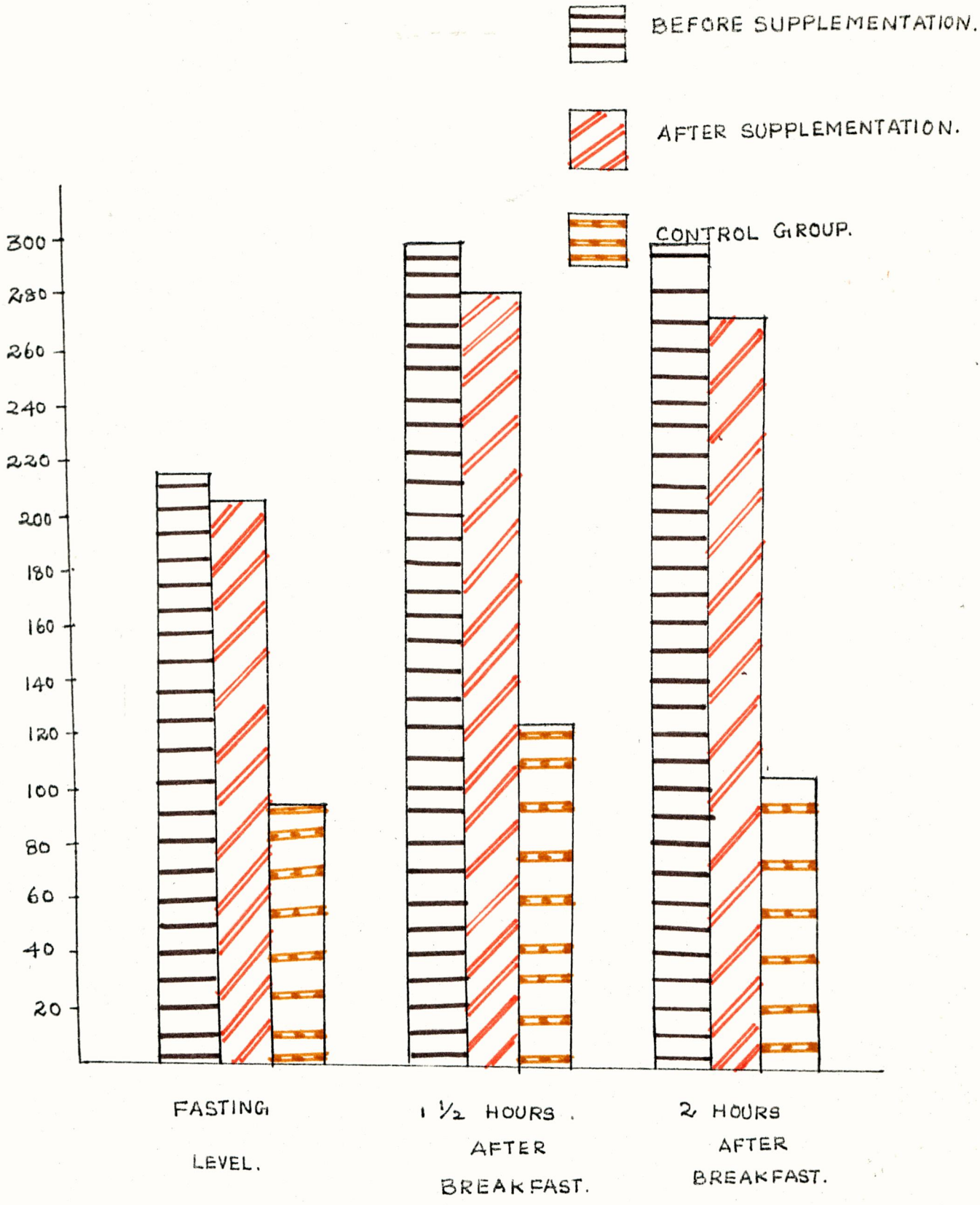

FIGURE - 7 MEAN GLYCEMIC RESPONSE OF DIABETICS FED COW PEA PODS.

Analysis of the blood glucose levels of subjects fed cow pea pods also showed a trend similar to that of cluster beans. Feeding of cow pea pods reduced the blood glucose value, but the reduction was not statistically significant.

But the values before and 1½ and 2 hours after feeding, when compared with the respective control values indicated a highly significant difference.

D. Comparison of the efficiency of the three selected vegetables in reducing blood glucose levels

Table XXI presents the blood glucose values registered by the three groups 1½ hours after administering the vegetables.

The comparitive values of the three selected Vegetables at 1½ and 2 Hours are depicted in Figure 8.

TABLE XXI

BLOOD GLUCOSE VALUES OF THE THREE GROUPS AFTER 1½ HOURS

Group	Blood Glucose Values					
	After 1½ Hrs Mean ± S.D	Groups compared	't' value	Fasting 1½ hrs mean ± S.D	Groups compared	't' value
Group A (Field bean)	227.83 ± 27.44	A Vs B	2.767 *	105.80 ± 24.32	A Vs B	2.674 *
Group B (Cluster bean)	191.33 ± 10.90	A Vs C	2.772 *	63.60 ± 25.83	A Vs C	1.605 NS
Group C (Cow pea pods)	282 ± 34.31	B Vs C	5.666**	75.66 ± 34.47	B Vs C	0.629 NS

NS - Not significant

* - Significant at 5% level

** - Significant at 1% level

SCALE : x axis 1cm = 30 minutes.

y axis 1cm = 20 mg of Glucose/100ml

- - - - - - - - Field bean Group (A)

———— Cluster bean Group (B)

x x x x x x x x Cow pea pod Group (c)

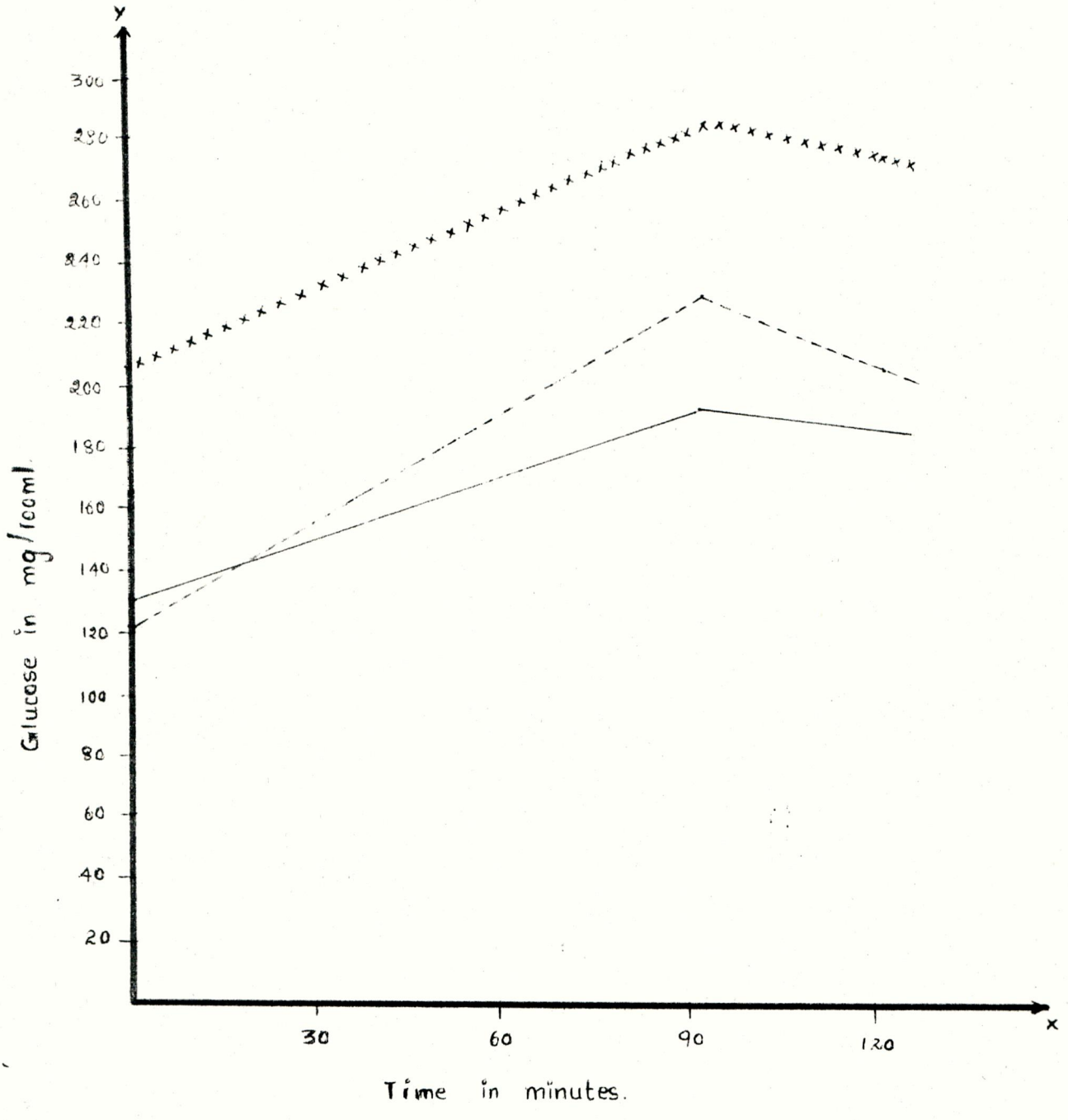

FIGURE - 8 COMPARISON OF THE EFFICIENCY OF THE THREE SELECTED VEGETABLES IN REDUCING BLOOD GLUCOSE LEVELS.

The blood glucose values registered the three groups fed field bean cluster bean and cow pea, after 1½ hours, were compared. The difference between the final values were statistically significant. The differences between field bean group when compared with the other two groups were significant only at five per cent level whereas the difference between the values of Cluster beans and Cow pea pods was significant at one per cent level.

Since the fasting blood glucose values were different for the three groups, the difference between the fasting value and the value registered after 1½ hrs. were calculates, and the significance of difference between these two values were calculated. The results indicated that cluster beans group had the lowest increase in blood sugar (63.69mg/100ml) followed by cow pea pods group (75.7 mg/100ml). The increase in blood sugar values of field bean group was the highest (105.8). The statistical analysis show that the difference between the field bean group and cluster bean group were only significant at five per cent level. The differences between the other groups were not significant.

These results show that Cluster bean is more efficient among the three vegetables and controlling the blood glucose level.

Table XXII presents the blood glucose levels registered by the three groups at 2 hrs after administering the vegetables.

TABLE XXII

BLOOD GLUCOSE VALUES OF THE THREE GROUPS AFTER TWO HOURS

Group	Blood Glucose Values					
	After 2 hrs mean ± S.D	Groups compared	't' value	Fasting 2 hrs mean ± S.D	Groups compared	't' value
Group A (Field bean)	204.5 ± 23.80	A Vs B	1.676NS	82.83 ± 31.70	A Vs B	1.351 NS
Group B (Cluster bean)	183.83 ± 14.20	A Vs C	4.829**	60.5 ± 19.3	A Vs C	0.826 NS
Group C (Cow pea pods)	273.66 ± 21.68	B Vs C	7.790**	67.3 ± 27.932	B Vs C	0.450 NS

NS - Not Significant

** - Significant at 5% level

The blood glucose values registered for the three groups fed field beans, Cluster beans and cow pea pods after two hours were compared. The difference between the final values were statistically analysed. The group fed cow pea pods had registered nigher blood glucose value was highly significant (P 0.01) when compared with field beans and cluster beans. The difference between the group fed field beans and cluster beans was not significant.

The difference between the fasting value and the values registered after 2 hrs were calculated and the values were statistically analysed. The results indicated that cluster beans group had the lowest increase in blood sugar (60.5 mg/ 100 ml) followed by cow pea pods (67.3 mg/100ml). The increase was the highest (82.83 mg/100ml) in the field bean group. The statistical analysis showed that difference was not significant among any of the two groups.

The results of the study indicate that cluster beans group has registered lower blood glucose levels than the other two groups. Hence, cluster beans could be considered as the efficient vegetables in controlling blood glucose levels. Cluster bean pods contain 20% guar gum (Indigestible polysaccharide) which could have been the factor responsible in reducing the blood glucose values.

Summary and Conclusion

V SUMMARY AND CONCLUSION

The present study on "Glycemic Response of selected vegetables in Non-Insulin Dependent Diabetics" was under taken with the following objectives:

> Selection of three vegetables which have high fibre. Identification of Non-Insulin dependent diabetic subjects. Formulation of a suitable recipe with the selected vegetables. Administration of the selected vegetables preparations to the diabetics. Study the glycemic response of the subjects before and after administration of the selected vegetable and compare the blood glucose lowering capacity of the three vegetables.

A total number of 50 diabetics were selected from three hospitals in Coimbatore city. The background information and dietary habits of these 50 selected subjects were studied using an interview schedule sub-sample of 18 subjects were selected. There were 9 males and 9 females within the age range of 40 to 50 years. These subjects were grouped into three groups of six in each group (three males and three females).

After a through survey of the fibre content of the vegetables, three vegetables namely field beans (Dolihos Lab-Lab), cluster beans (Cyamopsis tetragonoloba), Cowpeapods (Vigna catjang) were selected for testing their glycemic response. Vegetables were selected based on their availability, cost and high fibre content. About 100g of field beans and cowpeapods and 75g of cluster beans were prepared

into poriyal using standarised recipe. The three groups were given an iso-caloric breakfast along the selected vegetables. Their whole days energy intake was made approximately iso-caloric by controlling their other meals of the day during the experimental period of 15 days.

The blood glucose values were estimated before and after feeding the test vegetables. For the experiment group. A group of six normal subjects in the same age range were selected as controls. Their blood glucose levels were estimated by conducting glucose tolerance test (GTT).

The results obtained were statistically analysed and discussed.

The key findings of the study are as follows:-

1. The incidence of diabetes was high among in all the age groups.

2. The subjects were equally distributed in all income groups (32% : 32% and 36%) though high income had a small majority of 36%.

3. Eight per cent were illiterate, and till the rest had education upto different levels. High school educated subjects were maximum (36%).

4. 58% of the families had 4 - 6 members and 32% had

1-3 members. Only 10% had more than 7 members.

5. 76% of the subjects were doing moderate activity 20% sedentary and only 4% did heavy activity.

6. For about 74% either father, mother or both father and mother were diabetics.

7. 60% of the subjects were either over weight or obese and 40% had diabetes for more than 3 years.

8. All the subjects selected were either mild or moderate diabetics. No one had severe diabetes (i.e., blood glucose level above 350 mg/100dl).

9. Wheat, bitter gourd, ragi, fenugreek and greens were specially included by the subjects. Roots and tubers, specially potatoes, ghee, sweets and fruits were avoided.

10. 42% of the subjects were aware of crude fibre and they mentioned planrtain stem, beans, peas, pulses and told bean as fibre rich.

11. The weighment survey indicated that pulse, roots and tubers, fruits, milk and oil consumption was higher than the recommended allowance in all the 3 groups (males and females) wheares the cereal, Green leafy vegetables other vegetables and fleshy foods did not meet the allowance and sugar and jaggery were completely avoided.

12. Protein, fat, calcium and iron intakes were more than the recommended allowance but other nutrient consumption were below recommended allowances.

13. The groups fed field beans, cluster beans and cowpeapuds showed a reduction in the blood glucose values after the 15 days supplementation period. But when compared to normal control values, the blood glucose values registered by the diabetic subjects were significantly higher both after 1½ and 2 hours of feeding.

14. When the efficacy of the three vegetables were compared, cluster beans group had registered a significantly lower blood glucose value than the other two groups, followed by cowpeapod group and the field beans groups of the three selected vegetables field beans was least efficient in reducing the blood glucose values.

The results of the study indicated that cluster beans was the most efficient vegetables among the three selected vegetables. Inclusion of cluster beans in the diet of the diabetics could help a great deal and maintaining the blood sugar level within normal limits. The other two vegetables namely field beans and cowpeapods also had beneficial effects on blood glucose levels.

It is recommended that further studies could be undertaken not only to find out the glucose response of different foods but also to compute the glycemic index of various foods which would be most useful for the growth is dietetics and helpful for the growing number of diabetics.

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Appendix

APPENDIX I

INTERVIEW SCHEDULE TO ELICIT INFORMATION REGARDING THE DIABETIC PATIENT

1. Name of the investigator ..

   Name of interviewee

   Age ..

   Sex ..

   Address ..

   Family size ..

   Marital status ..

   Weight in kgs ..

   Height in cms ..

   Occupation ..

   Income per month ..

   Income of the family ..

2. Educational status:

   a. Illiterate

   b. Primary school (upto 5th std)

   c. Middle school (upto 7th std)

   d. High school (upto 10th std)

   e. College/Graduated/Post-Graduated

   f. Diploma holders

3. How many years have you been a diabetic?

   Recently ..

   Past 1½ years ..

   1½-3 years ..

4. History of diabetes in your family?

Grand father	..
Grand mother	..
Father	..
Mothers	..
Others (specify)	..

5. Are you taking

Insulin	..	Yes/No
Oral hypo glycemic drugs		Yes/No
Neither of above	..	Yes/No

6. Have you undergone any other form of medical treatment?

Homeopathic	..
Ayurvedic	..
Naturopathic	..
Others (specify)	..

7. Do you do any exercise? .. Yes/No

If yes, how often?

.. Daily/weekly once/
weekly twice

If so, what type of excercise?

Walking	..
Jogging	..
Cycling	..
Yoga	..
Others	..

8. Have you under gone a glucose tolerance test?

Yes/No

If yes, what is your blood glucose level?

Fasting level/½ hour/1 hour/1½ hours/2 hours

9. (a) Is there any foods, you include specifically to bring down your blood sugar level?

(b) Is there any foods, you avoid specifically to bring down your blood sugar level down?

10. Is meal planning done in advance?

Yes/No

11. Indicate your normal meal pattern (24 recall)

Breakfast Lunch

Tea Dinner

12. Number of meals/day:

13. Is food specifically prepared for you (or) as a part of the food prepared for the family:

14. (a) What is likely to happen when you post-pone eating in the usual time

(b) Has this happened to you any time

15. Do you take

	Never	Occasionally	Regularly
a. alcoholic beverages			
b. Tobacco chewing			
c. Smoking			

16. Do you have a knowledge of dietary fibre?

Yes/No

If yes give any 2 foods rich in dietary fibre?

APPENDIX II

WEIGHMENT SURVEY FORM

Name of the investigator : Door No :

Name of the Head of the family : Address :

Name of the subject Age :

Name of the meal	Menu	Weight of the raw Ingredients used by the family (g)	Weight of the total cooked food consumed by the family (g)	Amount of cooked food consumed by the Individual (g)	Raw equivalents consumed by the Individual (g)
BREAK-FAST:					
MID-MORNING:					
LUNCH:					
TEA:					
DINNER:					
BED-TIME:					

APPENDIX III

THE STANDARDISED RECIPE FOR THE SELECTED VEGETABLES

1. Field bean poriyal - A

Ingredients	Quantity in gms
Field beans	100
Onion	25
Oil	little (2-3g)
Mustard	a few for seasoning
Salt and chillipowder	to taste

Method:

1. Cut the vegetables into medium size pieces
2. Chop the onions
3. Heat oil in the frying pan, when heated up add mustard onion, salt and chillipowder.
4. Fry the onion till light brown in colour.
5. Add 1½ cups of water, when it boils add the vegetable and cook.
6. When the vegetable is cooked remove from fire and serve hot.

2. Cluster bean Poriyal - B

Ingredients	Quantity in gms
Cluster beans	75
Onion	25
Oil	little (2-3g)
Bengal gram dhal	5
Mustard	few for seasoning
salt and chillipower to taste	

Method:

1. Cut the vegetables into medium size pieces.
2. Chop the onions
3. Heat oil in the frying pan, when heated up add mustard, Bengal gram dhal, onion, salt and chilli powder.
4. Fry the onions till it becomes light brown in colour
5. Add 1¼ cups of water, when it boils add the vegetable and cook.
6. When it becomes soft remove from fire and serve.

3. Cowpea pods poriyal - C

Ingredients	Quantity in gms
Cow pea pods	100
Onion	25
Oil	little (2-3g)
Mustard	few for seasoning
salt and chillipowder	to taste

Method:

1. Cut the vegetables into medium size pieces.
2. Chop the Onions
3. Heat oil in the frying pan, when heated up add mustard, Onion, salt and chillipowder.
4. Fry the Onions till it becomes light brown in colour
5. Add 1½ cups of water, when it boils add the vegetable and cook.
6. When it becomes soft remove from fire and serve.

APPENDIX IV

ESTIMATION OF BLOOD GLUCOSE LEVEL - GLUCOSE OXIDASE PEROXIDASE METHOD

PRINCIPLE:

Glucose is oxidised by Glucose oxidase (GOD) to give gluconic acid and hydrogen peroxide. The hydrogen peroxide formed is broken down by peroxidase (POD) to water and oxygen. The latter oxidises phenol which combined with 4 amino phenazone to give a red coloured complex. The intensity of the red coloured complex is proportional to the concentration of glucose in the specimen under test. The intensity of the coloured complex is measured colorimetrically at 515nm (500-530nm).

REAGENTS:

1. Glucozyme - REAGENT (1) (Enzyme - Chromogen tablets)
2. Glucozyme - REAGENT (II) (Phenol solution)
3. Glucozyme standard 100mg /dl.

Glucozyme working reagent is prepared by dissolving of reagent in 49ml distilled water to which 1 ml of reagent II (Phenol solution is added to make final volume 50 ml).

APPARTUS:

1. Photo electric colorimetric with filters in the range 500nm to 530 nm.
2. Water bath (37^{o}c)
3. Centrifuge

4. Stop Watch

5. Pipettes 1 ml and 5 ml

6. Test tubes

7. Micropipettes 25 ul and 250 ul

SPECIMEN COLLECTION:

Serum, plasma (or) whole blood is used for the testing procedure.

SERUM:

1. Collect Venous blood into a clean dry test tube without antioagulant and allow it to clot.

2. Loosen the clot with a rod and centrifuge

3. Transfer serum into a clean and use for the test

NOTE:

Serum is seperated from the clot within 30 minutes after collection. Delay in seperation of serum from the clot would result glycolysis and low glucose values.

PLASMA, WHOLE BLOOD:

1. Collect venous blood into a clean dry test tube or bulbs containing dried sodium flouride.

2. Mix repeated inversions.

3. Centrifuge to seperate the plasma

4. Transfer plasma into a clean and dry test tube and use for the test.

USE OF A STANDARD AND/OR A CALIBRATION CURVE:

Glucose concentration in test samples may be calculated either from the optical density reading of a standard

which is run along with the test or from a calibration curve.

TESTING PROCEDURE WITHOUT DEPROTEINATION:

The method required a 1 to 10 dulition of test samples and standard (100mg/dl) 10.1 ml of serum or plasma or standard 0.9 ml of distilled water.

Pipette into three tubes labelled Test, Standard and Blank.

	TEST(T)	STANDARD(S)	BLANK(B)
Glucozyme working standard	5.0ml	5.0ml	5.0ml
Serum or plasma (diluted 1 to 10)	0.25ml	-	-
Standard diluted (1 to 10)	-	0.25ml	-
Distilled water	-	-	0.25ml

Mix the contents of the test tubes thoroughly and place them in a water bath at 37°c for 15 minutes or at room temperature (25°c ±5°c) for 30 minutes.

Measure the optical density (O.D) of the standard against blank at 515nm (range 500 to 530nm). The final colour complex is stable for more than two hours at room temperature (25°c ± 5°c)

CALCULATIONS:

$$\frac{\text{O.D (T)}}{\text{O.D (S)}} \times 100 = \text{Glucose concentration (mg/dl)}$$

NORMAL EXPECTED VALUES:

Whole blood 60 - 100 mg/dl

Serum or plasma 70 - 110 mg/dl

APPENDIX V

STANDARD WEIGHT FOR HEIGHT TABLES LIC (1983)

Weight in Kgs

Height in cms	Men	women
152	52.3 - 54.8	50.8 - 54.4
155	53.6 - 57.5	51.7 - 55.3
157	56.3 - 60.3	53.1 - 56.7
160	57.6 - 61.7	54.1 - 59.1
162	58.9 - 63.5	56.2 - 59.9
165	60.8 - 65.8	57.6 - 61.2
168	62.2 - 66.7	58.9 - 63.5
170	64.0 - 68.5	60.8 - 65.3
173	65.8 - 70.8	62.2 - 66.7
175	67.6 - 72.6	64.0 - 68.5
178	69.4 - 74.4	65.8 - 70.3
180	71.2 - 76.2	67.1 - 71.7
183	73.6 - 78.5	68.5 - 73.9
185	75.3 - 80.7	-
188	77.6 - 83.5	-
190	79.8 - 85.7	-

APPENDIX VIII

INDIVIDUAL BLOOD GLUCOSE VALUES OF SUBJECTS IN THE FIELD BEAN GROUP

Group	Before supplementation	After supplementation
Group A (Field beans)		
Fasting:	130	120
	135	120
	120	110
	123	110
	130	122
	172	150
1½ hrs after breakfast	240	195
	270	260
	240	240
	250	210
	230	200
	291	262
2 hrs after break fast	200	170
	210	220
	280	230
	202	194
	252	231
	198	182
Control		
Fasting	85	
	110	
	95	
	98	
	89	
	90	

1½ hrs after breakfast	118
	150
	116
	120
	110
	115
2 hrs after breakfast	108
	112
	100
	110
	90
	100

APPENDIX IX

INDIVIDUAL BLOOD GLUCOSE VALUES OF SUBJECTS IN THE CLUSTER BEAN GROUP

Group	Before supplementation	After supplementation
Group B (Cluster bean)	160	120
	120	120
	205	190
	160	130
	140	125
	180	95
1½ hrs after break fast	230	200
	260	185
	200	183
	227	205
	220	200
	260	175
2 hrs after break fast	200	175
	252	195
	192	170
	205	198
	200	200
	230	165

APPENDIX X

INDIVIDUAL BLOOD GLUCOSE VALUES OF THE SUBJECTS IN THE COWPEAPOD

Group	Before supplementation	After supplementation
Group C (Cow pea pods)	240	235
	207	205
	205	200
	230	225
	220	200
	186	173
1½ hrs after break fast	340	320
	257	253
	320	299
	330	300
	230	220
	314	300
2 hrs after break fast	340	300
	240	230
	290	277
	315	270
	310	278
	299	287

APPENDIX VI

INDIVIDUAL FOOD CONSUMPTION OF THE SUBJECTS IN THE THREE GROUPS

Groups	cereals (g)	pulses (g)	Green leafy Vegetables (g)	Other vegeta-bles (g)	Roots and Tubers (g)	Fruits (g)	Milk and Products (g)	Fats and oils (g)	Fleshy foods (g)	Sugar and jaggery (g)
Group - A (Field beans)										
Males:										
	367	66	38	17	50	208	183	28	17	-
	358	55	42	83	25	63	208	23	50	-
	313	70	25	42	42	117	158	28	17	-
Females:	242	48	37	17	27	143	133	23	17	-
	200	58	68	40	100	140	157	25	25	-
	267	55	17	28	45	140	142	30	17	-
Group - B (cluster beans)										
Males:	366	63	20	50	110	220	220	40	33	-
	308	80	25	58	100	183	183	30	17	-
	314	56	24	69	83	179	189	31	22	-
Females:	237	48	28	57	58	142	150	25	17	-
	217	44	38	42	67	108	142	25	25	-
	250	60	37	102	75	117	142	30	-	-
Group - C (Cowpeapods)										
Males:	283	80	25	78	50	108	158	27	33	-
	275	38	11	30	62	158	208	27	50	-
	333	30	-	53	67	77	208	28	33	-
Females:	285	47	40	25	67	137	150	25	-	-
	257	73	62	50	48	58	100	22	17	-
	208	73	60	42	50	67	217	15	17	-

APPENDIX VII

INDIVIDUAL NUTRIENT CONSUMPTION OF THE SELECTED SUBJECTS

Groups	Energy (Kcal)	Protein (g)	Fat (g)	Fibre (g)	Carbo-hydrate (g)	Calcium (mg)	Iron (mg)	β carotene (mg)	Thia-mine (mg)	Ribo-flavin (mg)	Niacin (mg)	Vita-min (mg)
Group - A (Field beans)												
Males:	2241	59.1	58.9	8.2	369	931	43	1203	2.3	0.9	17.2	113
	1996	62.7	56.8	5.8	348	641	33.8	2276	1.4	0.9	18	58
	1895	51.5	45.8	5.2	325	595	32.2	2055	1.5	0.7	14.2	35
Females:	1538	58.9	37.6	7.3	268	538	28.8	841	1.01	1.6	12.2	22
	1813	45.9	48.2	5.5	244	415	23.5	1999	1.05	2.8	9.5	94
	1664	42.14	43.2	3.3	264	533	23.2	2166	1.1	0.7	11.4	59
Group-B (Cluster beans)												
Males:	80.2	80.2	79.8	8.8	349	861	34.9	1698	1.9	1.1	20.2	69
	59.6	59.6	62.8	9.4	334	531	52.1	3004	1.5	0.9	16	105
	42.2	42.2	42.3	5.7	298	735	29.9	1918	1.5	0.9	15.1	100
Females:	1555	39.9	46.5	7.6	238	468	24	1442	1.6	1.2	13	75
	1572	43.2	42.3	6.0	262	1045	25.2	1740	1.3	0.6	11.2	84
	1734	46.7	50.2	5.2	284	637	29.3	1231	1.1	1.5	11.2	84
Group C (Cowpeapods)												
Males:	2176	56.3	57.5	6.8	262	551	37.3	1469	1.6	0.9	15.3	47
	1672	55.0	51.2	5.3	197	609	21.9	1729	1.2	1.3	11.0	49
	1837	50.1	48.7	5.8	315	479	31.4	585	1.6	0.7	8.1	24
Females:	1578	42.7	33.3	4.6	266	502	26.9	756	1.1	0.9	11.5	51
	1554	45.1	32.4	5.5	265	2269	28.8	2986	1.4	0.6	10.6	80
	1334	48.6	31.9	4.8	225	574	29.6	2917	1.4	0.7	11.1	63