Dr. S. Thilakavathy
Dept. of FSN

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CONTENTS

Pevalance of Diabetes Mellitus Among the Employees of Tamil Nadu State Transport Corporation and Development of High Fibre Recipes for Diabetic Employees

*Thilakavathy S[1]. and Vasanthamani G.[2]

1 Dept. of Food Science and Nutrition,
2 Dept. of Food Service Management and Dietetics, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore- 641 043
* Corresponding author: thilaka.ravichandran@gmail.com

ABSTRACT

The erratic dietary pattern of transport employees coupled with the frenzied pace of work makes the transport employees prone to getting diabetes mellitus along with many other chronic illnesses. A controlled dietary pattern along with adequate awareness of the importance of healthy lifestyle would enable them to manage the illness in a better manner. 9204 employees are engaged in different sectors of Tamil Nadu State Transport Corporation (TNSTC), Coimbatore division were selected and subjected to random blood glucose examination. Those who had random blood glucose level of more than 140mg/dl were selected and their lifestyle pattern was studied, and imparted diet counseling. For development of high fibre recipes, four legumes namely Bengal gram (*Cicer arietinum*), Green gram (*Phaseolus aureus roxb.*), Horse gram (*Dolichos biflorus*) and Dry peas (*Pisum sativum*) were sprouted, dried and powdered. These sprouted powders were incorporated at the level of 20, 40, and 60 percent in the common South Indian breakfast recipes namely dosai, adai, pittu and kozukattai and standardized. Glycemic index of these recipes were assessed by feeding the developed recipes to 120 nondiabetics. The glycemic index of the sprout powder incorporated high fibre recipes was lower than that of the standard recipes.

Key words: Glycemic index, dietary management, Postprandial glucose, Glycemic control, Legumes, high fibre recipes, therapeutic life style counseling, sprouts, standardized recipes.

INTRODUCTION

Transport facilities are indispensable for the development of a country. A good transport system in a country reflects directly on its growth and hence corporate sector personnel have to be given their due importance in terms of health and well being. A comparison of the health condition between transport workers and the general population in USA had shown high risk of diabetes and cardiovascular diseases among transport workers than normal people[1]. A controlled dietary pattern along with adequate awareness of the importance of healthy lifestyle would enable them to manage the illness in a better fashion.

Glycemic index (GI), a classification of the blood glucose raising potential of carbohydrate foods is a dietary management tool for diabetics to assist them in controlling postprandial glucose through diet[2]. Daily incorporation of low glycemic index carbohydrates in meal planning can be an effective self-management strategy for glycemic control and weight management[3].

A proper diabetic diet should include a balance of high proteins, low fat, complex carbohydrates and high fibre which are digested slowly without causing a rapid rise in blood sugar. Legumes share several qualities with whole grains of potential benefit to glycemic control including slow release of carbohydrate and a high fibre content.

Objectives

Keeping all these facts, the present study was planned, to develop high fibre recipes with low glycemic index for the corporate personnels with the following objectives

- To assess the prevalence of diabetes mellitus and elicit the dietary habits and lifestyle pattern of the selected diabetics
- To develop and standardize low glycemic recipes incorporating sprouted legume powders and find out the impact of glycemic index of the standardized recipes on non-diabetics.

MATERIALS AND METHODS

The area selected for the study was Tamil Nadu State Transport Corporation (TNSTC), Coimbatore division, a state government undertaking sector. All the 9204 employees working at various branches of Tamil Nadu State Transport Corporation, Coimbatore division were initially selected for identification of diabetics. This comprised of 804 administrative staff, 6923 running crews (3184 drivers, 3739 conductors) and 1477 technical staff. Technical staff members were the employees working in the industrial unit who were involved in manual work such as repair of tyres and assembly units.

Random blood glucose examination was done for all the 9204 employees using an one touch basic plus glucometer (Bayer) using lancets, which gives the test results in 45 seconds. The subjects who were known diabetics and those who had random blood glucose level more than 140mg/dl were judged as diabetics to be included in the study. This examination revealed that totally 463 were diabetics out of the 9204 employees. Out of this 406 subjects were known diabetics and 57 subjects were diagnosed as diabetics through the present study. The diabetics included 140 drivers, 150 conductors, 90 administrative staff and 83 technical staff. These 463 diabetics were selected to study the socio-economic status, dietary habits, life style pattern, health status, details regarding diabetes mellitus and anthropometric data.

Review of literature indicated great controversy on whether diabetics or non diabetics should be used for assessing glycemic index. However a group of 120 non diabetic subjects from the age group 40 – 50 years having normal body mass index were selected from the same transport corporation for evaluating the glycemic index of the sprouted legume incorporated recipes.

Development of high fibre recipes

Four legumes namely 1) Bengal gram (*Cicer arietinum*) 2) Green gram (*Phaseolus aureus roxb.*) 3) Horse gram (*Dolichos biflorus*) and 4) Dry peas (*Pisum sativum*) that were selected were washed thoroughly and soaked for eight hours and then germinated. The sprouted legumes were then sun dried and roasted till a good aroma arose. It was then cooled and ground to a fine powder and incorporated into four most common South Indian breakfast recipes namely dosai*, adai**, pittu*** and kozukattai****. In each recipe (adai, dosai, kozhukattai and pittu) along with the standard ingredients used for preparation, sprouted legume powders in the proportion of 20 %, 40 % and 60% was incorporated reducing the quantity of rice proportionately, making the total amount of ingredients to 100 g (Table 1). In each recipe 12 variations were tried out and totally 48 recipes were prepared and these recipes were subjected to acceptability trials.

Table 1 - Composition of Standardised Recipes (in percentage)

Ingredients	Adai		Dosai		Kozhukattai		Pittu	
	Legume in corporated	Standard	Legume in corporated	Standard	Legume in corporated	Standard	Legume in corporated	Standard
Rice	40	60	60	60	80	100	80	100
Red gram dhal	20	20	-	-	-	-	-	-
Black gram dhal	20	20	20	20	-	-	-	-
Sprouted Bengal gram	20	-	20	-	20	-	20	-
Sprouted green gram	40	-	40	-	20	-	20	-
Sprouted horse gram	40	-	20	-	20	-	20	-
Sprouted peas	20	-	20	-	20	-	20	-

** -Pan cake made out of fermented batter prepared using soaked rice and black gram dhal. ** -Pan cake prepared by soaking and grinding rice, black gram dhal, and red gram dhal. *** -Steamed rice flour seasoned with mustard, black gram dhal, onions, green chillies, curry leaves and coriander leaves. **** -Steamed rice balls prepared out of coarsely ground rice seasoned with mustard, onion, chillies, curry leaves and coriander leaves.*

Table 1 gives the composition of standardized recipes. The standardized recipes were evaluated by a trained panel of 15 members using a five point rating scale for quality attributes such as appearance, flavour, texture/consistency, taste and overall acceptability

The most accepted variations were finally identified and selected for the evaluation of glycemic index. Along with this the standard preparations without incorporation were also included for evaluation of glycemic index.

Assessment of Glycemic Index

The utility of the glycemic index in managing diabetes is fought with controversy. The American Diabetes Association (ADA) reviewed the evidence on glycemic index as a nutrition intervention for diabetes and concluded that the total amount of carbohydrate is more important than the source (starch or sugar) or type (low or high GI). While acknowledging that low GI foods may reduce postprandial blood glucose levels, they assert that there is insufficient evidence of long-term benefit to recommend using low GI diets as a primary strategy in meal planning[4] (American Diabetes Association, 2002).

Glycemic index was determined by feeding the accepted standardized recipes to 120 normal subjects. The subjects were divided into 20 test groups of six subjects in each group. After estimating fasting blood glucose, all of them were served white bread (75g) providing 50g of carbohydrate.

Blood samples were collected every half an hour for two hours and estimated the blood glucose level. Again after a period of one week, the fasting blood was drawn to estimate fasting blood glucose and then they were served the respective test food containing 50g of carbohydrate, for breakfast. The blood samples were collected at periodic intervals of 0, 30, 60, 90 and 120 minutes and blood glucose levels were estimated.

Glycemic index was calculated using the following formula[5].

$$\text{Glycemic Index} = \frac{\text{Area under the curve of test food}}{\text{Area under the curve of reference food (White bread)}} \times 100$$

RESULTS AND DISCUSSION

Prevalence of Diabetes Mellitus

The blood glucose level of all the 9204 employees were analysed and the results indicated that totally 463 were diabetics, where 86 percent were Type II diabetics and 14 percent were Type I diabetics.

Life Style Pattern of Diabetics

The lifestyle diseases, like coronary disorders, heart diseases, high blood pressure, diabetes or obesity cause the predominant part of all the mortality worldwide. These are such diseases which occur resulting from the way the people live their lives. In developed countries and societies, these diseases become more frequent as economic growth starts. More importantly, they are potentially preventable and can be lowered by changes in diet, lifestyle and environment[6].

Alcohol consumption

Table 2 shows the consumption pattern of alcohol by the selected diabetics.

Table 2 - 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
	Occasionally	250ml	10	8	Nil	Nil	9	15	8	15

Forty two percent of the administrative staff was non-alcoholics, where as 22%of conductors, 36% of drivers and 27% of technical staff consumed alcohol. A greater percentage of those who consumed alcohol did so once a week.

Smoking Pattern

The data pertaining to the habits of smoking and chewing pan by the selected diabetics are presented in Table 3.

Table 3 - Details of smoking and chewing pan by selected subjected

Details	Conductors N = 150		Drivers N = 140		Technical Staff N = 83		Adminis-trative 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

A greater percentage of subjects (77% of conductors, 57% of drivers, 72% of technical staff and 57% of administrative staff) were smokers who were smoking either cigarette or beedi. Income status had direct correlation with type of smoking. 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.

Data presented in Table 4 point out that all the diabetics performed exercise. Sixty nine percent of administrative staff undertook regular exercise. Among other groups only around 50 percent exercised regularly. The drivers, conductors and technical staff expressed shift system as the greatest hurdle for regular exercise. Walking, the main type of exercise was performed on an average duration of 30 minutes almost by all the categories.

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.

The acceptability trials showed that in all the recipes, incorporation of legume powders at 60 percent was not acceptable. In the case of adai, a mixture of 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 highly 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 and pittu are preparations in which normally no dhal or legume is added. So, in this preparation incorporation of sprouted legume powders was acceptable only at 20 percent level. The taste was not acceptable when legume powders were added above 20 per cent.

Thus in each variation the most acceptable level of incorporation was identified and those recipes were selected for evaluating glycemic index. The blood glucose values of the groups of subjects who were administered white bread and then the selected recipes were estimated every half an hour for 2 hours and the glycemic index was calculated.

The mean blood glucose level of the different groups estimated before and after two hours (postprandial) of administration of the test recipes are presented in Table 5.

Table 4 - Exercise pattern of 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
	30min	5	6	Nil	Nil	8	17	6	10
Yoga	45min	5	100	Nil	Nil	8	100	Nil	Nil
	60min	Nil	Nil	Nil	Nil	Nil	Nil	6	100

Table 5 - Mean blood glucose level of selected non-diabetics before and after administration of test recipes

Groups	Level of Incorporation (%)	Blood glucose level (mg/dl)		
		Before test food Mean ± S.D.	After test food Mean ± S.D.	't' Value
ADAI				
Group I (Bengal gram)	20	84 ± 2.87	81 ± 9.90	0.593 NS
Group II (Green gram)	40	83 ± 3.09	72 ± 12.51	2.24 NS
Group III (Horse gram)	40	79 ± 2.58	73 ± 6.72	1.95 NS
Group IV (Peas)	20	81 ± 2.60	77 ± 3.01	2.13NS
Group V (Standard)	Nil	85 ± 1.78	96 ± 5.46	4.98**
DOSAI				
Group VI (Bengal gram)	20	84 ± 4.87	88 ± 10.15	1.57NS
Group VII (Green gram)	40	79 ± 4.47	80 ± 11.83	1.031NS
Group VIII (Horse gram)	20	78 ± 2.63	86 ± 5.04	6.17*
Group IX (Peas)	20	82 ± 4.53	85 ± 6.65	2.07NS
Group X (Standard)	Nil	83 ± 1.47	84 ± 7.38	0.31NS
KOZHUKATTAI				
Group XI (Bengal gram)	20	78 ± 2.73	84 ± 5.76	3.28 *
Group XII (Green gram)	20	82 ± 4.95	80 ± 10.72	0.85NS
Group XIII (Horse gram)	40	80 ± 3.44	81 ± 4.58	0.408NS
Group XIV (Peas)	20	82 ± 3.37	85 ± 5.41	0.749NS
Group XV (Standard)	Nil	85 ± 1.47	91 ± 4.45	2.60**
PITTU				
Group XVI (Bengal gram)	20	80 ± 5.41	88 ± 9.45	2.79 *
Group XVII (Green gram)	40	79 ± 2.60	81 ± 5.98	0.78NS
Group XVIII (Horse gram)	20	79 ± 3.16	89 ± 6.0	4.10**
Group XIX (Peas)	20	81 ± 3.72	89 ± 13.52	1.81NS
Group XX (Standard)	Nil	84 ± 151	94 ± 3.92	4.60**

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

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

In the case of adai minimum increase in blood glucose values was found among the subjects who were fed sprouted horse gram powder incorporated adai, followed by adai incorporated with green gram, peas and bengal gram. The same trend was observed in the case of dosai and kozhukattai and pittu variations. Sprouted horse gram incorporation had produced lowest mean blood glucose values followed by green gram, peas and bengal gram.

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.

The post prandial blood glucose values of the subjects fed with adai were less than that of their 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) groups. In the case of kozukattai, green gram group registered the lowest value followed by horse gram, bengal gram and peas. Variations in pittu recipe also revealed 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. In legume powder incorporated variations the increase in post prandial values was not statistically significant except that of horse gram incorporated dosai ($P<0.05$) and pittu ($P<0.05$) and bengal gram incorporated kozukattai ($P<0.05$) and pittu ($P<0.05$).

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. Hence glycemic indices of the recipes which were most acceptable were evaluated by feeding them to groups of non diabetics and are presented in Table 6.

Table 6 - Glycemic Indices of Test and Standard Recipes

Groups	Level of Incorporation (%)	Glycemic Index
Adai		
Group I (Bengal gram)	20	90
Group II (Green gram)	40	91
Group III (Horse gram)	40	91
Group IV (Peas)	20	83
Group V (Standard)	Nil	96
Dosai		
Group VI (Bengal gram)	20	92
Group VII (Green gram)	40	93
Group VIII (Horse gram)	20	90
Group IX (Peas)	20	88
Group X (Standard)	Nil	98
Kozhukattai		
Group XI Bengal gram)	20	96
Group XII (Green gram)	20	96
Group XIII (Horse gram)	40	96
Group XIV (Peas)	20	92
Group XV (Standard)	Nil	99
Pittu		
Group XVI (Bengal gram)	20	99
Group XVII (Green gram)	20	97
Group XVIII (Horse gram)	20	96
Group XIX (Peas) 20%)		
Group XX (Standard)	20	94
	Nil	99

The glycemic indices of the standard recipes were higher than the legume powder incorporated recipes. The standard recipes had high carbohydrate content which got gelatinized during cooking. These high carbohydrate cereal based recipes had high glycemic index than the legume incorporated recipes.

In the case of adai the post prandial blood glucose was the highest (96%) for the standard recipe and the corresponding glycemic index was 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 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 postprandial blood glucose level (98%) for the group administered with the standard recipe. Among the recipes incorporated with sprouted legume powders, incorporation of sprouted peas powder had registered the lowest glycemic index followed by other legumes.

Standard kozukattai and pittu had produced the highest post prandial glycemic response and very high glycemic index of 99. 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 and gelatinization of rice granules increase glycemic index[7]. At the same time when different sprouted legume powders were incorporated the glycemic response was reduced. A high GI diet raises blood sugar levels, increases insulin demand and over burdens the ability of the pancreas to produce insulin, thereby increasing the risk of type 2 diabetes[8].

Results of the glycemic index of the different sprouted legume powders incorporated recipes clearly demonstrated that recipes made out of rice alone had registered very high glycemic index. However 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.

CONCLUSION

Standard recipes had produced very high blood glucose levels compared to the legume incorporated recipes developed during investigation; sprouted horse gram powder incorporated recipes had recorded only a minimum increase in blood glucose level followed by green gram, peas and Bengal gram powders incorporated recipes.

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