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**AWARENESS OF GLYCEMIC INDEX AND EVALUATION OF LOW GLYCEMIC INDEX
IN TYPE - 2 DIABETES MANAGEMENT**

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INTRODUCTION

Diabetes, recognized as a group of heterogeneous disorders is becoming an epidemic and is threatening the globe, especially in the developing countries. Unless diabetes prevalence is controlled, the mortality and disease burden from diabetes and other non – communicable diseases will continue to increase. According to Bermuda Diabetes Association (2011), type 2 diabetes constitutes about 85 – 95 per cent of all diabetes in developed countries and accounts for an even high percentage in developing countries. Approximately 8.3 per cent of the US population has diabetes and estimates indicate that 79 million adults have prediabetes and 33.8 per cent are obese, increasing their risk of diabetes¹. Diabetes is estimated to be responsible for 3.96 million adult deaths per year at global level. By 2025, the number of people with diabetes in India is estimated to rise to 70 million²

Diabetes in India is no longer a disease of the affluent or a rich man's disease. It is becoming a problem even among the middle income and poorer sections of the society. Poor diabetic subjects are more prone to complications as they have less access to quality health care.³ The fast changing lifestyle in Indians is making them prone to the disease and the incidence of the disease among the children is on the rise. This can be attributed to obesity and sedentary lifestyle among the children.⁴

Aging, urbanization, physical inactivity, increased maternal age at delivery, faulty diet and exposure to viral infections may initiate autoimmunity or accelerate an already ongoing beta cell destruction in type 1 diabetes. The year 2011 marked two important jubilees in the management of diabetes mellitus; one is the discovery of insulin 90 years ago and the other one is the introduction of the glycemic index, 60 years later, both originated at the University of Toronto, Canada. Both discoveries can help to improve diabetes tremendously and thus have contributed to the advancement of management of this troubling disease.⁵ Diet and proper nutrition play an important role in the prevention and treatment of diabetes. Eating healthy foods in the proper balanced amounts can help lower blood sugar and manage the symptoms of type 2 diabetes.

Balancing carbohydrates, eliminating sugars and adding protein will help stabilize blood glucose in people with type 2 diabetes.⁶ A new and significant focus on the role of unavailable carbohydrate in glycemic improvement is emerging. This has important application in increasing accessibility to health benefits by contributing to the prevention of and management of glucose intolerance, insulin resistance and associated chronic disease to a wider range of consumers.⁶

A low glycemic index diet can improve glycemic control in diabetes without compromising hypoglycemic events.⁷ A low glycemic index diet was associated with improved diet quality and a reduction in hyperglycemia. There were no differences in energy, carbohydrate or protein intake.⁸

Considering the importance of glycemic index and the role of it in effective diabetes management the study was planned with the following objectives: To

- Study the awareness regarding glycemic index among selected respondents.
- Develop and evaluate a product for low glycemic index.
- Formulate and evaluate a low glycemic index cycle menu for type 2 diabetes management.

METHODOLOGY:

The diabetics were selected from a hospital namely "Pondicherry Diabetic Speciality Centre" by convenient sampling method. Glycemic index is a number representing the ability of a food, relative to that of glucose, to increase the level of glucose in the blood.⁹

The awareness of glycemic index was studied among healthcare professionals, diabetics, cardiovascular patients and adolescents. Among a total of 500 respondents, 133 healthcare professionals comprising of nurses and dietitians, 115 diabetics and 47 cardiovascular patients were interviewed.

The questionnaire included questions like, knowledge about glycemic index (GI), source of knowledge, what is glycemic index, the benefits of low glycemic index foods, and awareness of packaged low glycemic index products, how glycemic index knowledge could be disseminated and whether a local database on glycemic index will be useful. The results of the awareness study pointed out the lack of awareness about glycemic index and hence in order to promote awareness and to promote the use of low glycemic index foods, a product was developed.

The criteria for product development was that the product should be rich in fibre and protein, less in fat and carbohydrate, easy to prepare and acceptable by the diabetics. Since diabetics experience polyphagia or frequent hunger, an ideal and healthy snack to be consumed during mid-morning or tea time would be biscuits and hence the product to be developed was chosen as biscuits.

To develop the biscuits, each ingredient was selected with utmost care. Inulins are a group of naturally occurring polysaccharides produced by many types of plants. They belong to a class of fibers known as fructans and is considered a form of soluble fiber. Inulin a natural sweetener, promises as a foundation for a sweetener replacement system. Inulin ranges from completely bland to subtly sweet and can be used to replace sugar, fat and flour,¹⁰

A standard biscuit was prepared and two variations of the standard were made by replacing sugar with inulin. Variation - 1 was made by incorporating five grams of inulin and variation - 2 was done by adding ten grams of inulin, each for a set of 22 biscuits.

The nutritive value of the biscuits and cycle menu was calculated for macronutrients such as energy, protein, fat, carbohydrates and fibre using the nutritive value of Indian foods, National Institute of Nutrition, 2007.

Twenty four diabetics were selected and grouped into two with 12 each as the experimental and control group. The selection criteria followed was that the subjects should be a type 2 diabetic, in the age of 40 – 70 years with no complications having a normal Body Mass Index and glycosylated hemoglobin (HbA_{1c}) greater than seven per cent. An informed consent was obtained from the patients and willingness to follow the diet plan and consumption of the snack was ensured.

An interview schedule was administered to the 24 diabetics to elicit details on socio – economic background, medical history, dietary and lifestyle pattern. Medical history such as duration of diabetes, type of treatment, complications, frequency of blood glucose check up and the family history of diabetes and obesity were elicited.

Details on lifestyle pattern namely type of work, leisure time activity; exercise pattern and frequency of exercise were also recorded. Dietary pattern such as vegetarian or non – vegetarian, consumption of oil and dietary restrictions were elicited. Biochemical assessments were done to elicit details on blood glucose parameters.

Fasting blood glucose, postprandial blood glucose, lipid profile and HbA_{1c} tests were conducted for all the 24 diabetics. Five ml of blood was drawn from the diabetics through a syringe to carry out the biochemical assessments. A ten hour fasting blood glucose level and two hour postprandial blood glucose levels was found out using glucose oxidase method (National Institute of Nutrition, 2003).

RESULTS AND DISCUSSION:

A. DETAILS ON AWARENESS OF GLYCEMIC INDEX AMONG THE SELECTED RESPONDENTS.

a. Awareness of glycemic index

Table I

Awareness of glycemic index by healthcare professionals and patients

Respondents (N = 500)	GI awareness	
	N	Percent
Healthcare professionals (N = 133)	111	83
Adolescents (N = 162)	118	73
Diabetics (N = 115)	6	5
Cardiovascular Patients (N=47)	2	4
Obese adults (N = 43)	1	2

Among 500 respondents, 238 respondents i.e (48 per cent) had awareness about glycemic index. The awareness of glycemic index was less among 109 i.e. (95 per cent) diabetics, 45 i.e (96 per cent) cardiovascular patients and 42 (98 per cent) obese adults.

b. Source of information about glycemic index

Table II

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P – 4	98	96	208	142	125	147	193	201
P – 5	110	118	170	142	185	196	360	362
P – 6	262	188	330	205	178	187	236	257
P – 7	140	102	194	138	182	241	280	292
Mean	170.47	132.14	237.57	160.71	157.14	176.0	255.57±	220.43
±S.D	±63.27	±31.98	±56.46	±24.63	±30.69	±38.06	54.66	±23.82
't' value	1.285 ^{ns}		3.923*		0.738 ^{ns}		1.573 ^{ns}	
Males								
P – 8	130	114	215	139	116	168	230	293
P – 9	130	107	180	131	125	134	170	187
P – 10	139	109	186	131	201	224	280	302
P – 11	220	173	360	198	110	122	135	171
P – 12	102	101	196	149	101	137	196	198
Mean	144.20	120.80	227.40	149.60	130.60	157.0	202.20	230.20
±S.D	±44.60	±29.55	±75.30	±28.05	±40.62	±41.12	±55.72	±62.26
't' value	0.875 ^{ns}		1.936 ^{ns}		0.916 ^{ns}		0.670 ^{ns}	

* Significant at 55 (t<0.05)

ns -- not significant

Three diabetics with normal fasting blood glucose level had a high postprandial blood glucose levels. The normal fasting blood glucose was maintained by them and the postprandial blood glucose level was decreased by the supplementation. The supplementation of the low glycemic index biscuits and low glycemic index cycle menu showed a great impact in reducing the blood glucose levels among the experimental group of diabetics. A five per cent level of significance was noted for postprandial blood glucose among female diabetics of experimental group. Male diabetics did not show significance for both fasting and postprandial blood glucose levels.

Patients with long duration of diabetes and who are taking multiple and hypoglycemic therapies were more likely to have elevation of postprandial glucose level in the presence of normal fasting blood glucose level.¹² In order to control diabetes well, there is need to control the blood sugars 24 hours a day and not just when fasting. People can have a pretty normal fasting blood sugar but still have a high postprandial level.¹³

SUMMARY

The research study shows that the awareness of glycemic index was very less particularly among the diabetics. An ideal snack for diabetics can be the developed biscuits where inulin is substituted for sugar. Following a low glycemic index menu everyday improved the chances of controlling blood glucose more effectively than a normal menu. The administration of the low glycemic index cycle menu showed a significant impact on reducing the mean fasting blood glucose levels. Hence glycemic index knowledge and education is essential for effective diabetes management.

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Source of information about glycemic index

Source*	Number of respondents (N = 238)
Internet	62
Product brochure	24
Magazines	34
Newspaper	9
Public talks	48
Friends/colleagues	38
Text books	102

*Multiple response

Sixty two respondents utilized internet to gain knowledge about glycemic index. Newspapers did not play a major role in educating people on glycemic index. Text books were the common source of information about glycemic index and was told by 102 respondents. A local database on glycemic index or websites / blog which will be the best source in future to reach people about glycemic index was expressed by 202 respondents.

c. Knowledge about glycemic index

Table III Respondents' knowledge about glycemic index

Glycemic index	Number of respondents (N=238)
Carbohydrate content of food	146
Nutritive value of food	18
Sugar content of food	73
Unsure / do not know	1

Among the 238 respondents who knew about glycemic index, 146 respondents had the knowledge to relate carbohydrate content of the food with glycemic index whereas 73 respondents think that glycemic index is the sugar content of the food. Eighteen respondents had a wrong idea about glycemic index, relating it to the nutritive value of foods.

c. Importance of glycemic index

Table IV Importance of glycemic index

Particulars	Most important	Very important	Important	Least important	Not important	Chi square
Diabetes	149	61	11	4	2	8.63*
Obesity/ overweight	53	95	55	9	14	
Heart health	35	52	56	56	21	
Sports nutrition	39	31	51	51	41	

*-significant at five per cent level

One forty nine respondents considered glycemic index to be most important for diabetics whereas six respondents mentioned least importance. Glycemic index was said to be important for obesity, heart health and sports nutrition by 55, 56 and 51 respondents respectively. Seventy six respondents stated that glycemic index is not important for obesity, heart health and sports nutrition.

d. Concerns in using the concept of glycemic index

Table V Concerns of glycemic index concept

Concerns in using the concept of GI*	Number of respondents (N= 238)
Lack of resources	41
Lack of education	192
GI is very complicated	47
GI value of local foods are not available	39
Therapeutic use of GI still remains controversial	11

*multiple response

The reason for the unawareness of glycemic index was found to be lack of education. Forty seven healthcare professionals said that glycemic index is very complicated and it is difficult to explain the subjects. As suggested by 39 respondents people should be made aware about the glycemic index value of the local foods. Lack of resources was also said to be a drawback in using glycemic index by 41 respondents.

e. Nutritive value

Table VI Nutritive value of the biscuits

Nutrients	Standard biscuits		Test biscuits	
	100 gms	Per serving	100 gms	Per serving
Energy (Kcal)	103.2	165	63.4	101
Protein (gms)	25.5	4	25.4	4
Fat (gms)	15.7	2	15.7	2
Carbohydrate(gms)	168.8	27	69.4	11
Fibre (gms)	4.9	0.78	4.9	0.78

The test biscuits yielded 101 Kcal of energy, which would be adequate for diabetics during the snack time. Four grams of protein per serving was obtained due to the incorporation of egg protein. The amount of energy and carbohydrate yielded by the test biscuits was less when compared to the standard biscuits, proving it to be an ideal snack for diabetics.

f. Glycemic index of the biscuits

Classification of glycemic index

Classification*	Glycemic index range
Low	Less than 55
Medium	56 – 69
High	Greater than 70

*Indian council of Medical Research, 2010

Some foods contain different fractions of soluble and insoluble fibers favour slow release of sugar into small intestine and its absorption into blood (reduced peak and prolonged rate). These foods are termed as low glycemic index foods which has practical utility in management of diabetes and control of obesity (Indian Council of Medical Research, 2010). Since the glycemic index of the formulated biscuits is 52, it could be termed as low glycemic index biscuits and could be used in diet management of type 2 diabetes.

Glycosylated Hemoglobin (HbA_{1c}) values

Table VII Glycosylated hemoglobin (HbA_{1c}) values of the selected diabetics

HbA _{1c} (per cent)	Experimental (N=12)	Control (N=12)
Less than 7.0	Nil	Nil
7.0 – 10.0	9	10
Greater than 10.0	3	2

Nineteen diabetics had a range of 7.0 – 10.0 per cent of Glycosylated hemoglobin (HbA_{1c}). Three diabetics of experimental group and two diabetics of control group had HbA_{1c} greater than 10.0 per cent showing uncontrolled diabetes for past three months. Aiming for HbA_{1c} levels of less than 7.0 per cent still remains the general target for good glucose control.¹¹

g. Evaluation of the Low Glycemic Index Menu

The impact of the low glycemic index menu was assessed by the evaluation of initial and final blood glucose levels and nutrient intake of the selected diabetics.

Table VIII Initial and final blood glucose levels

Patients	Experimental (N=12)				Control (N=12)			
	FBG		PPBG		FBG		PPBG	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Females								
P – 1	230	148	294	169	135	142	220	263
P – 2	144	124	237	151	115	133	230	287
P – 3	210	149	230	178	180	186	270	232