Results and Discussion

IV RESULTS AND DISCUSSION

The data obtained in the present research entitled, **"Development and Promotion of Low Glycemic Foods among Employees of Tamil Nadu State Transport Corporation, Coimbatore Division",** were tabulated and discussed under the following headings:

Phase I : Assessment of prevalence of diabetes mellitus among employees of Tamil Nadu State Transport Corporation, Coimbatore Division.

A. Background information of the diabetics

B. Facts and features of the disease in the diabetics

C. Life style pattern of the diabetics

D. Health and nutritional status of the diabetics

1. Dietary pattern of diabetics
2. Anthropometric indices
3. Biochemical profile

Phase II : Development of low glycemic recipes incorporating sprouted legume powders and evaluation of glycemic index.

A. Standardisation of recipes incorporated with sprouted legume powders

B. Nutritive value of standardized recipes

C. Evaluation of glycemic index of the standardized recipes

Phase III: Imparting diet and therapeutic lifestyle counselling and promoting low glycemic recipes among the diabetics of Tamil Nadu State Transport Corporation, Coimbatore Division.

A. Impact of counseling

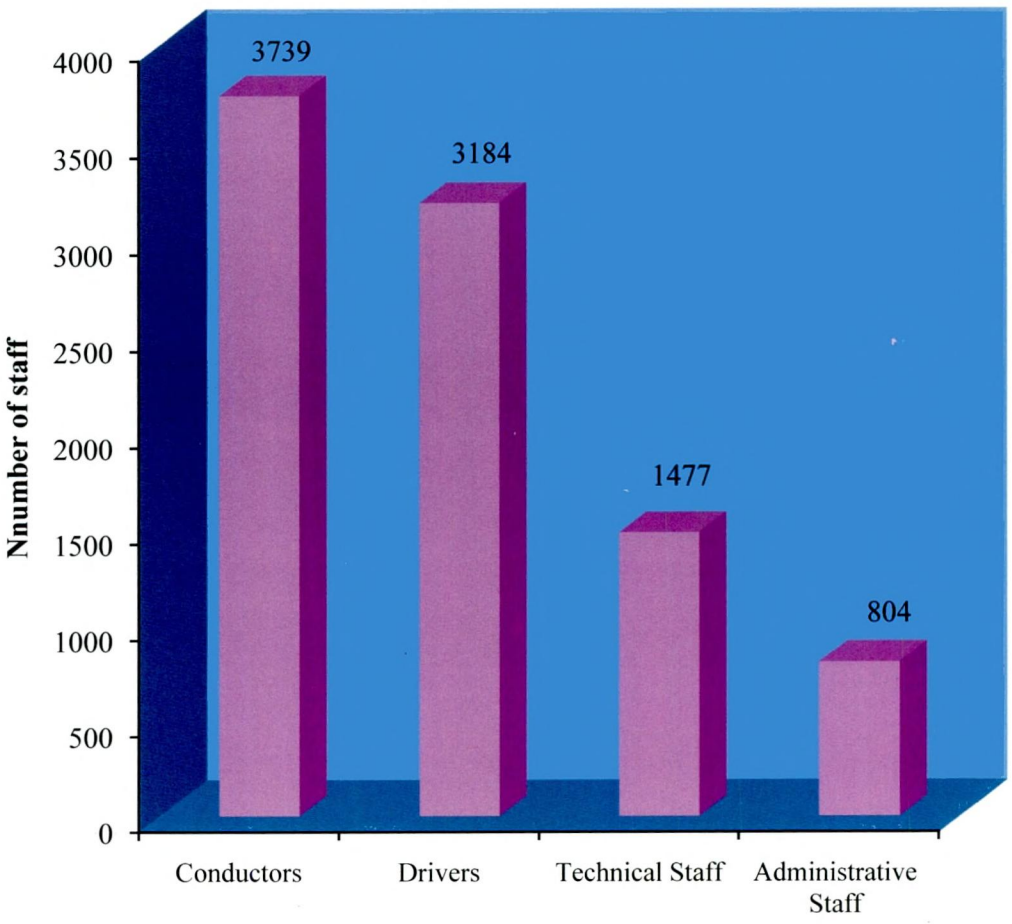
Phase I : Assessment of prevalence of diabetes mellitus among employees of Tamil Nadu State Transport Corporation, Coimbatore Division

A. BACKGROUND INFORMATION OF THE DIABETICS

1. Prevalence of diabetes

The blood glucose level of all the 9204 employees were analysed and the results indicated that totally 463 were diabetics. Figure 3 depicts the total number of subjects included in the study.

Table III portrays the distribution of diabetics according to age and type of diabetes.



TOTAL NUMBER OF STAFF IN THE TRANSPORT CORPORATION

FIGURE 3

TABLE III

DISTRIBUTION OF THE DIABETICS ACCORDING TO AGE AND TYPE OF DIABETES MELLITUS

N = 463

Age in years	Type I (N = 64)								Total		Type II (N = 399)								Total	
	Conductors		Drivers		Technical staff		Adminis-trative staff				Conductors		Drivers		Technical staff		Adminis-trative staff			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
28-38	-	-	-	-	-	-	2	4	2	4	-	-	-	-	-	-	2	1	2	1
38-48	12	19	9	14	1	2	9	14	31	48	58	15	64	16	37	9	27	7	186	47
48-58	8	13	8	12	7	11	8	12	31	48	72	18	59	15	38	10	42	11	211	52

From Table III, it is evident that prevalence of diabetes mellitus was 5.03 percent among the transport corporation staff. Out of the 463 diabetics 86 per cent were Type II diabetics and 14 percent suffered from Type I diabetes.

In the case of Type II diabetics majority (52%) belonged to 48 to 58 year age group followed by 38 to 48 year age group (47%). It is evident from the present data that the prevalence of diabetes mellitus was very high after the age of 40. From the results of the present study 48 to 58 year age group could be considered as the critical age around which incidence of diabetes had increased. Type I diabetics in the age bracket of 38 to 58 years had the condition when they were younger, but during the period of study they were found to be in this age group. Out of the 463 diabetics, four were below 38 years of age comprising two each from Type I and Type II diabetes. Rest of the Type I diabetics were equally distributed among 38 to 48 years and 48 to 58 years age group. The median age of Type I diabetics was 48 and Type II diabetics was 49 according to the study. Epidemiological studies in India have revealed that the incidence of diabetes is on the increase particularly during 40 to 49 years (American Diabetic Association, 2005). National urban diabetes survey in India showed that more than 50 percent of diabetes had onset below the age of 50 years (Vijay and Ramachandran, 2005), which is in support of the present results.

According to www.diabetic.india.com the prevalence of Type I diabetes mellitus was 10 percent of the diabetics and Type II diabetes mellitus was the most common type accounting for about 90 percent of all cases of diabetes in the year 2000. All the Type I diabetics of the present study took insulin injections to control blood glucose level while Type II diabetics used oral hypoglycemic drugs. Irregular diet control and lack of proper exercise were observed. Lack of knowledge and ignorance about diabetes management were found to be the cause for the insulin resistance and is the gateway for the diabetic disorders.

2. Educational status

Table IV and Figure 4 presents the details on the educational status of the diabetics.

TABLE IV

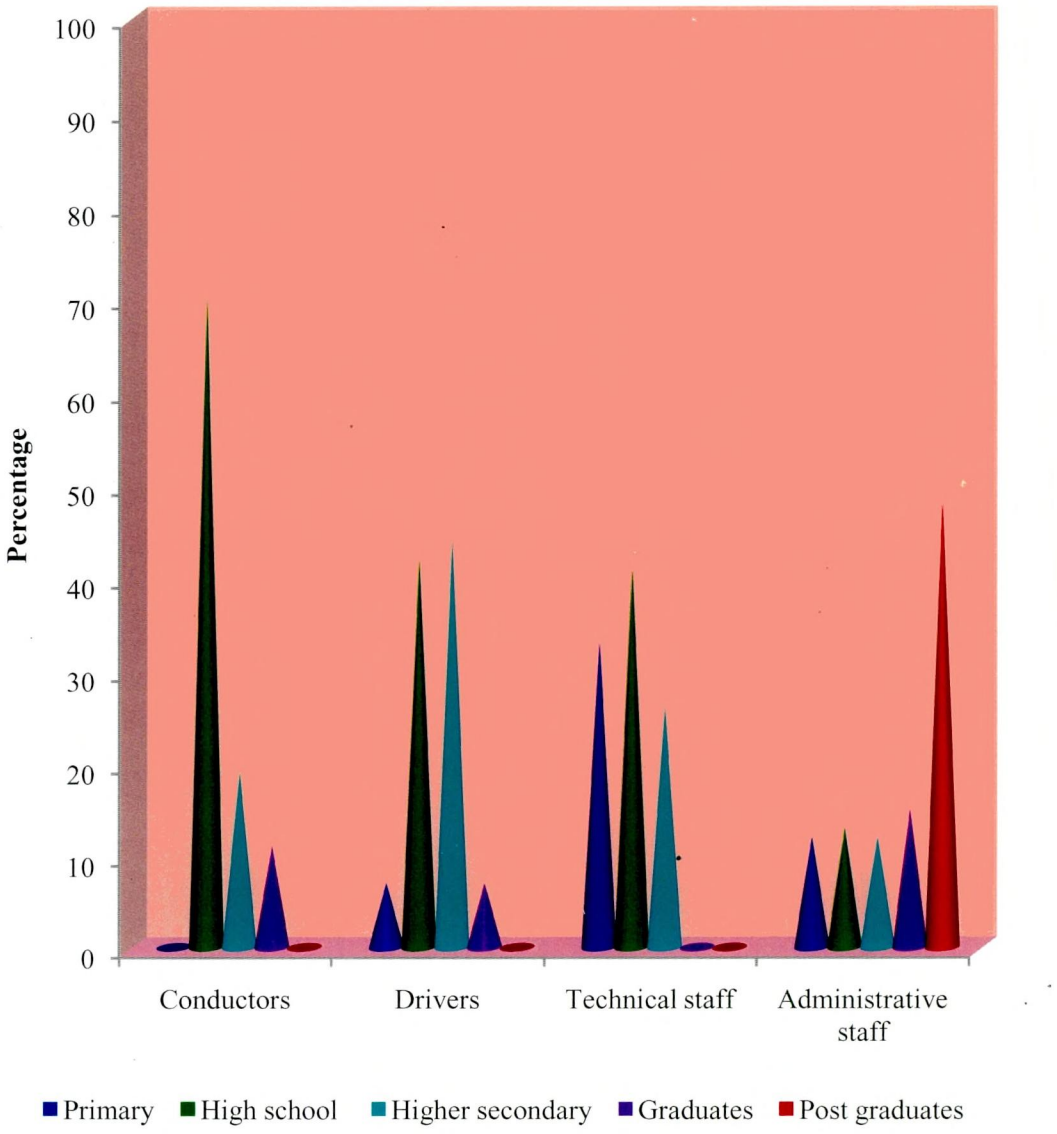
EDUCATIONAL STATUS OF THE DIABETICS

Educational status	Conductors N=150		Drivers N=140		Technical Staff N=83		Administrative Staff N=90	
	N	%	N	%	N	%	N	%
Primary	Nil	Nil	10	7	27	33	11	12
High school	105	70	60	42	34	41	12	13
Higher Secondary	28	19	62	44	22	26	11	12
Graduates	17	11	8	7	Nil	Nil	13	15
Post Graduates	Nil	Nil	Nil	Nil	Nil	Nil	43	48

It is interesting to note from Table IV that all the diabetics were literates and there was no illiteracy among these diabetics. It was also evident that all the conductors had completed high school education. This is because of the fact that high school education is compulsory for the post of conductors as this job involves issuing tickets and calculating the ticket amount for large groups of people. But no one was a post graduate in this category.

In the case of drivers seven percent had primary school education and no one was a post graduate. The educational level of technical staff indicated that they had education only up to higher secondary level. None of the technical staff were a graduate or a post graduate. Technical staff category involves manual activities like repairing the vehicle, servicing, replacing tyres, tinkering and painting. The educational level of technical staff was less compared to other categories.

Administrative category included top level executives as well as staff working as peon and attenders. The educational level of this category ranged from primary school to college education. Only the executive category had post graduates.



EDUCATIONAL STATUS OF THE DIABETICS

FIGURE 4

3. Income of diabetics

Table V and Figure 5 below chronicles the data on the income earned by the transport employees.

TABLE V

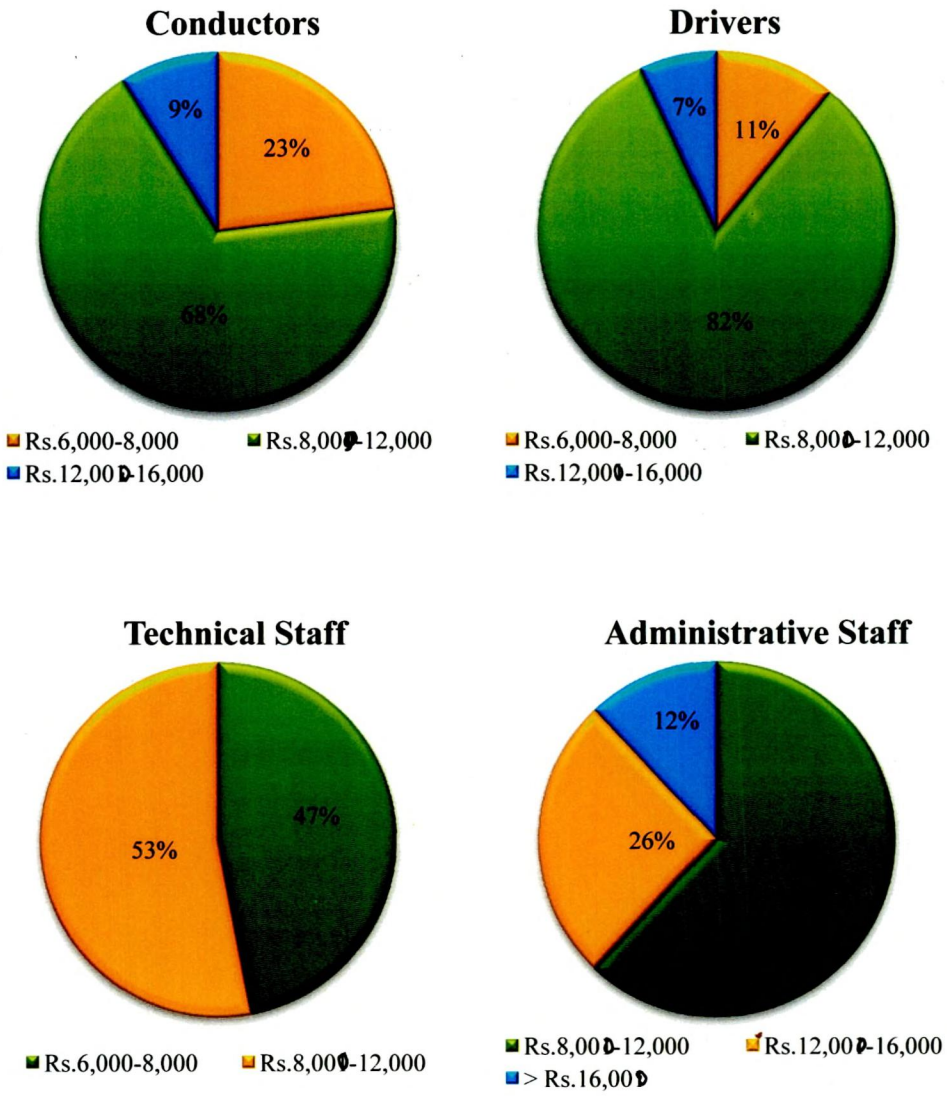
INCOME LEVEL OF DIABETICS

Income (Rs.)	Conductors N = 150		Drivers N = 140		Technical Staff N = 83		Administrative Staff N = 90	
	N	%	N	%	N	%	N	%
6,000 – 8,000	34	23	16	11	39	47	Nil	Nil
8,000 – 12,000	102	68	114	82	44	53	56	62
12,000 – 16,000	14	9	10	7	Nil	Nil	23	26
> 16,000	Nil	Nil	Nil	Nil	Nil	Nil	11	12

It is evident from Table V that the income status of the diabetics positively correlated with the educational status. Income level was found to be directly proportional to the level of education.

Transport corporation has fixed scale of pays for each category of employees and it can be noted that the minimum salary of the employees was above Rs.6,000 and the income increased according to the years of experience. Majority of drivers and conductors (82% and 68% respectively) earned an income of Rs.8,000 to Rs.12,000 per month. Forty seven percent of technical staff earned less than Rs.8,000 per month and none of them had more than Rs.12,000 per month.

Administrative staff who were in the higher cadre and who also had higher education had earned more than Rs.16,000 per month. In general it was evident that transport corporation employees were well paid.



INCOME LEVEL OF DIABETICS

FIGURE 5

When compared with the national average salary of workers with equivalent qualification it was found that the salary of the subjects of the present study were higher. Except the administrative staff the other transport workers had an income below Rs.8,000 (i.e.) 23 percent of conductors, 11 percent of drivers and 47 percent of technical staff.

Based on the years of service the scale of pay changes accordingly. For the employees salary is fixed and hence the income level for the selected diabetics was varying among the similar category.

B. FACTS AND FEATURES OF THE DISEASE

1. Pattern of inheritance

Table VI portrays the data on the pattern of inheritance or family history of diabetes mellitus.

TABLE VI

FAMILY HISTORY OF SELECTED DIABETICS

Family history	Conductors N=150		Drivers N=140		Technical Staff N=83		Administrative Staff N=90	
	N	%	N	%	N	%	N	%
No family history	62	41	62	44	31	37	42	47
Presence of family history	88	59	78	56	52	63	48	53
Father	51	34	59	42	24	29	38	42
Mother	62	42	55	39	28	34	30	33
Both Father and Mother	23	15	20	14	11	13	16	17
Maternal grandfather	10	7	9	6	7	8	5	6
Maternal grandmother	13	9	10	7	20	24	5	6
Paternal grandfather	16	11	14	10	8	10	9	10
Paternal grandmother	4	3	14	10	Nil	Nil	9	10

From Table VI it is obvious that 37 to 47 percent of diabetics in different categories did not have a family history of diabetes mellitus. In the rest of the diabetics (53-63 percent) there was a family history of diabetes mellitus. Influence of genetic factor was greater when either father or mother or both parents had diabetes mellitus. Twenty nine percent of the technical staff, 42 percent drivers and 42 percent administrative staff had either their father or mother diabetic. Only six to 24 percent of diabetics indicated that their maternal grandfather or grandmother had the disease. The inheritance was very low from paternal grandparents.

Neelam and Elizabeth (2005) have indicated that non insulin dependent diabetes has a genetic predisposition and the chances of developing diabetes if someone in the family has diabetes is 20 percent, if one parent has diabetes is 40 percent, if one parent has diabetes and the other parent is from a diabetic family 70 percent, and if both parents are diabetics – 90 percent. Ramachandran (2004) has also reported that one of the predisposing factors of diabetes is heredity.

2. Symptoms observed during the onset of diabetes mellitus

The selected diabetics had experienced the classical symptoms of uncontrolled diabetes mellitus, during the onset of disease. Polyphagia, polyuria,polydypsia were common among more than 70 to 80 percent of diabetics. Weight loss was prominent among 28 to 53 percent and leg pain was another classical symptom observed among 41 to 58 percent of diabetics. Polyneuritis in the form of burning feet and palm was prevalent only in 16 to 30 percent of the diabetics. Skin problems, body pain, giddiness and tiredness were the other complaints reported by the diabetics.

3. Complications present

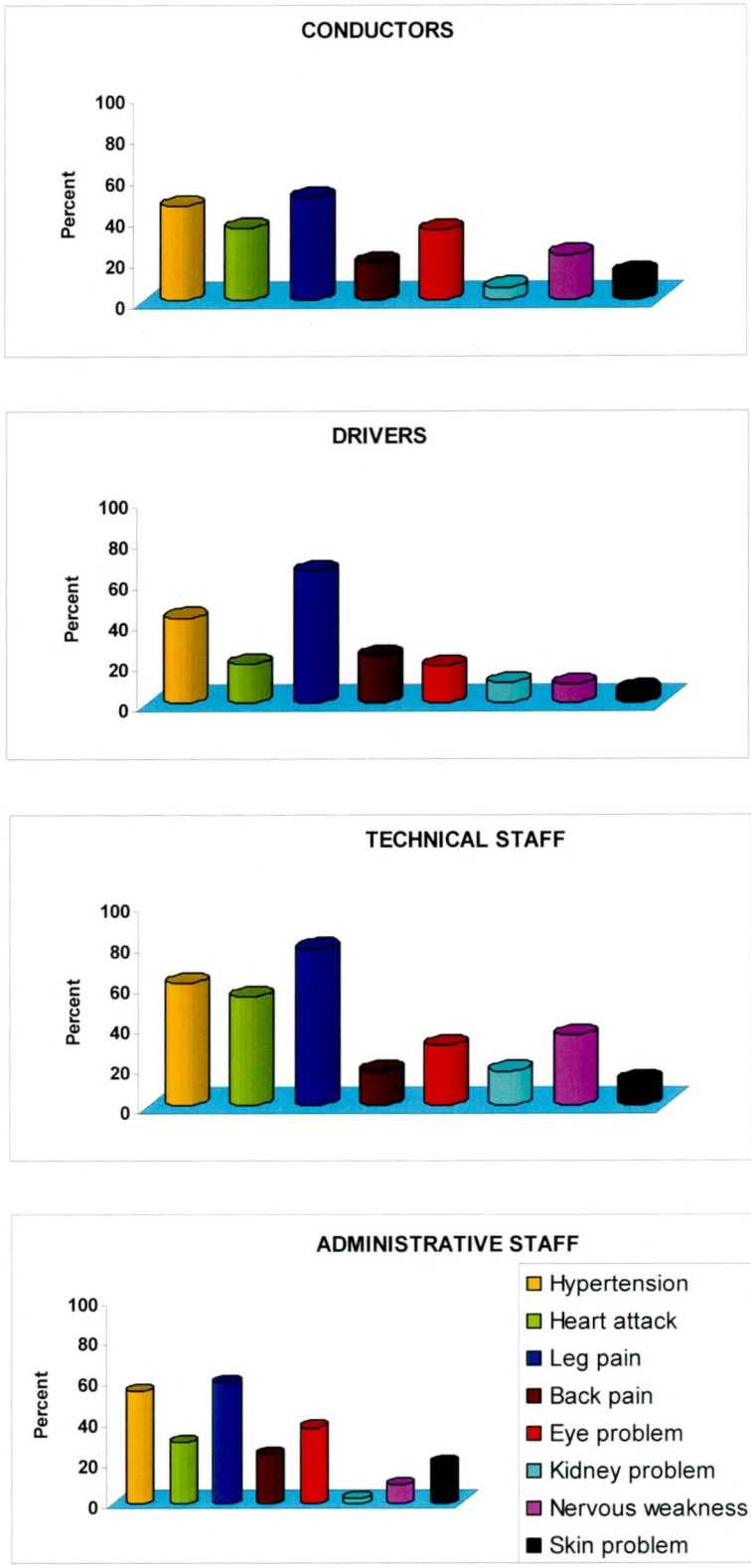
Table VII and Figure 6 presents the data on complications that were present in the diabetics.

TABLE VII

COMPLICATIONS PRESENT AMONG THE DIABETICS

Complications	Conductors N=150		Drivers N=140		Technical Staff N=83		Administrative Staff N=90		Total	
	N	%	N	%	N	%	N	%	N	%
Hypertension	69	46	59	42	51	61	50	55	229	49
Heart attack	53	35	26	19	45	54	27	30	150	32
Leg pain	74	50	91	65	65	78	54	59	284	61
Retinopathy	50	34	26	18	25	30	34	37	135	29
Nephropathy	9	6	14	10	14	17	2	2	55	12
Neuropathy	32	22	13	9	29	35	8	9	82	18
Skin irritation	20	13	8	6	10	12	18	20	56	12
Back pain	27	18	33	23	14	17	22	24	96	21

A total number of 379 (81%) diabetics had cardiovascular disease. Forty nine percent had hypertension while 32 percent suffered from cardiovascular problems. Poor control of diabetes mellitus and subsequent chronic hyperglycemia had produced organic disorders affecting heart, kidney, eyes, nervous system, skin and skeletal system. Leg pain was reported by 61 percent of the diabetics. Seventy eight percent of technical staff reported leg pain which may be related to their work pattern, but



COMPLICATIONS PRESENT AMONG THE DIABETICS

FIGURE 6

among these none reported of leg ulcers or gangrene. They had to stand and walk throughout their work shift for repair and maintenance of vehicles. Retinopathy was the next major complication followed by neuropathy and nephropathy. Ignorance about proper management of diabetes mellitus and wrong dietary practices were the causative factors for the rampant prevalence of the complications.

Shanthi Rani et al., (2006) and Zeymer, (2006) have also pointed out from their study that cardiovascular and renal diseases were the commonest causes of death among diabetic subjects. The present research also points out that 81 percent of the diabetics were suffering from problems of heart and hypertension. Anderson (1992) had established that back pain and leg pain were the commonest problems among the diabetic drivers in California compared to non diabetic drivers.

C. LIFE STYLE PATTERN OF THE DIABETICS

Health is a dynamic life process which begins at birth and healthy life is determined by genetic, nutritional and environmental factors throughout life. Poor diet, lack of exercise and smoking are associated with significantly increased risk of diabetes. Krishnaswamy and Ghafoorunissa (2004), Khan (2003) and Misia (2004) opine that dietary errors, lack of regular physical exercise, sedentary occupation and urbanization are major factors leading to diabetes mellitus in the urban middle and higher class people in India. Majority of Type II diabetes could be prevented by the adoption of healthier life style practices (Hu, *et al.*, 2002).

The life style pattern of the selected diabetics are presented in the following tables.

1. Alcohol consumption

Table VIII shows the consumption pattern of alcohol by the selected diabetics.

TABLE VIII

ALCOHOL CONSUMPTION PATTERN OF THE SELECTED DIABETICS

Criteria			Conductors N=150		Drivers N = 140		Technical Staff N = 83		Administrative Staff N = 90	
			N	%	N	%	N	%	N	%
Non-alcoholics			32	22	51	36	22	27	38	42
Alcoholics			118	78	89	64	61	73	52	58
Frequency of consumption of alcohol Quantity	Daily	250ml	Nil	Nil	6	7	2	3	2	4
	Weekly	250ml	108	92	83	93	50	82	40	77
		500ml	Nil	Nil	Nil	Nil	Nil	Nil	2	4
	Occasio-nally	250ml	10	8	Nil	Nil	9	15	8	15

Alcohol consumption pattern presented in Table VIII revealed that in all the four categories of diabetics, alcoholics out numbered non-alcoholics. Percentage of non-alcoholics was 42 percent in the administrative staff category followed by drivers, technical staff and conductors. Seventy seven percent of the administrative staff consumed 250ml per week. Only four percent of the administrative staff consumed alcohol daily. None of the conductors consumed alcohol daily. Ninety two percent consumed alcohol weekly and the quantity was also less. Only in the case of drivers, six subjects (7%) consumed alcohol daily. Weekly consumption of 250ml was observed among 82 percent of technical staff and 15 percent were occasional drinkers.

As there is strict rules against alcohol consumption by transport workers, those who took alcohol indicated that they did so only when they were off the road. In the present study 58 to 78 percent in different categories of diabetics were found to be

alcoholics. In general the results showed that transport workers were moderate drinkers and there were no addicts.

2. Smoking Pattern

Social and lifestyle factors and environmental factors such as illiteracy, smoking and stress are the primary causes of diabetes mellitus (Manama, 2002).

The data pertaining to the habits of smoking and chewing pan by the selected diabetics are presented in Table IX.

TABLE IX

PATTERN OF SMOKING AND CHEWING PAN AMONG THE SELECTED DIABETICS

Details	Conductors N = 150		Drivers N = 140		Technical Staff N = 83		Administrative Staff N = 90	
	N	%	N	%	N	%	N	%
Non Smokers	34	23	60	43	23	28	39	43
Smokers	116	77	80	57	60	72	51	57
Beedi	41	35	37	46	16	27	8	16
No/day								
0 – 5	6	15	3	8	5	31	8	100
5 – 10	35	85	34	92	11	69	Nil	Nil
Cigarette	75	65	43	54	44	73	43	84
No/day								
0 – 5	58	77	24	56	31	70	27	63
5 – 10	17	23	19	44	13	30	14	37
Chewing pan	18	12	16	11	3	4	16	18
Pan parag	6	34	7	44	Nil	Nil	5	31
Betel leaves	12	66	9	56	3	100	11	69

The findings made on the smoking habits were astounding. Smoking habits reduce the life span of individuals, but still it is the most common problem noticed

among population groups. The diabetics of the present study were no excuse to this habit. It was distressing to note that smoking was found to be common among more than 70 percent of the selected diabetics. Seventy seven percent of conductors followed by 72 percent of technical staff, 57 percent of drivers and 57 percent of administrative staff were smokers.

A comparison between alcohol consumption and smoking pattern points out that more number of drivers had the habit of consuming alcohol than smoking behaviour (64% against 57%). Type of smoking indicated that either cigarette or beedi was smoked. Higher income groups smoked cigarettes, while lower income groups smoked beedis. The number of beedi/cigarette smoked exceeded more than five per day among the running crews, compared to the other two groups.

Obelenis *et al.*, (2003) in their research on health of the employees of public transport in Lithuania has shown that 46 percent of the workers were smoking and 83 percent were drinking alcohol.

Nakanishi *et al.*, (2000) have found out from their research that the number of cigarettes smoked daily is associated with development of impaired fasting blood glucose and Type II diabetes. Schwart *et al.*, (2004) report that smoking increases the amount of free fatty acids which may promote atherosclerosis, hypertension and kidney damage in diabetic patients.

Though the government has banned the sale of pan parag, it was distressing to observe 44, 34 and 31 percent of drivers, conductors and administrative staff respectively consumed pan parag.

3. Exercise pattern

Obesity or excess body weight is one of the most important causes of Type II diabetes. Physical exercise will help in preventing insulin resistance and aid better blood glucose control.

Table X presents the information on type of exercise, frequency and duration of exercise undertaken by the selected diabetics.

TABLE X

EXERCISE PATTERN OF THE SELECTED DIABETICS

Exercise pattern		Conductors N=150		Drivers N=140		Technical Staff N=83		Administrative Staff N=90	
		N	%	N	%	N	%	N	%
Regular exercise		85	57	64	46	48	58	62	69
Irregular exercise		65	43	76	54	35	42	28	31
Type of Exercise		80	94	64	100	40	83	56	90
Walking	30min	63	79	52	81	20	50	15	17
	60"	22	21	12	19	20	50	15	17
Yoga	30min	5	6	Nil	Nil	8	17	6	10
	45min	5	100	Nil	Nil	8	100	Nil	Nil
	60min	Nil	Nil	Nil	Nil	Nil	Nil	6	100

Data presented in Table X regarding the exercise pattern, point out that all the diabetics in all the four categories performed exercise. Only regularity in performing exercise was the point of concern. Sixty nine percent of administrative staff undertook regular exercise. Among other groups only around 50 percent exercised regularly. These three categories namely drivers, conductors and technical staff worked in shift system and that was expressed as the greatest hurdle for regular exercise. These subjects expressed that they did not get adequate time to perform exercise. Walking was the main type of exercise performed by all categories and the average duration was 30 minutes. Among those who performed exercise 100 percent of the drivers, 94 percent of conductors, 90 percent of administrative staff and 83 percent of technical staff expressed walking as the sole type of exercise, yoga was practiced by six to seventeen percent of the diabetics.

Though exercise is the single most important measure any one can follow which has a tremendous effect in improving health and quality of life, the diabetics in the present research did not realize this and exercise was given least importance. This fact points out the necessity for life style counselling of the diabetics.

Shiyan *et al.* (2003) state that with the increasingly sedentary lifestyle, routine daily exercise of moderate intensity is highly recommended to reduce cardiovascular disease risk, the leading cause of death in diabetics.

Subramanian (2007) stated that diabetics who exercise regularly are less likely to experience a heart attack (or) stroke than diabetics who do not exercise.

Over the time several researches have brought out the positive impact of exercise in preventing complications of diabetes mellitus. Chandaraju (2005) opine that physical inactivity, in combination with improper diet and tobacco use, cause 90 percent of Type II diabetes.

4. Stress pattern

Table XI highlights the pattern of self-reported stress by the selected diabetics.

TABLE XI

PATTERN OF STRESS AMONG THE SELECTED DIABETICS

Stress pattern*	Conductors N=150		Drivers N=140		Technical Staff N=83		Administrative Staff N=90	
	N	%	N	%	N	%	N	%
Highly stressed	101	67	115	82	54	65	73	81
No stress	49	33	25	18	29	35	17	19
Reasons for stress* Occupational	81	80	87	76	44	81	58	79
Family problems	63	62	76	66	38	70	34	42
Economic/financial	53	52	46	40	30	55	24	30
Others	21	20	47	41	32	59	8	11

* Multiple responses

Thirty five and thirty three percent of technical staff and conductors respectively expressed that they did not have any stress. Drivers were the group who expressed maximum stress, especially because of the nature of their occupation. Maintaining the bus timings, poor roads, heavy traffic and competition between other bus drivers were specified as the reasons for stress by the drivers. Most of them also had family and financial constraints. Seventy nine percent of administrative staff also had stress because of their occupation. Out of the 65 percent of the technical staff who had stress, 81 percent had occupational stress. Family problems and financial constraints were the other forms of stress expressed by the selected diabetics.

Statistical analysis of correlation of stress with work category revealed highly significant relationship.

It is evident from these results that occupation was the most important form of stress among the transport corporation workers. Scoda et al., (2004) have also found out that stress and depression are the important factors which lead to chronic diseases like diabetes mellitus and cardio vascular diseases.

Time and again it has been proved by several scientists that both physical and mental stress elevates the blood glucose levels due to over production of steroid hormones.

When the sleeping pattern of the selected diabetics were analysed it was found that the majority of the subjects (61-78%) slept for an average of six hours daily. In the case of drivers and conductors because of the shift system and the associated stress most of them slept only for four hours daily. Inadequate sleep and increased stress are important causative factors in the occurrence of diabetes mellitus. Reuters (2006) has pointed out that the risk of diabetes was roughly two fold higher in men reporting short sleep duration compared to men sleeping seven to eight hours daily. In the present study inadequate sleep and stress could have been the causative factors for atleast a few of the diabetics.

D. HEALTH AND NUTRITIONAL STATUS OF THE DIABETICS

1. Dietary pattern of diabetics

Diet and nutrition are synonymous with health. Right kind of food intake is the single most important factor in the promotion of health and wrong kind of food is the single most important factor in the promotion of disease. Diet remains the cornerstone for diabetic patients especially for Type II diabetics.

Hence studying the dietary pattern of the diabetics is essential to find out the level of health risk with regard to food and nutrient intake. The dietary habits were studied for all the diabetics using the interview schedule. Twenty four hour dietary recall for three consecutive days was used to study the food and nutrient intake of the sub sample of 120 diabetics (30 in each category).

a. Type of diet consumed by the diabetics

Table XII presents the type of diet consumed by the diabetics.

TABLE XII

TYPE OF DIET CONSUMED BY THE DIABETICS

Food pattern	Conductors N=150		Drivers N=140		Technical Staff N=83		Administrative Staff N=90		Total	
	N	%	N	%	N	%	N	%	N	%
Vegetarian	15	10	40	29	13	16	20	22	88	19
Non-vegetarian	135	90	100	71	70	84	70	78	375	81

The data collected regarding the type of food consumed by the diabetics brings out the fact that 80 to 90 percent of the diabetics were non-vegetarians. There were only very less number of vegetarians (19%) compared to non-vegetarians. Protein content of vegetarian diet may be poor compared to non-vegetarian diet. Non-vegetarian foods supply good quality proteins. Though diabetics need proteins of good quality, excess consumption of saturated fat present in non-vegetarian foods pose the risk of developing vascular complications. Hence these diabetics who are non-vegetarians should learn right selection of non fat lean meat and judicious consumption of non-vegetarian items.

Strokle *et al.*, (2006) and Davis and Williams (2003) found out that prevalence of diabetes mellitus was less among vegetarians compared to non-vegetarians. Song and Franz (2005) have also reported that vegetarians have a low risk of Type II diabetes. The results of the present study also indicate the same trend.

b. Food and nutrient intake

The mean food and nutrient intake of the sub-sample was computed and the results are presented in Tables XIII and XIV.

Table XIII presents the mean food intake of selected diabetics compared with recommended dietary allowances along with percentage excess or deficit.

MEAN FOOD INTAKE OF SELECTED DIABETICS

Food stuff	Conductors			Drivers			Technical Staff			Administrative staff		
	Actual intake (g)	RDA	Difference Percentage	Actual intake (g)	RDA	Difference Percentage	Actual intake (g)	RDA	Difference Percentage	Actual intake (g)	RDA	Difference Percentage
Cereals	410	400	+3	436	400	+9	400	450	-12	399	350	+14
Pulses	40	50	-20	50	50	-	50	60	-17	52	45	+15
Green leaf vegetables	50	75	-33	50	75	-33	50	75	-34	60	75	-20
Roots and tubers	58	75	-23	60	75	-20	50	75	-34	100	75	+33
Other vegetables	50	75	-33	58	75	-23	50	75	-34	100	75	+33
Fruits	30	100	-70	50	100	-50	50	150	-77	150	100	+50
Milk and milk products	250	200	+25	275	200	+38	300	300	-	300	200	+50
Fleshy foods	35	30	+17	50	30	+67	35	35	-	40	25	+60
Fats and oils	30	20	+50	25	20	+25	32	20	+60	39	20	+95
Sugar and Jaggery	60	40	+50	55	40	+38	65	55	+18	45	25	+80

The food intake of the selected diabetics depicted in Table XIII points out that cereals were consumed adequately by all the diabetics. Cereal consumption was high only by 14 percent in the case of administrative staff and there was a 12 percent inadequacy in cereal intake by technical staff.

Consumption of pulses was deficient in the case of conductors and technical staff, while it was excess for administrative staff. The cost of pulses are high and the administrative staff who earned more had spent more money to purchase different pulses while the deficit was high for technical staff whose income was less.

Green leafy vegetable consumption was very much inadequate by all categories of employees. Deficit was 20 percent in the case of administrative staff while the deficit was greater in the case of running crews (33%) and technical staff (34%). Roots and tubers consumption was more than the Recommended Dietary Allowance for administrative staff. This was mainly due to excess consumption of potatoes. Potato was used both in household cooking and in the snacks consumed by the diabetics during their working hours as potato chips and potato bonda. But roots and tubers consumption was inadequate by all the other categories of diabetics.

Same pattern as that of roots and tubers was found in the consumption of other vegetables also. Administrative staff consumed excess and other categories showed deficient consumption. Milk and milk products consumption was adequate in the case of technical staff while other categories consumed excess quantities. Milk and milk products consumption was more mainly because of frequent consumption of tea and coffee. It was found out that more than six cups of coffee or tea was consumed everyday by all the diabetics. They indicated that the nature of the job necessitated this habit. The important factor to be observed here is that beverages were consumed with sugar. None of the diabetics consumed beverages without sugar. Sugar consumption was excess by 50 to 80 percent.

A very poor picture was depicted in the case of fruits consumption by drivers, conductors, and technical staff. They exhibited a deficit of 50 to 70 percent inadequacy in fruits consumption. This 50 percent consumption was because of the consumption of plantain sold in the beeda stall and petty shops in the bus terminals.

All the groups of diabetics were found to be favourites of fleshy foods. Consumption of fleshy foods was excess by 67 percent in the case of drivers, 60 percent in the case of administrative staff and 17 percent in the case of conductors. Technical staff consumed just adequate quantity. Even though the cost of fleshy foods was high its consumption was not low. Same trend was reflected in fats and oils intake also. Fats and oils intake was very high by 95 percent in the case of administrative staff. The reason was found to be consumption of non-vegetarian foods, sweets and snacks. Higher the income level greater was fats and oils consumption. High fats and oil intake was because of the excess and erratic consumption of deep fried snacks during working hours. Vadai, bajji, potato bonda, potato stuffed samosa and chips were the favourite snacks consumed daily.

High fats and oils intake leads to overweight and obesity and pose risk for the development of complications. Zammit (2004) reports that diets high in fat especially saturated fat, worsen glucose tolerance and increase the risk of Type II diabetes. Lee (2003) has pointed out that snacking habits could result in high energy intake and consequent health problems.

c. Mean nutrient intake of selected diabetics

The nutrient consumption of the selected diabetics was calculated and the results are presented in Table XIV.

MEAN NUTRIENT INTAKE OF DIABETICS

Nutrient	Conductors			Drivers			Technical Staff			Administrative staff		
	Actual intake (g)	RDA	Difference Percentage	Actual intake (g)	RDA	Difference Percentage	Actual intake (g)	RDA	Difference Percentage	Actual intake (g)	RDA	Difference Percentage
Energy (Kcal)	2987	2875	+4	3090	2875	+7	3408	3800	-11	3010	2425	+24
CHO(g)	290	-	-	322	-	-	343	-	-	289	-	-
Protein(g)	62	60	+3	69	60	+15	54	60	-10	67	60	+7
Fat (g)	31	20	+55	32	20	+60	30	20	+50	38	20	+90
Fibre (g)	32	40	-20	29	40	-27.4	30	40	-25	36	40	-9
Calcium(mg)	734	400	+83	786	400	+96	804	400	+101	696	400	+74
Iron (mg)	28.3	28	+1	30.2	28	+7	27	28	-4	29	28	-4
β.carotene(μg)	2600	2400	+8	2703	2400	+12	2310	2400	-4	2750	2400	+14
Thiamine(mg)	1.5	1.4	+7	1.6	1.4	+14	1.6	1.6	-	1.5	1.2	+25
Riboflavin(mg)	2.1	1.6	+31	1.9	1.6	+18	1.8	1.9	-6	2.0	1.4	+42
Ascorbic acid	53	40	+32	49.5	40	+23	46	40	+15	57.3	40	+43

Corollary to cereal intake presented in Table XIV, energy consumption was also adequate and had met the recommended dietary allowances in the case of running crews, while a slight excess (+24%) was observed in the case of administrative staff and deficit (-11%) was observed in the case of technical staff. Carbohydrate consumption was adequate. Protein consumption was satisfactory in all the categories except technical staff who showed a deficit of -10 percent. Though protein was inadequate for technical staff fat intake was more (+50%). A very high fat intake was observed in the case of administrative staff (+90%) followed by drivers and conductors. High fat intake could be related to excess intake of deep fat fried items during working hours and to high consumption of fleshy foods.

There was a deficit of 10 to 25 percent in the intake of fibre among the running crews, technical staff and administrative staff. This deficit may be due to inadequate intake of whole grains, whole grams, green leafy vegetables, and other vegetables which are good sources of dietary fibre.

Intake of milk and milk products and fleshy foods showed an excess by all the categories and this is well reflected in intake of calcium, which was 75 percent more than the recommended dietary allowance. But in the case of iron there was a minimum deficit (4%) by technical staff and administrative staff. Other micronutrients namely β-carotene and β-complex vitamins (thiamine and riboflavin) consumption was greater than Recommended Dietary Allowance. Adequate intake of milk and fleshy foods consumption could have contributed these vitamins. Varghese (2004) reports that in the affluent city of Thiruvananthapuram majority of Type II diabetics consumed high amount of calorie and fat and low amount of fibre. Therefore to stabilize the macro and micronutrient intake and prevent malnutrition among diabetics intense education programmes are necessary.

d. Eating food out side home

Table XV presents the data on the habit of eating food away from home.

TABLE XV

PATTERN OF EATING FOOD OUTSIDE HOME

Details		Conductors N=150		Drivers N=140		Technical Staff N=83		Administrative Staff N=90	
		N	%	N	%	N	%	N	%
Eating food outside	Yes	131	87	123	88	72	87	76	84
	No	19	13	17	12	11	13	14	16
If yes, Type of food outlet	Hotel	90	69	80	65	46	64	46	61
	Canteen	34	26	39	32	17	24	30	39
	Roadside vendors	7	5	4	3	9	12	Nil	Nil
Food most liked*	Idli/dosai varieties	33	25	26	21	35	49	14	18
	Parotta varieties	30	23	27	22	13	18	16	21
	Chinese food	74	56	72	59	33	46	44	58
	Others	13	10	12	10	2	3	17	22

* Multiple responses

The data presented on the habit of eating food away from home showed that 84 to 88 percent of the diabetics consumed food outside home daily. It was found out that only breakfast was consumed at home by majority of the diabetics. Lunch and dinner were consumed outside home. Only 40 percent of the diabetics took packed lunch from home.

Sixty one to sixty five percent of the diabetics ate in hotels. Though food was served at a very cheap cost in transport canteen only 24 to 39 percent ate in canteen

because canteen facility was available only in the main branch of the transport corporation. Three to twelve percent consumed food in the road side eateries, among whom majority was technical staff. None of the administrative staff consumed from road side food vendors. Administrative staff had easy access to canteen where food was served at very low cost.

Data collected on preference for type of foods eaten outside home revealed that Chinese food preparations like noodles, chilly gobi and chilly mushroom were the most preferred items followed by parotta varieties, idli and dosai. Laker (2006) and Mathew (2005) express that snacks are generally high in fats, salt, sugar, rich in calories and low in fibre, vitamins and minerals and are unhealthy foods. According to studies done by Stern (2003) upto 20 percent of Indian urban population above the age of 15 years have diabetes due to the fast food culture and less physical activity.

e. Type of oil consumed

The type of oil used has great impact on incidence of complications. Hence the type of oil used was studied and the data are presented in Table XVI.

TABLE XVI

TYPE OF OIL CONSUMED BY DIABETICS

Type of oil*	N	%
Refined groundnut oil	364	78
Sun flower oil	207	45
Groundnut oil	192	41
Gingelly oil	187	40
Coconut oil	79	17
Palm oil	75	16
Butter	177	38
Dalda	99	21
Ghee	52	11

* Multiple response

The data presented in Table XVI brings forth that more than one type of oil was used in cooking.

Refined groundnut oil was the most preferred oil. Seventy eight percent of the diabetics indicated that they consumed only refined groundnut oil. Unrefined groundnut oil was used by 41 percent of the diabetics. Groundnut oil contains more of monounsaturated fatty acid which is beneficial to health. The note worthy point is that majority of the families used monounsaturated fat containing groundnut oil. The next most preferred oil was sunflower oil (45%) followed by gingelly oil (40%). These plant oils are rich in polyunsaturated fatty acids and essential fatty acid which are salubrious. Coconut oil which contains more saturated oil was consumed by only 17 percent of the diabetics, especially for selected items.

2. Anthropometric indices

Table XVII shows the distribution of diabetics according to their body mass index (BMI) and waist hip ratio(WHR).

TABLE XVII

DISTRIBUTION OF THE DIABETICS ACCORDING TO BMI AND WHR

Body Mass Index (BMI)		**Conductor N=150**		**Driver N=140**		**Technical Staff N=83**		**Administrative Staff N=90**	
		N	%	N	%	N	%	N	%
<18.5	Underweight	Nil	Nil	Nil	Nil	Nil	Nil	9	10
18.5 – 24.9	Normal	78	52	73	52	36	43	43	47
25 – 29.9	Grade I obesity	67	45	56	40	33	40	24	27
>30	Grade II obesity	5	3	11	8	14	17	14	16
Waist – Hip ratio (WHR)									
0.8 – 0.9		48	32	65	46	33	40	37	41
>1		102	68	75	54	50	60	53	59

From the facts presented in Table XVII it could be ascertained that in the first three categories namely conductors, drivers and technical staff, no one had body mass index below 18.5, indicating that none of them were underweight. Only among the administrative staff 10 percent were underweight. Almost 50 percent of diabetics in each category were classified as having normal body mass index. Grade II obesity was less common compared to Grade I obesity. Twenty seven to forty five percent of conductors, drivers and technical staff had Grade I obesity. It was obvious from these results that administrative staff were less obese and 43 percent had normal body mass index. The same trend was reflected in the case of conductors also. The conductors had more physical activity, walking up and down in the bus and thus spending more energy.

The data on waist hip ratio show that about 54 to 68 percent of the diabetics had high waist hip ratio. Body mass index and waist hip ratio reflect the body fat content and fat distribution. The present study indicate greater body fat and abdominal obesity in the diabetics of the present study.

Excess consumption of fried foods and beverages and wrong dietary practices coupled with lack of exercise have resulted in higher body fat content. These results show the need for diet and lifestyle counselling.

Okhuba (2004) opines that the most important morphological factor linked to Type II diabetes mellitus is waist hip ratio, the mark of central adiposity.

Mean body mass index and WHR values

Table XVIII depicts the mean values of BMI and WHR of different groups of subjects.

TABLE XVIII

MEAN BMI AND WHR VALUES

Parameters	Conductors (C) N : 30	Drivers (D) N : 30	Technical staff (T) N : 30	Administrative staff (A) N : 30	'F' value x groups	Least significant difference
Body Mass Index	24.37 ± 4.73	24.56 ± 3.94	26.01 ± 4.73	24.43 ± 4.32	3.47*	C Vs T 1.647* D Vs T 1.44* T Vs A 1.58*
Waist Hip Ratio	1.00 ± 0.07	0.99 ± 0.07	0.99 ± 0.07	0.99 ± 0.05	0.738^{NS}	-

* Significant at five per level
NS – Non Significant

The mean body mass index (BMI) values of all the groups ranged from 24.37 to 26.01. Statistical analysis of difference in means showed 'F' value of 3.47 which was significant. Further analysis between groups showed that there was significant difference ($P < 0.05$) at five per cent level between the means of conductors and technicians, drivers and technicians and technicians and administrative staff.

The mean waist hip ratio of all the groups were between a narrow range of 0.99 to 1.00. The difference in means was not statistically significant.

3. Blood glucose

The fasting and post prandial blood glucose levels of the selected diabetics are portrayed in Table XIX and the individual values given in Appendix X.

TABLE XIX

BLOOD GLUCOSE LEVELS OF THE DIABETICS

Blood glucose levels (mg/dl)	Conductors N=30		Drivers N=30		Technical Staff N=30		Administrative Staff N=30	
	N	%	N	%	N	%	N	%
Fasting								
100 – 120	3	10	Nil	Nil	3	10	5	17
121 – 140	21	70	21	70	22	73	17	56
141 – 160	6	20	9	30	5	17	8	27
Post prandial								
150 – 170	4	13	7	23	3	10	5	17
171 – 190	8	27	12	40	9	30	7	23
191 – 210	8	27	7	23	9	30	13	44
211 – 230	8	27	4	14	7	23	3	10
231 – 250	2	6	Nil	Nil	2	6	2	6

From the Table XIX it is evident that only a minimum of 10 to 17 percent of conductors, technical staff and administrative staff maintained fasting blood glucose

level within normal range, while none of the drivers showed normal fasting blood glucose level. A majority of running crews (70%) and technical staff (73%) registered fasting blood glucose between 121 to 141 mg/dl, while 56 percent of the administrative staff maintained at 121 to 140 mg/dl. Twenty to thirty percent of the diabetics of all categories showed a very poor control with fasting blood glucose levels above 141 mg/dl.

When the post prandial blood glucose level was analysed none had blood glucose level in the normal range of 140mg. Ten to twenty three percent of all the categories of diabetics showed blood glucose level between 150 to 170 mg/dl. Twenty seven to forty percent of the diabetics had blood glucose level at 171 to 190 mg/dl. The remaining 50 to 60 percent of the diabetics had a very high post prandial level of 191 to 250mg/dl. This data reveal the fact that the diabetics in the present study did not know the right dietary principles and hence showed very high blood glucose levels. This necessitated the need for counselling on right dietary principles.

b. Glycosylated haemoglobin

Table XX and Figure 7 presents the distribution of diabetics according to glycosylated haemoglobin values (HbA_1C). Individual values are presented in Appendix XI.

TABLE XX

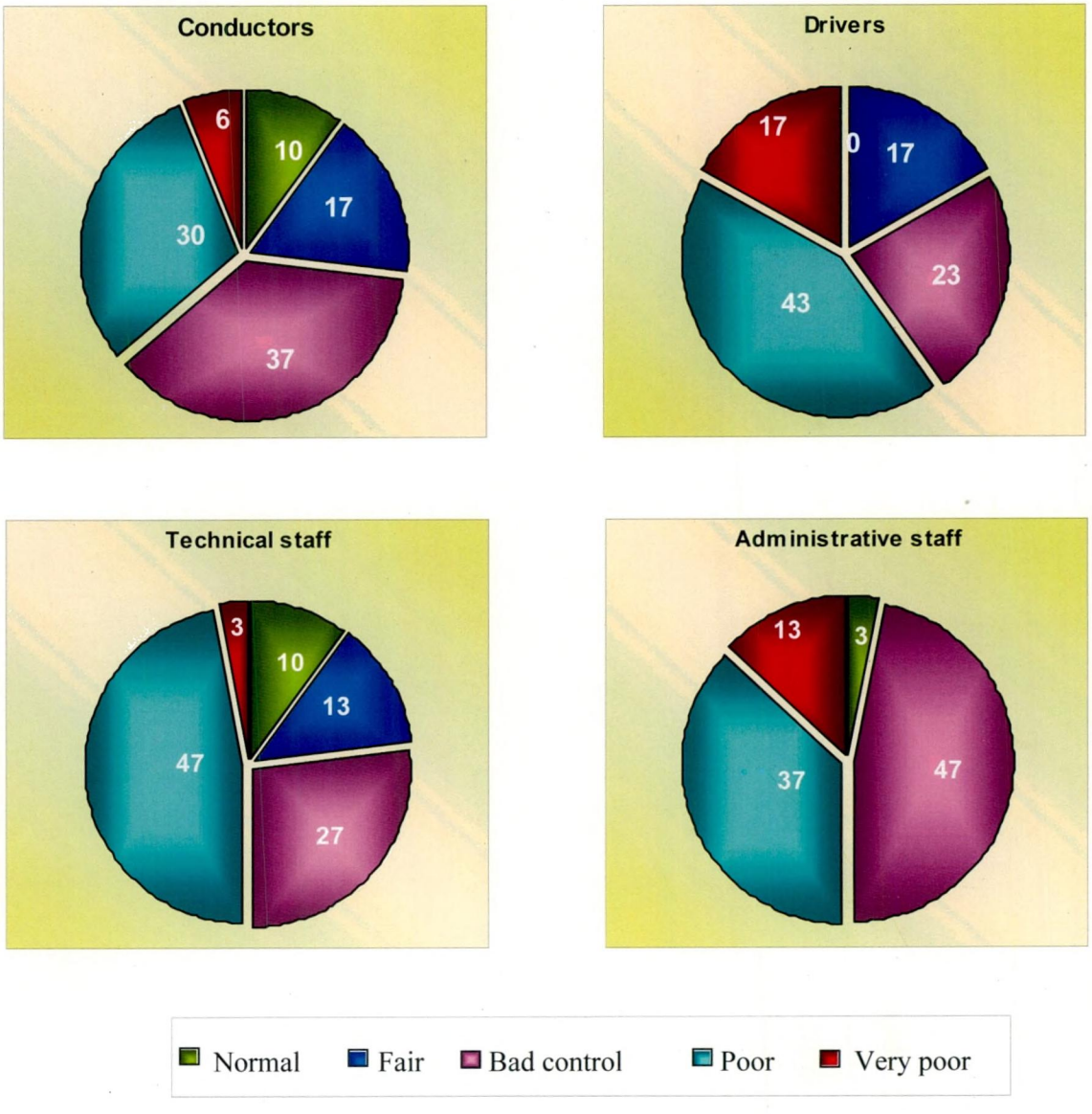
DISTRIBUTION OF DIABETICS ACCORDING TO GLYCOSYLATED HAEMOGLOBIN VALUES (HbA_1C)

Blood level of HbA_1C (%)	Conductors N=30		Drivers N=30		Technical Staff N=30		Administrative Staff N=30	
	N	%	N	%	N	%	N	%
5.1- 6.0 Normal	3	10	Nil	Nil	3	10	1	3
6.1 - 7.0 Fair	5	17	5	17	4	13	Nil	Nil
7.1 - 8.0 Bad control	11	37	7	23	8	27	14	47
8.1 - 9.0 Poor	9	30	13	43	14	47	11	37
9.1 - 10 Very Poor	2	6	5	17	1	3	4	13

5-7% → normal to fair >7% → poor control

Glycosylated haemoglobin value, is a measure of haemoglobin that had combined with glucose. As the blood glucose value increases the percentage of glycosylated haemoglobin also increases and show greater risk for diabetic complications.

Table XX points out that majority of the diabetics had registered glycosylated haemoglobin values of more than seven. This indicates poor blood glucose control over the past three to four months.



DISTRIBUTION OF DIABETICS ACCORDING TO GLYCOSYLATED HAEMOGLOBIN VALUES (HbA_1C)

FIGURE 7

Examination by work category showed that none of the drivers showed normal values while 10 percent each of conductors and technical staff registered normal values. A very minimum number namely 13 to 17 percent had registered values in the fair control range. The HbA_1C picture was very poor in the case of administrative staff. All the selected diabetics except only three percent were classified under poor control categories. Their values were greater ranging from seven to ten.

Glycosylated haemoglobin values are better predictors of blood glucose control than the fasting and post prandial glucose value and the diabetics of the present study showed very poor control of blood glucose. For every one percent reduction in HbA_1C, the relative risk for micro vascular complications decreased by 37 percent, diabetes related deaths by 21 percent and heart attack by 14 percent. (ndep.nih.USA.gov 2007).

Mean blood glucose and glycosylated haemoglobin values

Table XXI presents the mean blood glucose and glycosylated haemoglobin values.

TABLE XXI

MEAN BLOOD GLUCOSE AND GLYCOSYLATED HAEMOGLOBIN VALUES

Parameters	Conductors (C) N : 30	Drivers (D) N : 30	Technical staff (T) N : 30	Administrative staff (A) N : 30	'F' value x groups	Least significant difference
Fasting blood glucose (mg/dl)	132.88 ± 8.82	138.27 ± 5.11	132.73 ± 8.68	134.07 ± 10.72	3.06*	C Vs D* 5.933 D Vs T* 5.53
Postprandial blood glucose (mg/dl)	198.83 ± 24.07	185.77 ± 20.96	201.03 ± 19.64	194.13 ± 22.86	2.84*	C Vs D* 13.06 D Vs T* 15.26
Glycosylated haemoglobin (HbAc) (%)	7.53 ± 1.00	7.98 ± 0.87	8.03 ± 0.77	8.03 ± 0.77	2.80*	C Vs A* 0.50 T Vs A* 0.50

* Significant at five per level

** Significant at one per cent level

NS – Non Significant

The mean fasting blood glucose values of all the groups ranged from 132.33 to 138.27 mg / dl. Statistical analysis of the difference in means showed 'F' value of 3.06 which was significant. Further analysis between groups showed that there was significant difference in the means of drivers and conductors and drivers and technical staff. The difference was significant at five per cent level.

The mean postprandial values of all the groups were higher than normal value showing hyperglycemia in all the groups. Here again the 'F' value showed significance at five per cent level. Analysis of difference between groups showed that the mean postprandial value of conductors was significantly higher than conductors and technical staff ($P < 0.05$). the difference was not significantly different between drivers and administrative staff.

The mean glycosylated haemoglobin values of all the groups also showed higher values than normal. 'F' value was significant at five per cent level. Analysis of least significant difference showed that the mean value of conductors and administrative staff and administrative staff and technical staff were significantly different at five per cent level. As the mean value of drivers was in between the other groups the difference was not significant.

c. Lipid profile

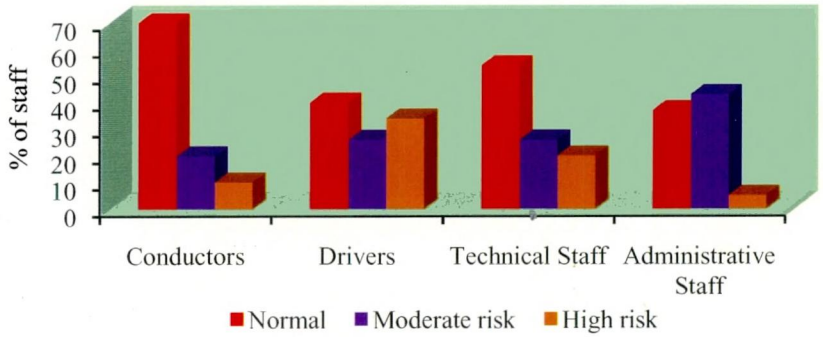
Table XXII and Figure 8 bring out the distribution of diabetics according to blood lipid levels. Individual values are presented in Appendix XII.

TABLE XXII

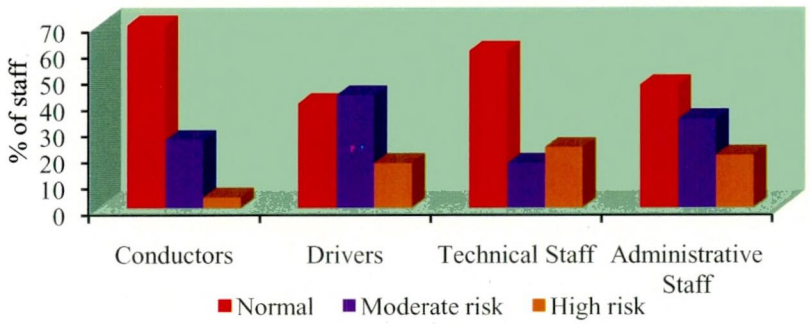
DISTRIBUTION OF DIABETICS ACCORDING TO BLOOD LIPID LEVELS

Blood Lipid levels mg/dl	Conductors N=30		Drivers N=30		Technical Staff N=30		Administrative Staff N=30	
	N	%	N	%	N	%	N	%
Total cholesterol								
Normal (<200)	21	70	12	40	16	54	11	37
Moderate risk (200 – 250)	6	20	8	26	8	26	13	43
High risk (>250)	3	10	10	34	6	20	6	20
Triglyceride								
Normal (<150)	21	70	12	40	18	60	14	47
Moderate risk (150 – 199)	8	26	13	43	5	17	10	34
High risk (>250)	1	4	5	17	7	23	6	20
Low Density Lipoprotein								
Normal (<130)	12	40	14	47	13	43	10	34
Moderate risk (130 – 159)	5	17	8	26	8	26	18	60
High risk (>160)	13	43	8	26	9	30	2	6
High Density Lipoprotein								
Normal (<50)	23	77	6	20	16	52	9	30
Moderate risk (35– 50)	7	23	12	40	11	37	15	50
High risk (<35)	Nil	Nil	12	40	3	10	6	20

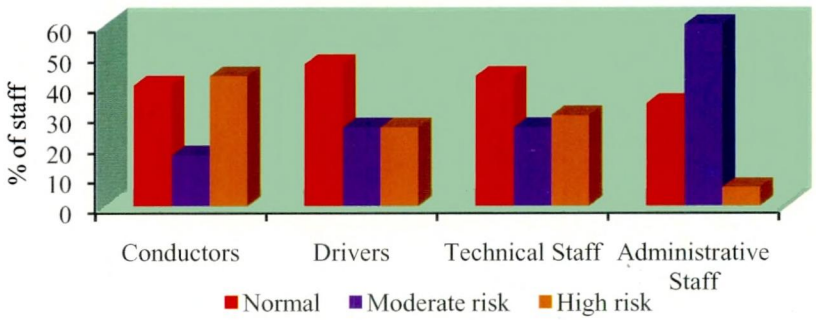
From Table XXII it could be observed that majority of diabetics had normal blood cholesterol levels. Total cholesterol levels were below 200mg/dl for 70 percent of conductors and 54 percent of technical staff and 40 percent of drivers. But in the case of administrative staff only 37 percent had normal cholesterol level. Forty three percent of the administrative staff had high cholesterol level and were classified as moderate risk group. This group also came under high income group.



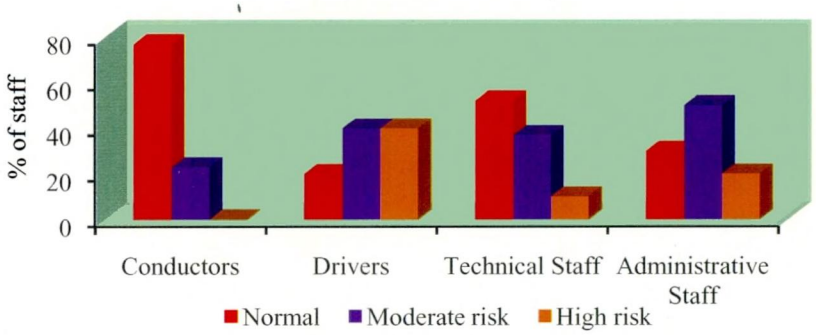
Total cholesterol



Triglyceride



Low Density Lipoprotein



High Density Lipoprotein

BLOOD LIPID LEVELS OF THE DIFFERENT GROUPS OF SUBJECTS

FIGURE 8

High total cholesterol may be because of frequent fasting and feasting. Thirty four percent of the drivers had total cholesterol greater than 250mg and were classified as high risk group. This again reflects the poor control of diabetics by this group.

In the case of triglycerides also 70 percent of the conductors had normal levels followed by technical staff, administrative staff and drivers. Here again drivers and administrative staff had high triglyceride levels and were under moderate and high risk categories.

Low Density Lipoprotein (LDL) levels showed that 47 percent of the drivers, 43 percent of the technical staff, 40 percent of conductors and 34 percent of administrative staff were in the normal category. Sixty six percent of administrative staff had moderate to high risk level of LDL (Low Density Lipoprotein) followed by drivers, conductors, and technical staff.

High Density Lipoprotein (HDL) level depicted in Table XXII also reflect the same pattern of risk described for other lipid fractions. Seventy seven percent of conductors had high density lipoprotein greater than 50mg/dl. In general conductors had normal levels of blood lipid fractions followed by technical staff followed by administrative staff and drivers. Blood lipid profile of the diabetics showed that drivers had very high levels of total cholesterol, triglyceride and LDL cholesterol and were rated as high risk group followed by administrative staff, technical staff and conductors. High lipid levels are associated with cardiovascular disease risk in diabetes. People with Type II diabetes have high rates of cholesterol and triglyceride abnormalities, obesity and high blood pressure, all of which are major contributors to higher rates of cardiovascular diseases. (http: // www n dep. nih.gov/campaigns / Besmart / htm.2006)

Mean lipid values

Table XXIII presents mean lipid levels and the resulting statistical analysis.

TABLE XXIII

MEAN LIPID LEVELS OF THE DIFFERENT GROUPS OF SUBJECTS

Parameters	Conductors (C) N : 30	Drivers (D) N : 30	Technical staff (T) N:30	Administrative staff (A) N:30	'F' value x groups	Least significant difference
Total cholesterol (mg/dl)	198.10 ± 33.45	218.03 ± 49.41	207.40 ± 43.48	217.80 ± 43.65	1.48^{NS}	-
Triglyceride (mg/ dl)	149.37 ± 28.61	175.43 ± 48.51	175.77 ± 58.92	171.07 ± 50.31	2.05*	C Vs D 26.06* C Vs T 26.40*
Low density lipoprotein (mg/dl)	152.20 ± 34.45	144.57 ± 29.96	146.07 ± 27.33	136.67 ± 19.16	1.53*	C Vs A 15.53*
High density lipoprotein (mg / dl)	55.10 ± 9.52	40.60 ± 9.82	49.43 ± 9.14	44.23 ± 8.75	13.78**	C Vs D 14.50* C Vs T 5.66* C Vs A 10.86* D Vs T 8.83* T Vs A 5.20*

* Significant at five per level
** Significant at one per cent level
NS – Non Significant

The mean total cholesterol values depicted in Table XXIII ranged from 198.12 to 218.03 mg / dl. Statistical analysis indicated that there was no significant difference between the mean values of the four groups.

Mean triglyceride levels ranged between 149.37 to 175.77 mg / dl showing greater difference. Analysis of 'F' value indicated that there was a significant difference at five per cent level ($P < 0.05$) between the mean values. Further analysis showed that the values of drivers and technical staff were significantly higher than that of conductors, with a statistical difference at five per cent level.

The low density lipoprotein values ranged from 136.67 to 152.2 mg / dl. The difference between the values were minimum showing an 'F' value of 1.53 which was significant at five per cent level. Statistical analysis of difference between means, showed that the mean value of conductors (152.20 mg / dl) was significantly greater than that of administrative staff (136.67 mg / dl). All the other values did not show statistically significant difference.

In the case of high density lipoprotein, the mean values ranged from 40.60 mg / dl (drivers) to 55.10 mg / dl (conductors). The analysis of difference between groups ($F = 13.78$) showed very high difference which was significant at one per cent level.

Analysis of least significant difference indicated that mean values of all the groups were significantly difference compared with other groups except the mean values of drivers and administrative staff.

Phase II : Development of low glycemic recipes incorporating sprouted legume powders and evaluation of glycemic index

The result of Phase I of the present research brought forth the inadequate knowledge, improper diet, ignorance about blood glucose management and wrong life style practices. They were ignorant about low glycemic foods. This necessitated the need to develop recipes with low glycemic index that can help the diabetics in better

management of blood glucose level. Hence phase II was planned, to develop high protein, high fibre recipes with low glycemic index using legumes.

Four legumes namely Bengal gram, green gram, horse gram and dry peas were selected based on their protein and fibre contents. Powders of these sprouted legumes were prepared and were incorporated into four selected recipes commonly prepared for breakfast in South India. The legume powders were incorporated into the selected recipes to increase the protein and dietary fibre content. Among the sprouted legume powder incorporated recipes most acceptable recipes were selected and standardized. These standardized recipes were fed to Type II diabetics and non diabetic subjects and the glycemic index was calculated. The results of the phase II are presented and discussed under the following headings.

A. Acceptability of recipes incorporated with sprouted legume powders
B. Nutritive value of most acceptable recipes
C. Evaluation of glycemic index of the selected recipes

A. Acceptability of recipes incorporated with sprouted legume powders

The four legume powders were incorporated at 20, 40 and 60 percent levels in the selected recipes namely adai, dosai, kozukattai and pittu. These recipes were prepared in the laboratory and presented to a panel of 15 judges for evaluating the acceptability. Evaluation was done for taste, flavour, texture, consistency and appearance using a five point rating scale (Appendix IV). The acceptability trials were repeated three times and the average scores were calculated.

Table XXIV presents the scores obtained by each variation in the four selected recipes.

TABLE XXIV

MEAN ACCEPTABILITY SCORES OF RECIPES INCORPORATED WITH SPROUTED LEGUME POWDERS

Recipes and Variations	Sprouted Bengal gram powder			Sprouted green gram powder			Sprouted horse gram powder			Sprouted Peas Powder		
	Overall scores											
	0-5	5-10	10-15	0-5	5-10	10-15	0-5	5-10	10-15	0-5	5-10	10-15
Adai												
I (20%)	Nil	Nil	14	Nil	10	Nil	Nil	8	Nil	Nil	Nil	14
II (40%)	Nil	6	Nil	Nil	Nil	15	Nil	Nil	14	Nil	6	Nil
III (60%)	1	Nil	Nil	4	Nil	Nil	3	Nil	Nil	3	Nil	Nil
Dosai												
I (20%)	Nil	Nil	13	Nil	10	Nil	Nil	Nil	15	Nil	Nil	13
II (40%)	Nil	7	Nil	Nil	Nil	14	Nil	6	Nil	Nil	6	Nil
III (60%)	3	Nil	Nil	4	Nil	Nil	2	Nil	Nil	2	Nil	Nil
Kozukattai												
I (20%)	Nil	Nil	14	Nil	Nil	14	Nil	7	Nil	Nil	Nil	15
II (40%)	Nil	6	Nil	Nil	7	Nil	Nil	Nil	15	Nil	6	Nil
III (60%)	3	Nil	Nil	2	Nil	Nil	Nil	4	Nil	4	Nil	Nil
Pittu												
I (20%)	Nil	Nil	15	Nil	Nil	14	Nil	Nil	15	Nil	Nil	15
II (40%)	Nil	5	Nil	Nil	7	Nil	Nil	8	Nil	Nil	7	Nil
III (60%)	2	Nil	Nil	Nil	4	Nil	3	Nil	Nil	4	Nil	Nil

From Table XXIV it is obvious that in all the recipes, incorporation of legume powders at 60 percent was not acceptable. In the case of adai sprouted Bengal gram powder and sprouted peas powder incorporated at 20 percent level was found to be acceptable while sprouted green gram and sprouted horse gram were acceptable at 40 percent level. Adai is normally prepared using a mixture of dhals and hence 40 percent incorporation of legume powders did not alter the taste.

In the case of dosai green gram incorporated at 40 percent was acceptable while other legume powders were acceptable only at 20 percent level.

Kozukattai is a preparation in which normally no dhal or legume is added. So, in this preparation sprouted legume powders incorporation was acceptable only at 20 percent level. The taste was not acceptable when legume powders were added above 20 per cent. But it was surprising to note that incorporation of sprouted horse gram powder was acceptable at 40 per cent level.

Next item namely Pittu is prepared using rice flour. Normally no pulse or legumes are used in this preparation. Hence only 20 percent incorporation was acceptable in all the variations. Incorporation at 40 percent and 60 percent levels were unacceptable.

Thus in each variation the most acceptable level of incorporation was identified and those recipes were selected for evaluating the glycemic index.

B. Nutritive value of sprouted legume powder incorporated recipes

Table XXV presents the major nutrient content of 100g portion of the recipes incorporated with sprouted legume powders along with their standard recipe.

TABLE XXV

NUTRITIVE VALUE (per 100g) OF SELECTED RECIPES

Recipes with variations	Level of incorporation (%)	Energy (K.cal)	Protein (g)	Fat (g)	Carbo-hydrate (g)	Fibre (g)
Adai						
Bengal gram	20	404	13.4	5.1	79	2
Green gram	40	406	14.2	4.4	79	1.8
Horse gram	40	406	17.2	5.8	75	2.4
Peas	20	400	13	4.4	79	1.8
Standard	-	400	13	5.8	78	0.4
Dosai						
Bengal gram	20	372	12.4	3.4	73	2.4
Green gram	40	374	16.8	4.1	68.4	2.8
Horse gram	20	368	13.2	2.8	72.2	2.2
Peas	20	368	12	2.8	73	2.2
Standard	-	382	6.3	2.8	72	0.26
kozukattai						
Bengal gram	20	404	13.2	1.4	82	2.2
Green gram	20	394	11.4	1.4	85	1.8
Horse gram	40	392	11.6	1	85	1.6
Peas	20	392	10.4	0.9	86	1.6
Standard	-	390	4.6	1.6	82	0.2
Pittu						
Bengal gram	20	352	9	1.3	76	0.6
Green Gram	20	348	9.8	0.6	76	0.44
Horse gram	20	350	9.6	1.1	76	0.6
Peas	20	348	8.6	0.6	77	0.44
Standard	-	350	7.2	0.3	80	.01

The nutrient content of standard adai and the different legume powder incorporated variations bring forth that there was no difference in the energy content of 100g portions. With regard to protein, horse gram incorporated adai had the highest protein content of 17.2g/100g. Protein content was more by 4.2g compared to standard adai. Dry peas and Bengal gram powders did not produce any increase in

protein content. Fat content was lowered by 1.4g for green gram and dry peas incorporated recipes. There was not much difference in the carbohydrate contents. Fibre content had shown a striking increase in all the legume powder incorporated variations. The maximum fibre content was registered by horse gram incorporated recipe followed by Bengal gram, green gram and dry peas.

In the case of dosai also the same trend was observed with prominent hike in fibre content. The protein content of the legume incorporated dosai recipes was two to three times greater than that of standard recipe.

Kozukattai also showed an increase in protein and fibre contents in the legume incorporated recipes. There was not much difference in energy, fat and carbohydrate contents.

In the legume powder incorporated pittu recipe there was no change in energy content but protein and fibre content had increased significantly. At the same time there was a noticeable decrease in carbohydrate content. A slight increase was observed in the case of fat as all the legume powders showed a minimum hike in fat content after sprouting. But the fatty acids were unsaturated fatty acids which may not produce harm to health.

C. Evaluation of Glycemic Index of the selected recipes

As detailed in methodology glycemic index of the selected recipes were evaluated by feeding the test recipes to groups of diabetic subjects and also to non diabetic subjects and the results are presented and discussed as follows.

1. Mean blood glucose level

The mean blood glucose values of the groups of subjects who were administered white bread and then the selected recipes, were estimated every half an hour and the glycemic index was calculated. The mean blood glucose levels of the

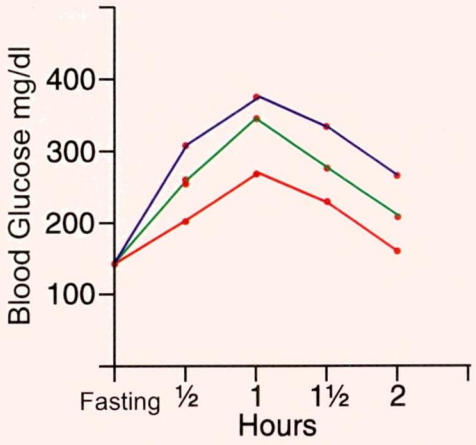
different groups estimated before and after two hours (post prandial) of administration of the test recipes are presented in Table XXVI and Figure 9a-9d. Appendix XIII present the blood glucose values of diabetic individuals for every half an hour after feeding the test recipe and white bread.

TABLE XXVI

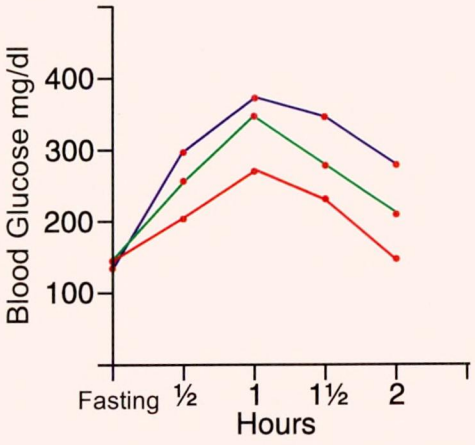
MEAN BLOOD GLUCOSE LEVEL OF THE SELECTED DIABETICS BEFORE AND AFTER THE ADMINISTRATION OF TEST RECIPES

Groups	Level of Incorporation (%)	Blood glucose level (mg/dl)			
		Fasting Mean ± S.D.	Post prandial Mean ± S.D.	't' Value	'P' Value
ADAI					
Group I (Bengal gram)	20	141 ± 2.78	160 ± 3.38	1.24^{NS}	0.268^{NS}
Group II (Green gram)	40	141 ± 2.04	143 ± 16.02	0.316^{NS}	0.765^{NS}
Group III (Horse gram)	40	146 ± 7.13	140 ± 12.94	1.351^{NS}	0.235^{NS}
Group IV (Peas)	20	141 ± 5.31	155 ± 47.89	0.740^{NS}	0.493^{NS}
Group V (Standard)	Nil	140 ± 3.12	207 ± 47.40	3.40*	0.019*
DOSAI					
Group VI (Bengal gram)	20	140 ± 2.25	172 ± 40.39	1.91^{NS}	0.114^{NS}
Group VII (Green gram)	40	141 ± 7.05	165 ± 40.86	147^{NS}	0.201^{NS}
Group VIII (Horse gram)	20	140 ± 6.89	163 ± 13.38	3.79*	0.013*
Group IX (Peas)	20	141 ± 6.06	165 ± 32.11	2.26^{NS}	0.073^{NS}
Group X (Standard)	Nil	147 ± 7.19	196 ± 50.80	2.42^{NS}	0.060^{NS}
KOZHUKATTAI					
Group XI (Bengal gram)	20	145 ± 6.18	171 ± 19.26	4.38**	0.007**
Group XII (Green gram)	20	152 ± 5.40	163 ± 28.18	1.09^{NS}	0.325^{NS}
Group XIII (Horse gram)	40	144 ± 5.57	165 ± 32.73	1.77^{NS}	0.136^{NS}
Group XIV (Peas)	20	145 ± 4.79	162 ± 42.50	1.02^{NS}	0.351^{NS}
Group XV (Standard)	Nil	144 ± 11.48	200 ± 15.88	7.51**	0.001**
PITTU					
Group XVI (Bengal gram)	20	143 ± 4.03	166 ± 23.95	2.36*	0.034*
Group XVII (Green gram)	40	141 ± 3.49	192 ± 24.44	4.71^{NS}	0.065^{NS}
Group XVIII (Horse gram)	20	140 ± 3.94	155 ± 17.44	2.04^{NS}	0.096^{NS}
Group XIX (Peas)	20	152 ± 6.29	164 ± 35.69	1.60^{NS}	0.363^{NS}
Group XX (Standard)	Nil	140 ± 3.60	199 ± 33.57	4.59**	0.006^{**}

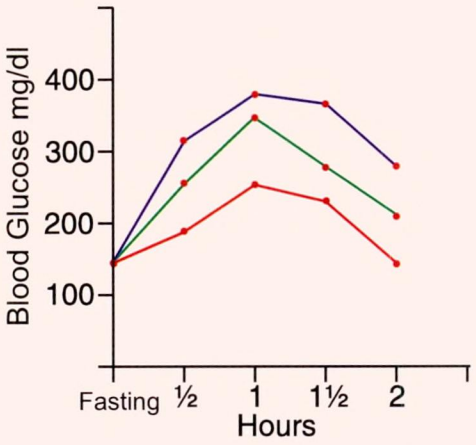
** - Significant at one percent ($P < 0.01$) * - Significant at five percent ($P < 0.05$)
NS – Not significant ($P > 0.05$)



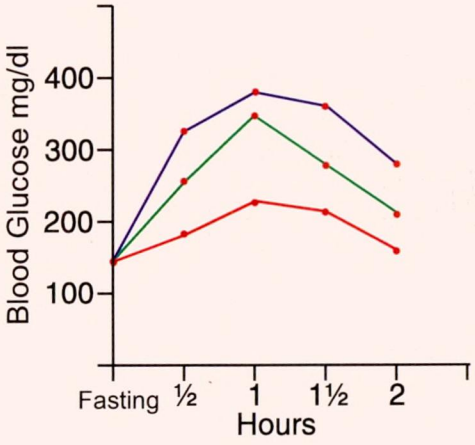
Sprouted Bengal Gram Powder incorporated Adai



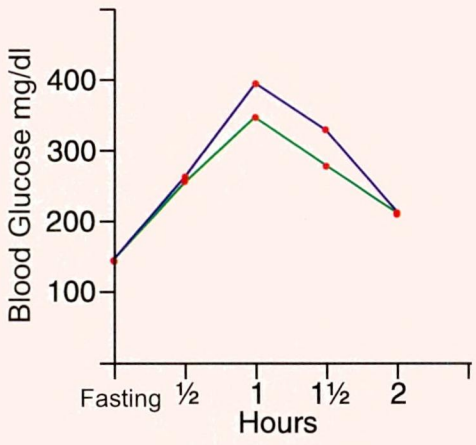
Sprouted Green Gram Powder incorporated Adai



Sprouted Horse Gram Powder incorporated Adai



Sprouted Peas Powder incorporated Adai

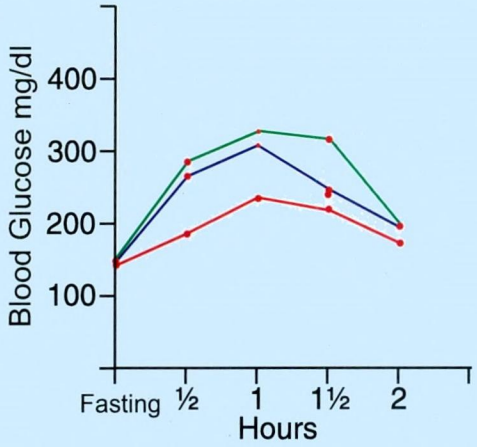


Standard Adai

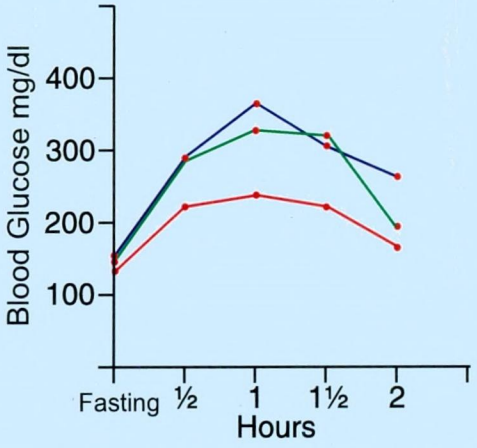
— TEST RECIPE
— WHITE BREAD
— STANDARD

Mean blood glucose level of the selected diabetics before and after the administration of test recipe adai compared with white bread and standard adai.

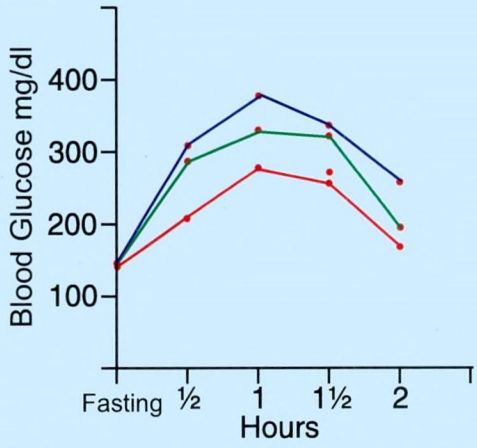
Figure 9 a



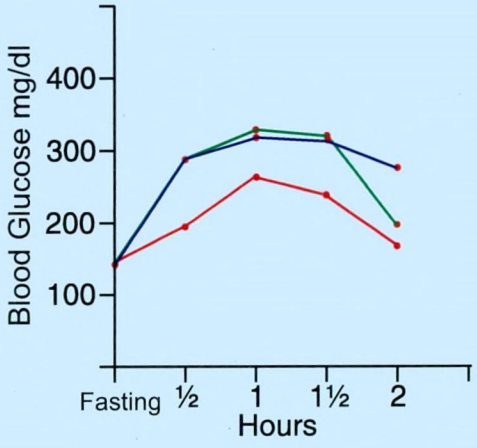
Sprouted Bengal Gram Powder incorporated dosai



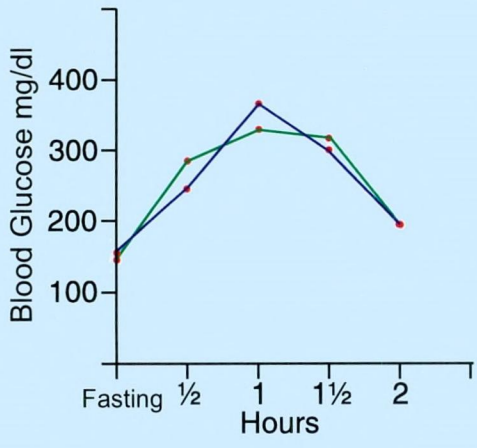
Sprouted Green Gram Powder incorporated dosai



Sprouted Horse Gram Powder incorporated dosai



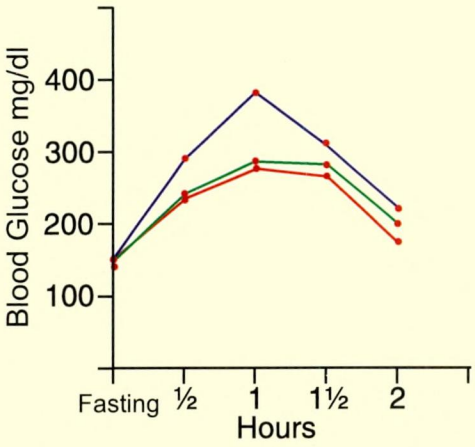
Sprouted Peas Powder incorporated dosai



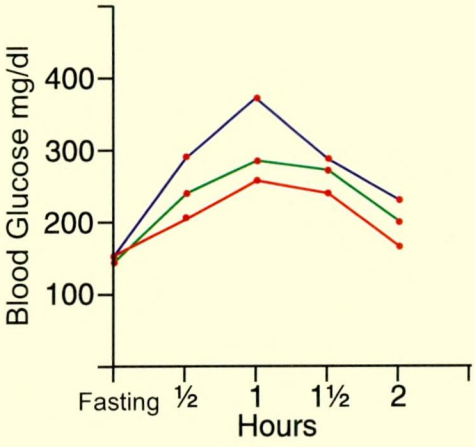
Standard dosai

Mean blood glucose level of the selected diabetics before and after the administration of test recipe dosai compared with white bread and standard dosai.

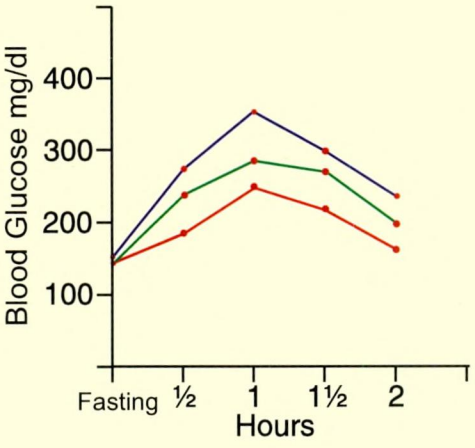
Figure 9b



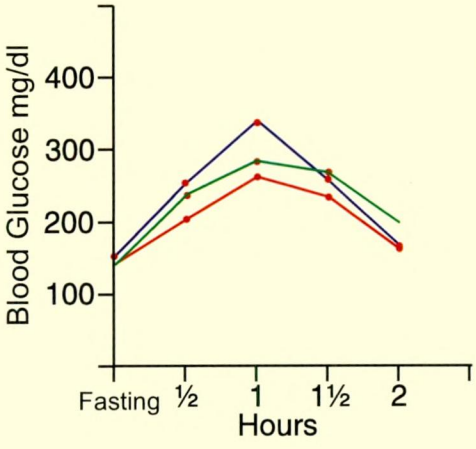
Sprouted Bengal Gram Powder incorporated kozukattai



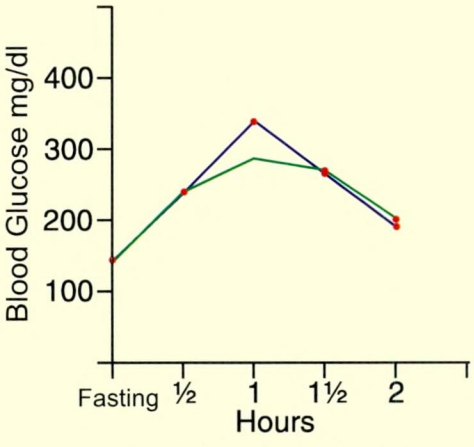
Sprouted Green Gram Powder incorporated kozukattai



Sprouted Horse Gram Powder incorporated kozukattai



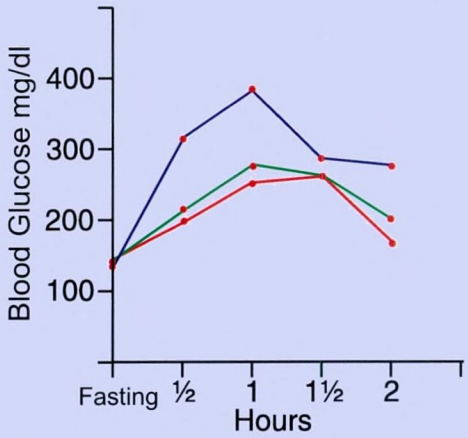
Sprouted Peas Powder incorporated kozukattai



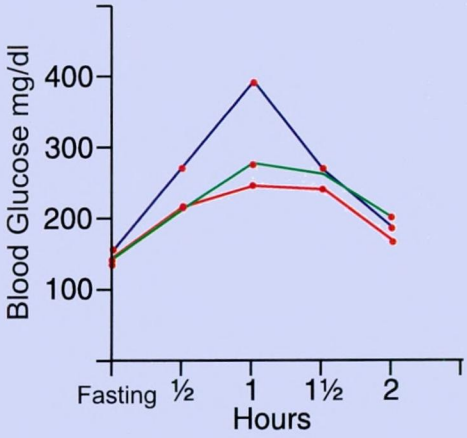
Standard kozukattai

Mean blood glucose level of the selected diabetics before and after the administration of test recipe kozukattai compared with white bread and standard kozukattai.

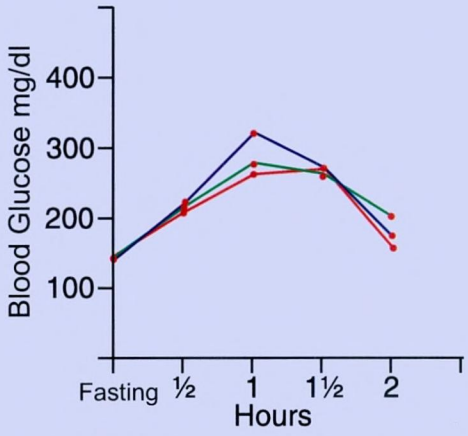
Figure 9c



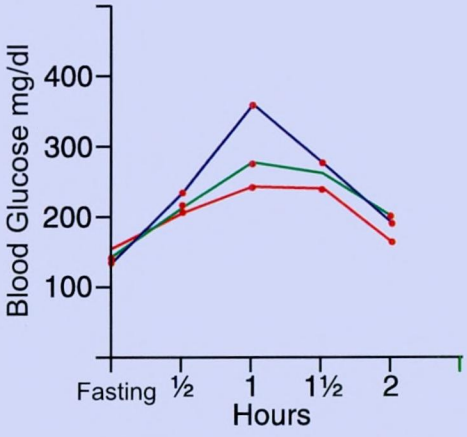
Sprouted Bengal Gram Powder incorporated pittu



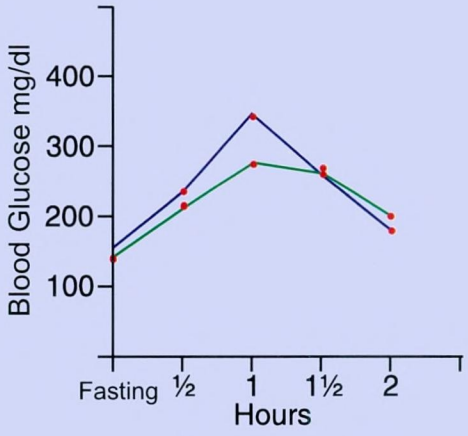
Sprouted Green Gram Powder incorporated pittu



Sprouted Horse Gram Powder incorporated pittu



Sprouted Peas Powder incorporated pittu



Standard pittu

TEST RECIPE
WHITE BREAD
STANDARD

Mean blood glucose level of the selected diabetics before and after the administration of test recipe pittu compared with white bread and standard pittu.

Figure 9d

As evident from Table XXVI for calculating the glycemic index, the diabetics were grouped in such a way that the mean fasting blood glucose levels were between 141 to 152 mg/dl.

The mean blood glucose values of subjects who were fed standard and the four sprouted legume powder incorporated recipes indicate that standard recipes had produced very high blood glucose levels compared to legume incorporated recipes.

In the case of adai minimum increase in blood glucose values were found in the subjects who were fed sprouted horse gram powder incorporated adai, followed by green gram, peas and Bengal gram. Horse gram incorporation had produced favourable blood glucose value.

Same trend was observed in the case of dosai and kozhukattai variations. Sprouted horse gram incorporation had produced lowest mean blood glucose values followed by green gram, peas and Bengal gram. Bengal gram had produced high blood glucose value.

Though pittu incorporated with sprouted horse gram powder had produced very low blood glucose value of 155 mg/dl, in this case, green gram showed the highest blood glucose value of 192 mg/dl followed by Bengal gram (166 mg/dl) and peas (164 mg/dl).

These results bring out the fact that horse gram was more effective in lowering blood glucose levels followed by green gram, peas and Bengal gram. More than the amount of fibre the nature of fibre in horse gram could have been the reason for its beneficial effect. Studies by Anthony and Hussain (1998) have shown that fibre alters the time during which the nutrients are digested and absorbed and flattens the blood glucose responses.

Statistical analysis revealed that in the case of adai, the increase in post prandial blood glucose values registered by all the four test recipes were not

significant. But in the case of standard recipe, the increase was significant at five percent level. In the case of dosai, only horse gram incorporation had produced significant increase in blood glucose values. Standard kozhukattai and pittu had registered post prandial blood glucose values which were significantly greater than the fasting blood glucose levels. Bengal gram incorporation in kozhukattai and green gram incorporation in pittu had also produced significantly high post prandial blood glucose values.

Jenkins *et al.*, (2000) have pointed out that fibre rich foods have a low glycemic index and are resistant to rapid digestion and flattens the blood glucose responses.

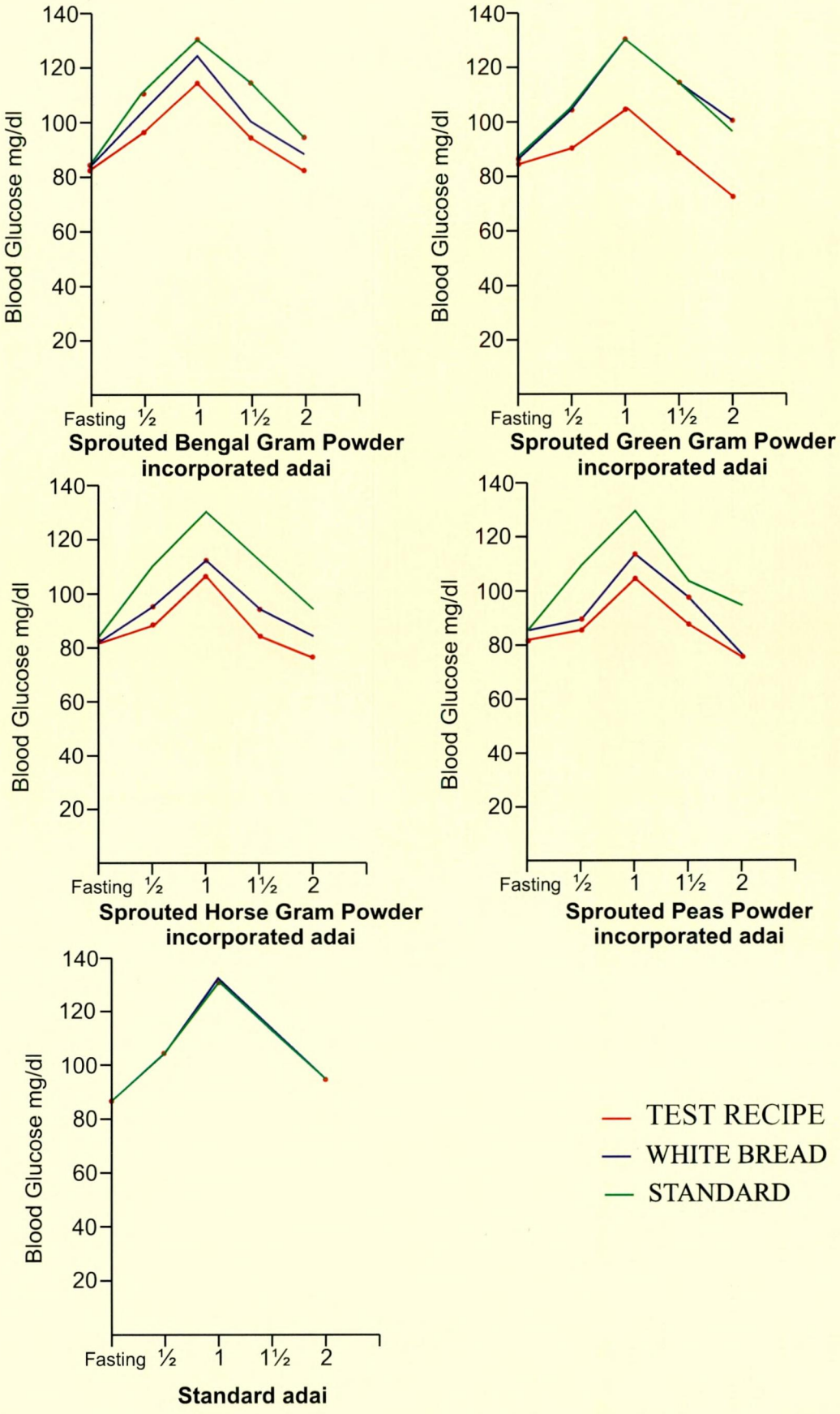
As there is great controversy about whether glycemic index should be calculated on diabetics or non diabetics in the present study the investigator tested the glycemic index both on diabetics and non diabetics. The blood glucose values of the non diabetics are presented in Table XXVII and Figure 10a-10d. Appendix XIV presents the blood glucose values of diabetic individuals for every half an hour after feeding the test recipe and white bread.

TABLE XXVII

MEAN BLOOD GLUCOSE LEVELS OF NON-DIABETIC SUBJECTS BEFORE AND AFTER THE ADMINISTRATION OF TEST RECIPE

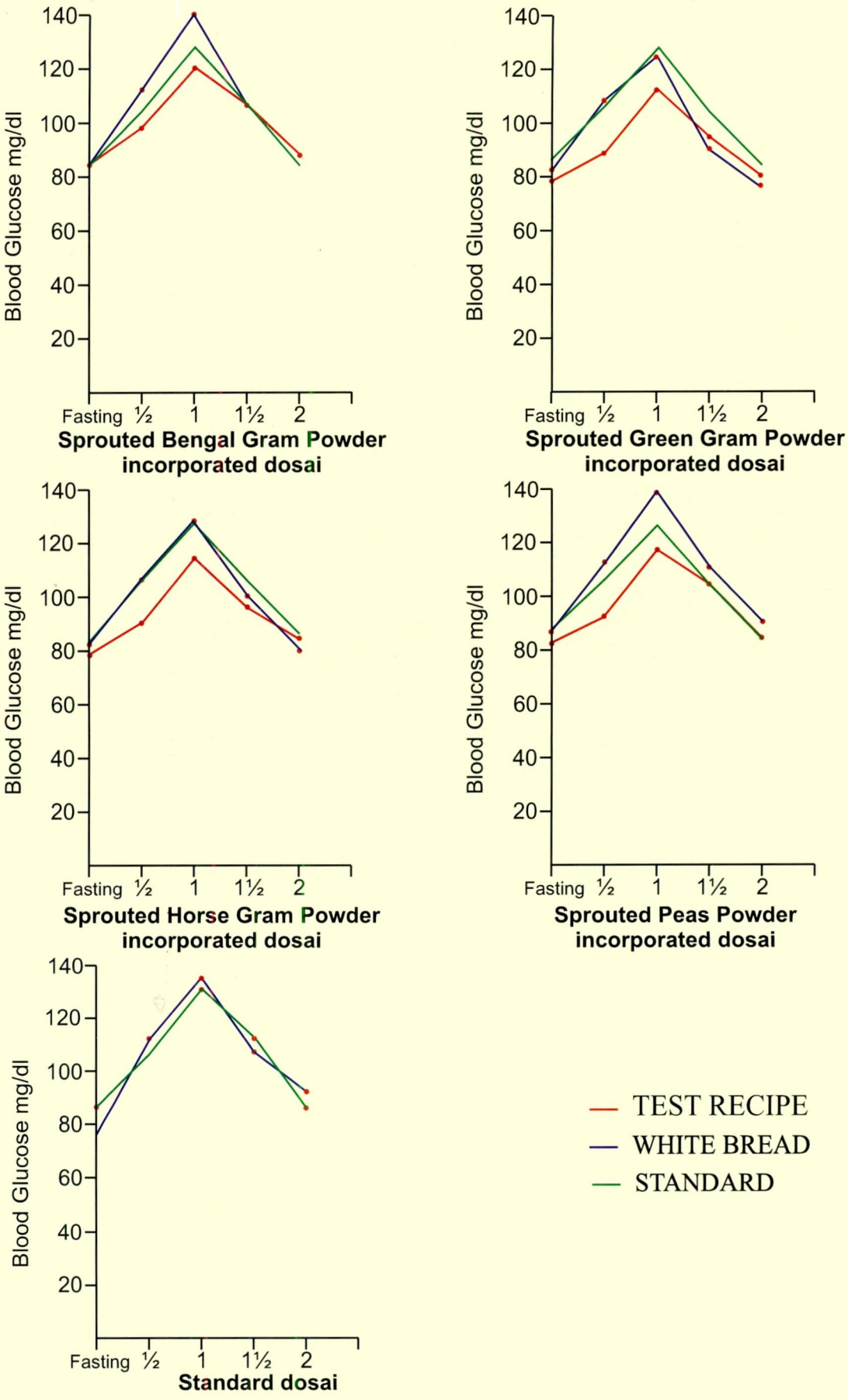
Groups	Level of Incorporation (%)	Blood glucose level (mg/dl)			
		Before test food Mean ± S.D.	After test food Mean ± S.D.	't' Value	'P' Value
ADAI					
Group I (Bengal gram)	20	84 ± 2.87	81 ± 9.90	0.593^{NS}	0.579^{NS}
Group II (Green gram)	40	83 ± 3.09	72 ± 12.51	2.24^{NS}	0.075^{NS}
Group III (Horse gram)	40	79 ± 2.58	73 ± 6.72	1.95^{NS}	0.108^{NS}
Group IV (Peas)	20	81 ± 2.60	77 ± 3.01	2.13^{NS}	0.086^{NS}
Group V (Standard)	Nil	85 ± 1.78	96 ± 5.46	4.98**	0.004**
DOSAI					
Group VI (Bengal gram)	20	84 ± 4.87	88 ± 10.15	1.57^{NS}	0.177^{NS}
Group VII (Green gram)	40	79 ± 4.47	80 ± 11.83	0.031^{NS}	0.976^{NS}
Group VIII (Horse gram)	20	78 ± 2.63	86 ± 5.04	3.17*	0.027*
Group IX (Peas)	20	82 ± 4.53	85 ± 6.65	1.07^{NS}	0.334^{NS}
Group X (Standard)	Nil	83 ± 1.47	84 ± 7.38	0.31^{NS}	0.766^{NS}
KOZHUKATTAI					
Group XI (Bengal gram)	20	78 ± 2.73	84 ± 5.76	3.28 *	0.022*
Group XII (Green gram)	20	82 ± 4.95	80 ± 10.72	0.85^{NS}	0.434^{NS}
Group XIII (Horse gram)	40	80 ± 3.44	81 ± 4.58	0.408^{NS}	0.700^{NS}
Group XIV (Peas)	20	82 ± 3.37	85 ± 5.41	0.749^{NS}	0.488^{NS}
Group XV (Standard)	Nil	85 ± 1.47	91 ± 4.45	2.60**	0.048**
PITTU					
Group XVI (Bengal gram)	20	80 ± 5.41	88 ± 9.45	2.79 *	0.038**
Group XVII (Green gram)	40	79 ± 2.60	81 ± 5.98	0.78^{NS}	0.467^{NS}
Group XVIII (Horse gram)	20	79 ± 3.16	89 ± 6.0	4.10**	0.09**
Group XIX (Peas)	20	81 ± 3.72	89 ± 13.52	1.81^{NS}	0.130^{NS}
Group XX (Standard)	Nil	84 ± 151	94 ± 3.92	4.60**	0.006 **

** - Significant at one percent * - Significant at five percent NS – Not significant



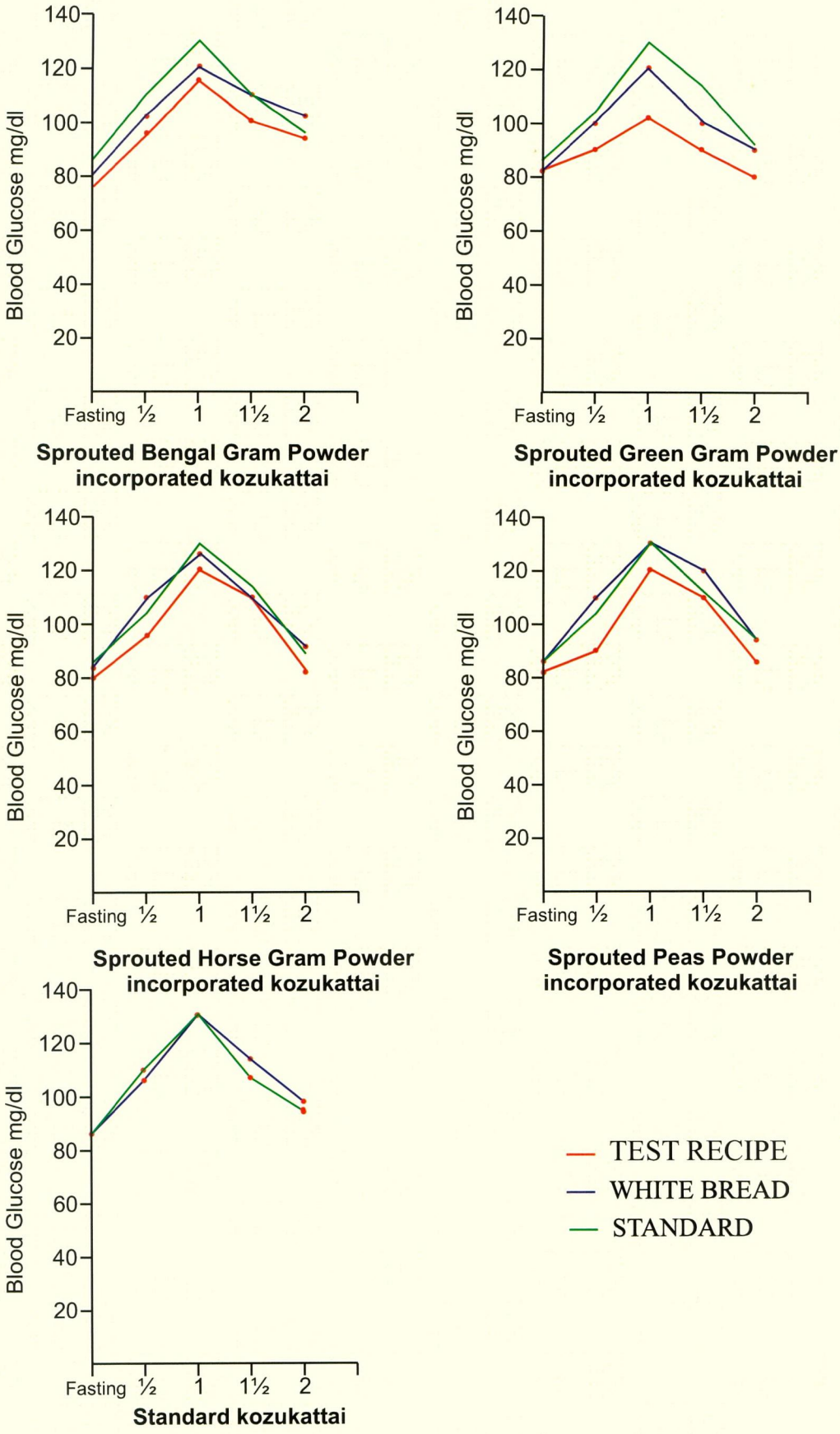
Mean blood glucose level of the selected non diabetics before and after the administration of test recipe adai compared with white bread and standard adai.

Figure 10a



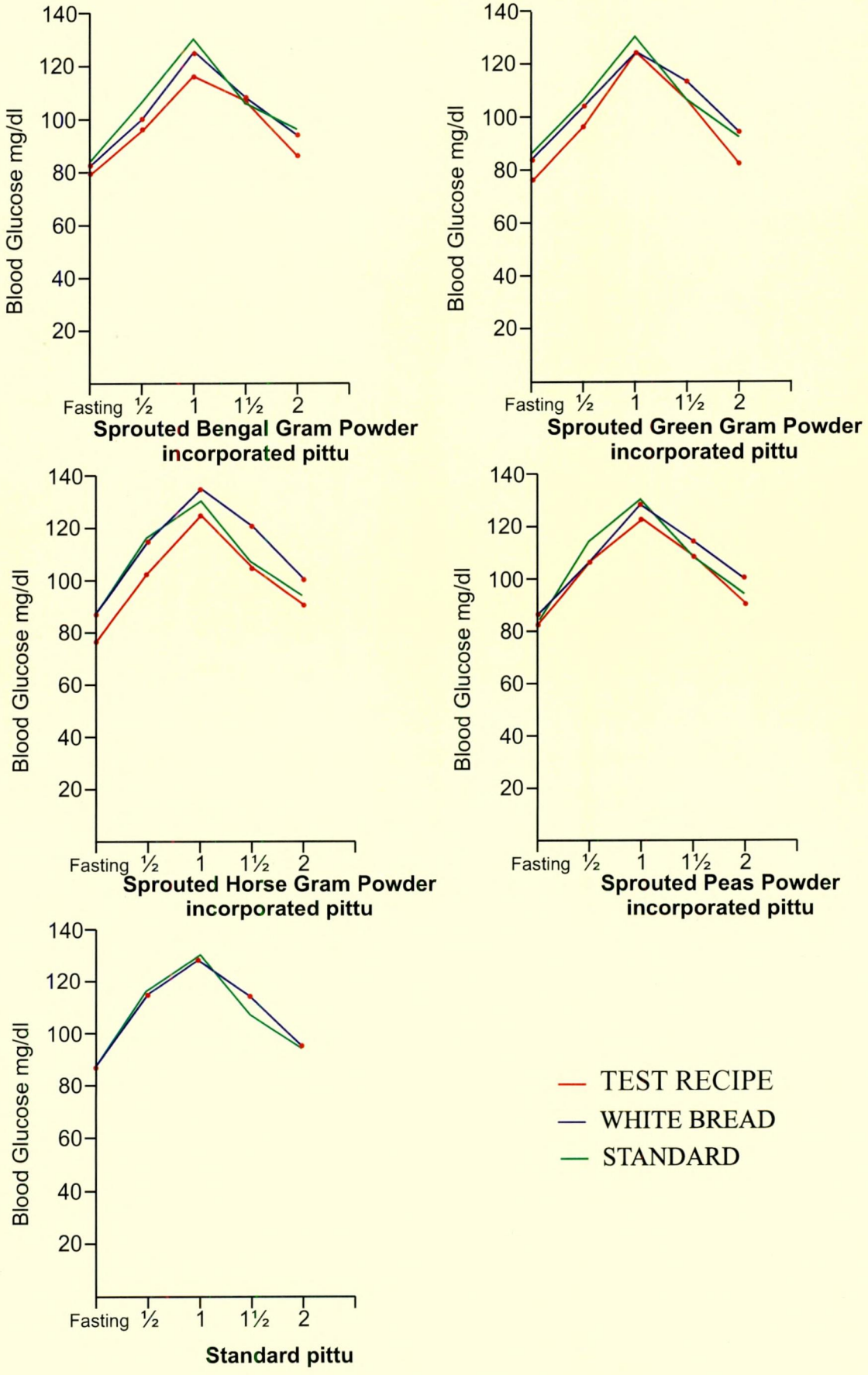
Mean blood glucose level of the selected non diabetics before and after the administration of test recipe dosai compared with white bread and standard dosai.

Figure 10b



Mean blood glucose level of the selected non diabetics before and after the administration of test recipe kozukattai compared with white bread and standard kozukattai.

Figure 10c



Mean blood glucose level of the selected non diabetics before and after the administration of test recipe pittu compared with white bread and standard pittu.

Figure 10d

It is evident from Table XXVII that all the blood glucose values of non-diabetic subjects before and after feeding the test food showed normal values between 70 and 100 mg/dl. As discussed earlier for diabetics and non-diabetics also the post prandial blood glucose values of the standard recipes were higher than that of the legume powder incorporated recipes. This could be attributed to high availability of carbohydrates and low dietary fibre.

The post prandial blood glucose values of subjects fed adai were less than that of fasting values. Here again horse gram and green gram had registered lower values, while Bengal gram showed high value.

In dosai variations, green gram group had shown the lowest mean blood glucose value of 80 mg/dl followed by peas (85 mg/dl), horse gram (86 mg/dl) and Bengal gram (88 mg/dl).

In the case of kozukattai, green gram group had registered lowest value followed by horse gram, Bengal gram and peas. Variations in pittu recipe also showed that green gram group had registered lower value while the other three groups had registered high values which were almost equal. In non-diabetic subjects green gram was found to exert beneficial effect than horse gram.

Statistical analysis indicated that all the standard recipes had produced blood glucose values which were statistically significant at one percent level except standard dosai group. In legume powder incorporated variations the increase in post prandial values were not statistically significant except horse gram incorporation in dosai and pittu and Bengal gram in kozukattai and pittu groups which were significant at five percent level.

2. Glycemic Index

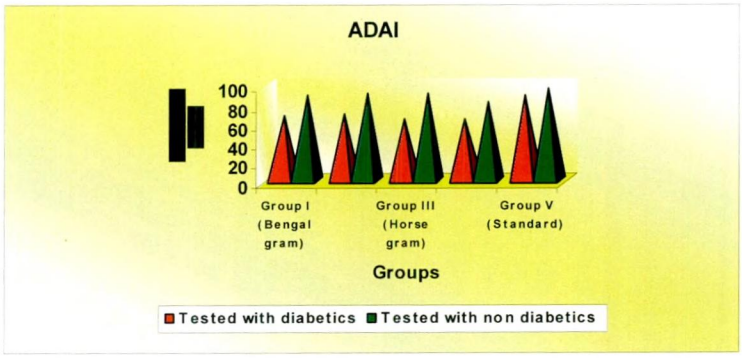
Glycemic index (GI) is ranking of foods on a scale from 0 to 100 according to the extent to which they raise blood glucose levels after they are consumed. Calculating the glycemic index was developed by Jenkins *et al.*, (1981) to assist diabetic patients in reducing post prandial blood glucose through diet. Foods with high glycemic index are those which are rapidly digested and absorbed and result in marked increase in blood glucose levels. Low glycemic index foods, by virtue of their slow digestion and absorption, produce gradual rise in blood glucose levels. Low glycemic index diets improve both glucose and lipid levels in people with diabetes. They have benefits for weight control because they help control appetite and delay hunger. Low glycemic index diets also reduce insulin levels and insulin resistance.

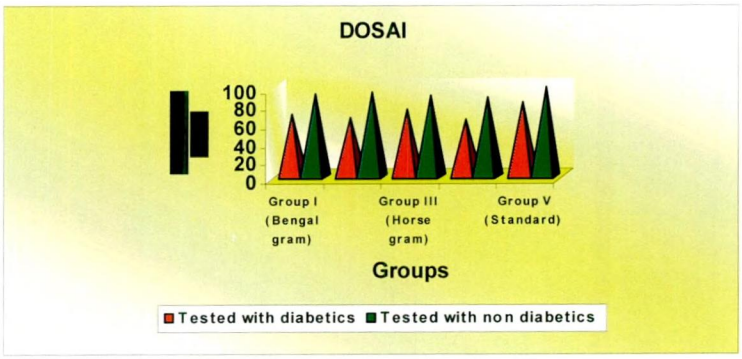
Hence glycemic indices of the recipes which were most acceptable were evaluated by feeding them to groups of Type II diabetics and non diabetics. Following the procedure recommended by Jenkins *et al.*, (1981), the glycemic indices were calculated and are presented in Table XXVIII and Figure 11.

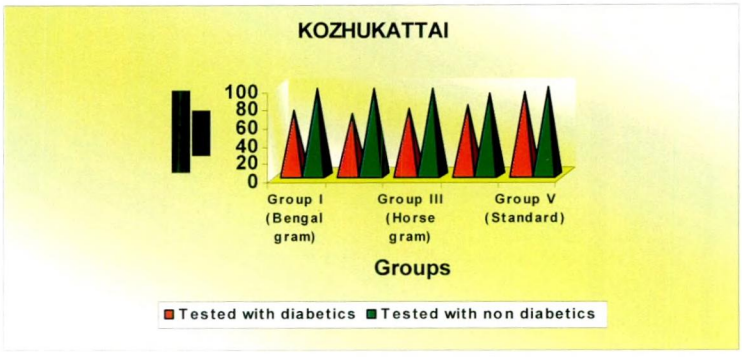
TABLE XXVIII

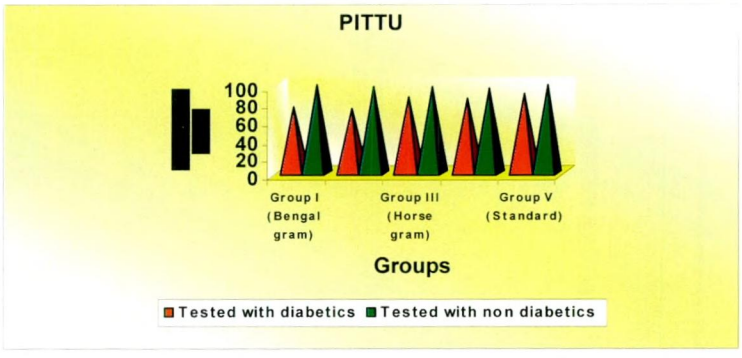
GLYCEMIC INDICES OF THE TEST AND STANDARD RECIPES

Groups	Level of Incorporation (%)	Glycemic Index	
		Tested with diabetics	Tested with non diabetics
Adai			
Group I (Bengal gram)	20	68	90
Group II (Green gram)	40	70	91
Group III (Horse gram)	40	65	91
Group IV (Peas)	20	64	83
Group V (Standard)	Nil	90	96
Dosai			
Group VI (Bengal gram)	20	69	92
Group VII (Green gram)	40	65	93
Group VIII (Horse gram)	20	75	90
Group IX (Peas)	20	63	88
Group X (Standard)	Nil	82	98
Kozhukattai			
Group XI Bengal gram)	20	72	96
Group XII (Green gram)	20	69	96
Group XIII (Horse gram)	40	75	96
Group XIV (Peas)	20	79	92
Group XV (Standard)	Nil	93	99
Pittu			
Group XVI (Bengal gram)	20	74	99
Group XVII (Green gram)	20	72	97
Group XVIII (Horse gram)	20	86	96
Group XIX (Peas) 20%)	20	84	94
Group XX (Standard)	Nil	90	99









GLYCEMIC INDICES OF THE TEST AND STANDARD RECIPES

FIGURE 11

The glycemic indices presented in Table XXVIII show high glycemic index for standard recipes when compared to legume powder incorporated recipes. The standard recipes have high carbohydrate content which had gelatinized during cooking. These high carbohydrate cereal based recipes have high glycemic index than the legume incorporated recipes.

In the case of adai the post prandial blood glucose was the highest for the standard recipe and the corresponding glycemic index was 90 in diabetics and 96 in non-diabetics. In recipes incorporated with different legume powders the glycemic response was moderate which had resulted in lower glycemic indices. Incorporation of sprouted peas at 20 percent incorporation had registered the lowest glycemic index of 64 in diabetics and 83 in non-diabetics, followed by horse gram, Bengal gram and green gram in ascending order.

Variations tested by incorporating sprouted legume powders in dosai recipe showed high post prandial blood glucose level for the group administered the standard recipe. The glycemic index was also high namely 82 and 98 in diabetics and non-diabetics respectively. Among the recipes incorporated with sprouted legume powders, sprouted peas powder incorporation had registered the lowest glycemic index of 63 in diabetics and 88 in non-diabetics, followed by other legumes. Here again sprouted peas powder was incorporated at 20 percent level. Nalwade *et al.*, (2003) have concluded from their study that boiled form of dry peas and Bengal gram had brought about significantly low glycemic responses and hence these can be advocated for consumption to the diabetic subjects. In the present investigation also dry peas incorporation has produced low glycemic index.

Standard kozukattai had produced the highest post prandial glycemic response and very high glycemic index of 93 in diabetics and 99 in non-diabetics. Kozukattai is a recipe prepared by steaming the rice balls prepared out of rice flour. During steaming gelatinization of rice granules occur, which elevates the glycemic response.

Greater the degree of gelatinization of rice granules, higher the glycemic index. Smiller (1994) and Kavitha *et al.*, (2001) have pointed out that gelatinization of rice granules increase glycemic index. At the same time when different sprouted legume powders were incorporated the glycemic response had reduced. Green gram incorporation showed lowest glycemic index of 69 in diabetics while in non-diabetics peas incorporation showed lowest glycemic index of 92.

Pittu is yet another preparation completely made out of steamed rice flour. This is again reflected in high glycemic index of 90 and 99 for standard pittu preparation in diabetics and non-diabetics respectively. Incorporation of different legume powders did produce significant lowering in glycemic index except in non-diabetics fed Bengal gram incorporated pittu.

Results of the glycemic index of the different sprouted legume powders incorporated recipes clearly demonstrate that recipes made out of rice alone had registered very high glycemic index. But adai and dosai variations which had different percentages of legume powder incorporation registered low glycemic index. Blending of rice with equal quantities of pulses alters the availability of starch to digestive enzymes and thus lowers the glycemic response. The results of the glycemic indices strongly point out the fact that incorporation of sprouted legume powders favourably alters the glycemic index and thus will be highly beneficial to diabetics.

The recipe pittu and kozukattai showed high glycemic values. According to Miller (1994), on the basis of glycemic index of glucose as 100, the glycemic index of breakfast cereals range from 43 to 90. Different studies quote different values for the same food at different times to the varying responses of individuals to influence the glycemic index markedly. In addition, particle size also play an important role as the particle size decreases, the glycemic index increases.

Phase III : Imparting diet and therapeutic lifestyle counselling and promoting low glycemic recipes among the diabetics of Tamil Nadu State Transport Corporation, Coimbatore

The results of phase I of the present research indicated a very poor control of blood glucose by the selected diabetics of the present study and lack of knowledge regarding the different aspects of diabetes mellitus. These diabetics had increased risk of developing life threatening diabetic complications due to inadequate knowledge on blood glucose control and dietary management. Hence phase III was planned to educate the diabetics for better management of diabetes mellitus and to promote low glycemic recipes developed by the investigator, among the diabetics.

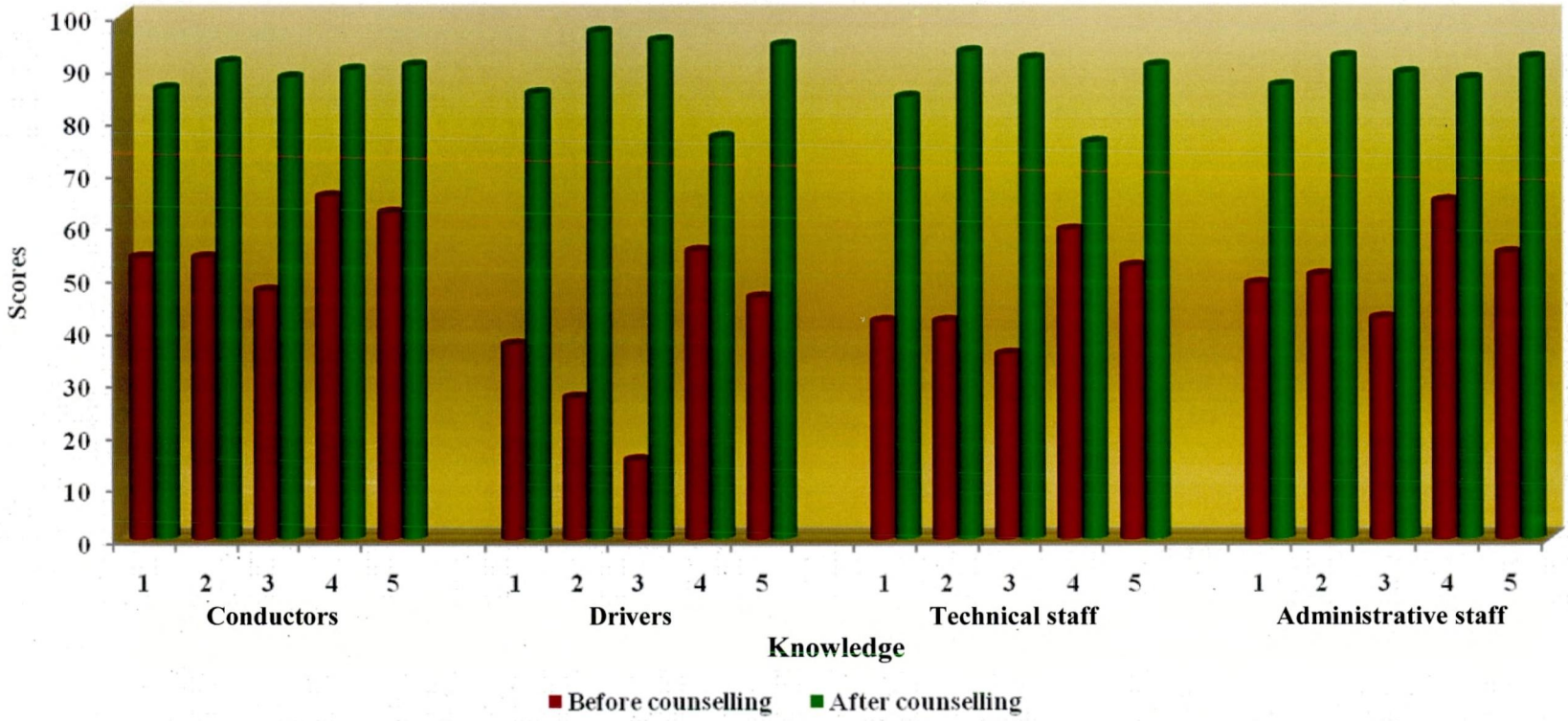
In this direction the initial knowledge and practices of the diabetics were evaluated by administering a questionnaire presented in Appendix V. At the end of diet and therapeutic lifestyle counselling the knowledge of the diabetics was assessed after one month using the same questionnaire. Based on the answers given by the diabetics percentage scores were calculated. The questionnaire evaluated the knowledge of diabetics on five major aspects, namely a) causes of diabetes b) dietary management c) facts of diabetes d) complications of diabetes mellitus and e) Therapeutic life style modifications.

Table XXIX and Figure 12 presents the mean scores obtained before counselling and after counselling for each concept.

MEAN SCORES OBTAINED BEFORE AND AFTER COUNSELLING

Knowledge		Conductors	Drivers	Technical staff	Administrative Staff
Causes of diabetes	Before counselling	53.86 ± 10.15	37.2 ± 14.58	41.68 ± 15.52	48.9 ± 10.6
	After counselling	86.26 ± 10.15	85.28 ± 11.2	84.57 ± 11.07	86.8 ± 10.0
	't'	28.47**	30.11**	21.49**	24.79**
Symptoms observed in a diabetic	Before counselling	53.86 ± 36.28	27.07 ± 9.63	41.68 ± 31.07	50.55 ± 34.13
	After counselling	91.26 ± 11.07	97.00 ± 6.53	93.25 ± 10.48	92.33 ± 10.60
	' t '	10.98**	70.58**	12.76**	10.12**
Complications of diabetes mellitus	Before counselling	47.53 ± 39.30	15.14 ± 7.91	35.42 ± 34.11	42.33 ± 38.36
	After counselling	88.33 ± 11.78	95.35 ± 7.71	91.92 ± 9.68	89.22 ± 11.63
	' t '	10.75**	87.66**	13.77**	9.72**
Dietary management to control blood glucose	Before counselling	65.53 ± 15.12	55.07 ± 12.72	59.15 ± 14.15	64.7 ± 15.0
	After counselling	89.80 ± 9.99	76.85 ± 9.67	75.90 ± 10.2	88.10 ± 10.26
	' t'	15.63**	25.45**	13.37**	12.57**
Therapeutic life style modifications	Before counselling	62.40 ± 22.66	46.21 ± 15.38	52.21 ± 18.61	54.77 ± 21.88
	After counselling	90.60 ± 9.60	94.50 ± 6.49	90.60 ± 10.28	92.1 ± 8.1
	' t '	13.26**	33.27**	13.27**	13.69**

** Significant at one percent level



1 – Causes of diabetes
2 – Symptoms observed in a diabetic
3 – Complications of diabetes mellitus
4 – Dietary management to control blood glucose
5 – Therapeutic life style modifications

MEAN SCORES OBTAINED BEFORE AND AFTER COUNSELLING

FIGURE 12

Mean scores obtained by the diabetics when evaluated about the causative factors of diabetes, indicated that the scores ranged from 37 to 53 percent before counselling. All the four categories of diabetics were well aware that heredity is one of the risk factors and insulin deficiency is a cause for diabetes. The diabetics were not aware of the other causes of diabetes mellitus. Knowledge evaluated after counselling showed marked improvement with an average score of 85 percent after counselling. The increase in knowledge was statistically significant at one percent level ($P < 0.01$).

Evaluation of knowledge about right principles of food intake showed that the diabetics had better knowledge about foods to be avoided. The initial average score was 60 percent. These diabetics had already consulted diabetologists and hence they had some knowledge on foods. The diabetics in all the categories were very much interested and anxious to learn about diet control. They participated in all the counselling sessions and registered very high scores. The dietary principles were reiterated several times to ensure better understanding about good food habits. After counselling the average score had risen to 88 percent.

Conductors and administrative staff had scored very high marks and this well correlates with their educational status. They were the groups for whom minimum education is a requirement for the job. Higher the educational status better was the understanding. For all the groups the improvement in knowledge after diet counselling was statistically significant.

The knowledge of the diabetics regarding the symptoms of diabetes mellitus and symptoms of poorly controlled diabetes mellitus reflected very poor knowledge. Here too drivers and technical staff scored low scores (27.07 and 41.68) compared to conductors and administrative staff (53.86 and 50.55). But after diet counselling all the categories of diabetics showed very high scores, which were above 90 percent. The overall enhancement of the percentage of the diabetics from 27.07 percent prior

counselling to 90 percent after counselling reiterates the fact that counselling had promisingly enabled the beneficiaries to acquire familiarity on this aspect. The improvement was statistically significant at one percent level ($P < 0.01$).

Knowledge regarding complications of poor diabetic control again showed that all the categories of diabetics had very poor knowledge. Here again drivers and technical staff showed very poor knowledge with scores of 15.14 and 35.42 while conductors and administrative staff had obtained better score (47.53 and 42.33). After diet counselling all the groups of diabetics understood the complications of poor diabetic control and realized the need for taking more care towards maintaining normal blood glucose level. They realized that poor control can lead to life threatening complications. Here again the increase in knowledge after counselling was highly significant ($P < 0.01$). Escalation in the percentage distinctly shows that the counselling had made a thrust in the recipients.

Assessment of the knowledge about lifestyle factors which help to maintain normal blood glucose showed an average score of 54 percent before counselling. This initial high score can be attributed to the advice given by their diabetologist. During counselling the life style factors that influence blood glucose control were high lighted and taught repeatedly to make the diabetics retain the facts life long. At the end of counselling all the diabetics had scored more than 90 percent indicating significant gain in knowledge ($P < 0.01$). A study conducted by Xavier (2007) showed that an intensive lifestyle intervention with weight loss and increased physical activity is effective in reducing the onset of diabetes and in the long run it is more effective in reducing the incidence of diabetes related complications particularly cardiovascular disease.