



FORMULATION OF MILLETS FLAKES BALLS AND STUDY OF GLYCEMIC INDEX (GI) & GLYCEMIC LOAD (GL)

Diabetology

Sujitha. S*

Research Scholar, Department of Nutrition and Dietetics, PSG College of Arts and Science, Coimbatore - 641014, India *Corresponding Author

Chithra. R

Associate Professor, Department of Nutrition and Dietetics, PSG College of Arts and Science, Coimbatore - 641014, India

ABSTRACT

Diabetics are recommended foods with low Glycemic Index (GI) in order to have good glycemic control. Hence in the present study, mixed millets flakes balls were developed, organoleptically evaluated, standardized and the nutritive value was estimated by factorial method. The GI and GL (Glycemic Load) of these items were studied. The millets flakes balls were highly acceptable organoleptically. The quantity of millets flakes balls containing 50 g of carbohydrate was determined to be 133g and that quantity was administered for the study of GI. The nutritional value also was ascertained for the same quantity. The energy value was 283.82 k cal. With regard to the protein and fat content the values were 8.6 and 5.4g respectively. The other nutrients studied were Calcium(105.45mg), iron(2.8mg), Vitamin A(40.6mcg), Vitamin B1(0.25mg), Vitamin B2(1.3mg) and Vitamin C(0.4mg). The Millets Flakes Balls registered low GI of 53 and a Medium GL of 17.

KEYWORDS

Glycemic Index, Glycemic Load, Carbohydrates, Blood Glucose, Millets Flakes Balls.

INTRODUCTION

The glycemic index (GI) concept was introduced by Jenkins *et al.* as early as 1980 as a ranking system for carbohydrates based on their immediate impact on blood glucose levels. GI was originally designed for people with diabetes as a guide to food selection, advice being given to select foods with a low GI. Lower GI foods were considered to benefit as a result of the relatively low glycemic response following ingestion compared with high GI foods. Glycemic load (GL), a product of GI and quantity of carbohydrate eaten provides an indication of glucose available for energy or storage following a carbohydrate containing meal. Although GI is usually tested on individual foods, there are methods described whereby the GI and GL of meals and habitual diets can be estimated. In addition to a role in the treatment of diabetes, low GI and GL diets have more recently been widely recommended for the prevention of chronic diseases, including diabetes, obesity, cancer and heart disease and in the treatment of cardiovascular risk factors, especially dyslipidemia (Venn and Green, 2007).

In 1988, Jenkins *et al.* confirmed that glycemic index was an important tool used in dietary management of people with diabetes and in weight loss programs. Low glycemic index foods, by virtue of the slow digestion and absorption of their carbohydrates were reported to produce a more gradual rise in blood sugar and insulin levels with associated health benefits. Low glycemic index foods had thus been shown to improve the glucose tolerance in both healthy and diabetic subjects.

With these points in mind, the present study was taken up with the following objectives:

- 1) To develop mixed millets flakes balls and study the acceptability & nutritive value and
- 2) To estimate the Glycemic Index and Glycemic Load

Methodology

The methodology was framed and a presentation was made to the ethical committee at the Coimbatore medical college hospital. The queries raised by the panel were answered appropriately and the ethical clearance was granted after submitting necessary documents.

1) Development, Organoleptic Evaluation and Standardization of Millets flakes balls

Ingredients	Quantity (g)
1. Kodo millet (Varagu) Flakes	20
1. Finger Millet (Ragi) flakes	15
2. Wheat flakes	15
3. Honey	10
4. Pistachio	2
5. Almonds	4
6. Roasted Bengal gram flour	10
7. Milk	20

Method of preparation:

- 1) Dry toasted and combined the kodo millet flakes, ragi flakes, wheat flakes, roasted bengal gram flour, grated pistachio and almonds in a mixing bowl.
- 2) Added hot milk to the flakes mixture and mixed well.
- 3) Added honey and made stiff round balls and served.



The developed food was organoleptically evaluated for appearance, texture, flavour, taste and overall acceptability by thirty semi trained panel members using a five - point hedonic rating scale.

2) Estimation of Carbohydrate Content and Portion Size of the Food Item for the Study of GI

The determination of carbohydrate content and the portion size is an important step in the study of GI of a food item.

Step 1: Carbohydrate content of the developed food item for the quantities given above was assessed making use of the "dietcal" software based on food composition table.

Step 2: Prepared the food item

Step 3: Weighed the prepared items.

Step 4: Based on the weight and carbohydrate content, the portion size containing 50 g of carbohydrate was determined.

Note: On the day of the study of glycemic response (on the administration of the test food), the test food was prepared in bulk for ten volunteers as per the recipe and the above steps were repeated for administering accurate portion sizes.

3) Assessment of Nutritive Value of One Portion of Millets Flakes Balls

The energy, protein, fat, total dietary fiber, calcium, iron, carotene, vitamin B₁, B₂ and C content in one portion (containing 50 g carbohydrate) of the standardized food were also assessed making use of the above mentioned food composition table and "dietcal" software.

4) Determination of Glycemic Index (GI) and Glycemic Load (GL) of Selected Millets Flakes Balls

a) Estimation of GI

By convenience sampling method, ten non - diabetic healthy adult

volunteers were selected and the importance of the study was explained to them. They were asked to assemble on a fixed day with empty stomach in the early morning. The fasting blood glucose levels of the volunteers were recorded. The glycemic responses at 30, 60, 90 and 120 minutes after the administration of the reference food (glucose – 50g) were recorded. On the following day the same procedure was repeated with the test food (Mixed Millets Flakes Balls – 133g containing 50g of carbohydrate). Using these values, graph was plotted and the GI of the food item was determined using the standard formula given by Brand Miller *et al.* (2004).

Study of GL

Ebbeling and Ludwig (2001) defined GL as the weighted mean of the dietary GI multiplied by the available carbohydrate content per nominal serve size divided by 100. The GL was calculated using the value of GI and the available carbohydrate content in one nominal serve size of the food item. The GL is an arbitrary value as the nominal serve size is based on individual judgement and not on any objective distinction. Hence the GL of a food item would vary depending on the nominal serve size and the number of servings consumed.

RESULTS AND DISCUSSION

1) Organoleptic acceptability of the Millets Flakes Balls (Table 1)

Organoleptic acceptability of the millets flakes balls showed that the colour and appearance, texture, flavour and taste were highly acceptable to the selected panel of 30 semi trained judges. The mean scores obtained by the developed food item was 4.6 out of 5.0.

Table 1 Organoleptic Acceptability of the Millets Flakes Balls

Criteria	Mean Scores out of 5
Colour & Appearance	4.8
Texture	4.2
Flavour	4.8
Taste	4.7
Overall Acceptability	4.7
OVERALL MEAN	4.6 ± 0.25 (SD)

2) Nutritive Value / Portion Size of the Millets Flakes Balls (Table 2)

The quantity of millets flakes balls containing 50 g of carbohydrate was determined to be 133g (Portion Size). The energy value was 283.82 k cal. With regard to the protein and fat content the values were 8.6 and 5.4g respectively. The other nutrients studied were Calcium (105.45mg), iron (2.8mg), Vitamin A (40.6mcg), Vitamin B1 (0.25mg), Vitamin B2 (1.3mg) and Vitamin C (0.4mg).

Table 2 Nutritive Value / Portion Size of the Millets Flakes Balls

Nutrients (Units)	Energy (kcal)	CHO(g)	Protein (g)	Fat (g)	Calcium (mg)	Iron (mg)	Vitamin A (µg)	Vitamin B1 (mg)	Vitamin B2 (mg)	Vitamin C (mg)
Quantity	283.82	50.04	8.673	5.466	105.45	2.897	40.68	0.249	0.138	0.4

3) Mean Glycemic Responses to Glucose (Reference Food) and the Millet Flakes Balls (Test Foods) in the Selected Volunteers (Table 3)

a) Mean Glycemic Response to Glucose:

The mean fasting glycemic level of the selected volunteers was 86 mg / dL. On administration of 50 g of glucose with water, the blood glucose values got elevated to the peak in 30 minutes with a mean value of 141 mg / dL. The values followed a reducing trend thereafter. After 1 hour of administration of glucose the mean blood glucose dropped down to 133 mg / dL. After 90 minutes and 120 minutes, the mean blood glucose values reduced to 115 mg / dL and 92 mg / dL respectively.

b) Mean Glycemic Responses to the Formulated Millets Flakes Balls (Table 3)

The mean glycemic responses are given in table 3 & figures 1.

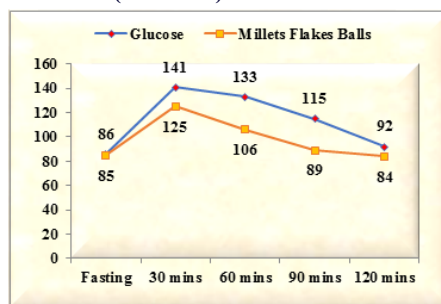
Table 3 Mean Glycemic Responses to Glucose (Reference Food) and the Millets Flakes Balls (Test Foods) in the Selected Volunteers (n=10)

Items Administered	Glycemic levels (Fasting and after administration- mg / dL)				
	Fasting	30 mins	60 mins	90 mins	120 mins
Glucose (50g)	86	141	133	115	92
Millets Flakes Balls (133g with 50 g carbohydrate)	85	125	106	89	84

The mean fasting blood glucose levels of the selected volunteers was 85 mg / dL. Half an hour after administration of test food the mean blood glucose levels increased to 125 mg / dL. After 60 minutes and 90 minutes, the mean blood glucose values reduced to 106 mg / dL and 89 mg / dL respectively. Two hours after administration of the test foods the mean glycemic levels dropped down to 84 mg / dL almost nearing the fasting blood glucose levels.

These levels are remarkably lower than the levels recorded by the reference food “glucose” showing the role of millets in excellent glycemic control.

Figure 1 Glycemic Responses to Glucose (Reference Food) and the Millets Flakes Balls (Test Foods) in the Selected Volunteers



4) Glycemic Index of the Millets Flakes Balls

The range of glycemic index and the category viz., low GI, medium GI and high GI are given in table 4 (Brand - Miller *et al.*, 2004).

Table 4 Categories of Glycemic Index

Range of GI	Category
1 - 55	Low GI
56 - 69	Medium GI
70 - 100	High GI

The Millets Flakes Balls registered low glycemic index of 53. Millets Flakes Balls is a sweet item made without sugar but with honey. Hence the item recorded a low GI making it a healthy sweet.

5) Glycemic Load of the Millets Flakes Balls:

The GL of the Millets Flakes Balls was found to be 17 (Medium GL). GI and a “nominal serve size are taken into consideration for calculating the GL. The categories of GL viz., “low, medium and high” and the respective range of GL are given in table 5 (www.mendosa.com/gilists.htm).

Table 5 Categories of Glycemic Load

Range of GL	Category
1 - 10	Low GL
11 - 19	Medium GL
20 and more	High GL

CONCLUSION:

Glycemic index and glycemic load of foods generally reduce on the incorporation of millets, pulses and vegetables. Substitution of these ingredients in the place of medium or high carbohydrate foods reduces the GI and GL of the diet making it more suitable for diabetics. Such combinations should be encouraged for the non- diabetic individuals too in order to reduce the glycaemic peaks.

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