

Low Glycaemic Index Snacks Formulation for Diabetics

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Abstract

The investigation was undertaken to develop low glycaemic index snacks namely *Lentflax* mix and *khastapuri* utilizing wheat flour, barnyard millets flour, bengal gram dal flour, drumstick leaves powder, lentil, groundnuts, flax seeds, gingelly seeds, coriander and omum. Acceptability of the developed snacks was studied. Result of organoleptic evaluation indicated that *Lentflax* mix (8.8) and *khastapuri* (8.3) secured scores for overall acceptability. Nutrient analysis indicated that *Lentflax* mix and *Khastapuri* developed snacks were rich in protein and fiber content. Blood glucose response of developed snacks was studied among normal subjects and glycaemic index was calculated. Glycaemic index of *Lentflax* mix was 34.8 and *khastapuri* was 31.3. Even after sixty days of storage both the products were well accepted and microbial level found to be below detectable (BDL) level. Hence these low glycaemic index snacks may be suggested for the consumption by the diabetic subjects.

Keywords: Low glycaemic index snacks; Sensory evaluation; Nutrient and Microbial evaluation.

Introduction

Diabetes Mellitus is the most common metabolic disorder affecting humankind and creating health hazards. According to International Diabetes Federation estimates, around 415 million people had Diabetes Mellitus in 2015 and this number is expected to rise to 642 million by 2040. Diabetes is an increasing problem among urban as well as in rural population (Hwang 2012)⁶. India is home to 69.1 million people with diabetes mellitus and is estimated to have the second highest number of cases of diabetes mellitus in the world after China in 2015 (IDF 2016)⁷.

Low glycaemic index foods, by virtue of their slow digestion and absorption, produce gradual rises in blood sugar and insulin levels, and have proven benefits for health. They have benefits for weight control because they help control appetite and delay hunger. Various researches have proved that low glycaemic index foods control blood glucose levels and effectively manage diabetes. (Silambuselvi and Hemamalini 2016)⁸.

Snacks are foods consumed between meals. In today's hectic lifestyle, meals are often taken on the run, between classes, in the car and on the work desk. Snack foods have become part of everybody's life, and often consumed in place of regular meals. Snacks and light meals are popular forms of catering at any time of the day or night and there is a wide variety of foods to be offered (Foskett *et al.*, 2004)⁴. In this contest low glycaemic snacks will be beneficial for prevention, maintenance and treatment of diabetes. Therefore, an attempt was made to develop such snacks which may be useful for consumption of diabetics.

Materials and Methods

Twelve normal randomly selected subjects those willing to serve as experimental subjects were

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selected for experiment. The measurements were taken for height (cm) and weight (kg) and body mass index was calculated for selected subjects.

Preparation of snacks: The present study was conducted to develop low glycaemic index snacks. *Lentflax mix* and *khastapuri* these two snacks were developed utilizing wheat flour, barnyard millet flour, bengal gram dal flour, drumstick leaves powder, lentil, groundnuts, flax seeds, gingelly seeds, cumin seeds, coriander seeds, omum, cooking oil and salt. The composition of developed low glycaemic index snacks is given in (Table 1).

Sensory evaluation: The developed snacks were evaluated for different sensory attributes by panel member of 10 semi-trained judges using a nine-point hedonic scale (Amerine *et al.*, 1965).

Nutritional Evaluation of formulated snacks: The parameters analysed were moisture, total minerals, total fat, dietary fiber, by AOAC procedures (1990). The crude protein content was evaluated by micro K-jeldhal method while crude fat was estimated by Soxhlet method. The minerals i.e., iron, manganese, copper and zinc were estimated by atomic absorption spectrophotometer, Perkin R. Elmer Model - 3110. The values of carbohydrate and energy were calculated by using the food composition tables (Gopalan *et al.*, 2010)⁵.

Glycaemic index evaluation: Each developed snack was evaluated individually in twelve subjects. Blood glucose response technique was employed to evaluate the glycaemic index of glucose and each test food. Weighted amount of developed test foods providing 50 g of carbohydrate was served to the subject around 7.30 am. Then finger prick samples of blood were collected with lancet at 0, 30, 60,

90 and 120 minutes. Glucose content in the blood was determined by Glucometer. In the same way glucose response in the blood of the subjects was also determined by administering 50g of glucose. Using the blood glucose tolerance curve and food tolerance curve the glycaemic index of the test food was calculated using the formula given by Woleven and Jenkins (1981).

Shelf Life Study: The shelf life of the best accepted snacks was studied. It was packed in polythene pouch and stored at room temperature and refrigeration temperature for a period of 2 months. The samples were drawn fortnightly for assessing the quality by organoleptic evaluation.

Microbial Evaluation: Total bacterial count and presence of yeast and mould at the initial and final day of storage period were analysed by Direct Method of Counting (DMC) given by Dubey and Maheshwari (2004)³.

Statistical Analysis: To analyse the data 't' test and analysis of variance (ANOVA) were used to compare the differences in organoleptic scores of products. The statistical analysis was carried out by following the procedures prescribed by Panse and Sukhatme (1985)¹¹.

Results and Discussion

A total sample of twelve normal subjects comprised of six male and six females from 30 to 40 years of age group were selected for the experiment. Anthropometric measurements of the selected subjects are given in Table 2. The height of the selected male and female subjects ranged from 151 to 170 cm and 149 to 155 cm with an average

Table 1: Composition of the developed low glycaemic index snacks

Sr. no.	Ingredients (g)	<i>Lentflax mix</i>	<i>Khastapuri</i>
1.	Wheat flour	-	38
2.	Barnyard millet flour	-	22
3.	Bengal gram dal flour	-	20
4.	Lentil	38	-
5.	Groundnuts	12	-
6.	Flaxseeds	25	-
7.	Gingelly seeds	7	-
8.	Cumin seeds	1	-
9.	Coriander	1	-
10.	Omum	-	0.5
11.	Drumstick leaves powder	-	1.5
12.	Cooking oil	16	18

value 169 ± 0.89 cm and 151.5 ± 2.58 cm respectively. The mean value of body weight of the selected male subjects was 66 ± 2.19 kg and it was ranged from 55 to 72 kg. Whereas for female subjects it ranged from 50 to 56 kg with the mean value of 52.5 ± 2.94 kg. Average value of the body mass index of male subjects was 24.83 and 23.0 for female subjects.

Mean values of organoleptic scores for the acceptability of the developed low glycaemic index snacks are presented in Table 3. Results indicated that *Lentflax mix* obtained the highest score (8.5 ± 0.51) for overall acceptability followed by *khastapuri* (8.4 ± 0.59). On the whole both the products found to have good acceptability as the scores obtained for organoleptic characteristics were more than 8.0.

The nutrient content of developed snacks are presented in Table 4. The mean value of moisture (g%), protein (g%), fat (g%), fiber (g%), iron (mg%), copper (mg%), manganese (mg%) and zinc (mg%) of *Lentflax mix* were 3.14, 18.97, 38.82, 2.89 3.15,

1.04, 1.98 and 2.09 respectively. The respective values for corresponding nutrients of *khastapuri* were 5.7, 10.68, 23.04, 3.93, 2.90, 0.46, 0.37 and 1.74. Calculated value of carbohydrate (g) and energy (kcal) of *Lentflax mix* and *khastapuri* was 52.95, 51.47 and 520, 458 respectively. In conclusion the results indicated that both the developed snacks were rich in protein and fiber content. Development of cereal pulse-based value added nutritious instant mixes studied by Lohekar (2014)¹⁰ also reported all most same amount of nutrient content.

The mean values of blood glucose response in normal subjects at 0, ½, 1, ½ and 2 hours after the intake of the test food was studied (Table 5). From the results it is evident that the blood glucose was at the highest peak at half an hour following the ingestion of the food for both *Lentflax mix* (100.38 ± 7.24) and *Khastapuri* (109.5 ± 10.11). There after the level of the blood glucose found to be declined gradually. On the whole blood glucose response values for developed snacks were ranging from 94.08 ± 7.78 to 93.16 ± 7.22 .

Table 2: Mean values of anthropometric measurements of selected subjects

Anthropometric measurements	Men (N=6)		Women (N=6)		‘t’ value
	Range	Mean \pm SD	Range	Mean \pm SD	
Height (cm)	151-170	169 ± 0.89	149-155	151.5 ± 2.58	11.05**
Weight (kg)	55-72	66 ± 2.19	50-56	52.5 ± 2.94	14.73**
BMI	22.5-24.5	24.83 ± 2.48	22.2-23.8	23 ± 0.57	14.48**

** Significant at 1 per cent level

Table 3: Mean scores of organoleptic characteristics for the acceptability of developed snacks

Products	Mean value of organoleptic scores of developed snacks				
	Colour	Texture	Taste	Flavour	Overall acceptability
<i>Lentflax mix</i>	8.1 ± 0.55	8.8 ± 0.41	8.4 ± 0.50	9.0 ± 0	8.5 ± 0.51
<i>Khastapuri</i>	8.0 ± 0.72	8.4 ± 0.50	8.0 ± 0.56	8.8 ± 0.41	8.4 ± 0.59

Table 4: Proximate and mineral composition of developed snacks

Nutrients	<i>Lentflax mix</i> (Mean \pm SD)	<i>Khastapuri</i> (Mean \pm SD)
Moisture (g)	3.14 ± 0.02	5.7 ± 0.15
Protein(g)	19 ± 0.03	10.68 ± 0.04
Fat (g)	38.82 ± 0.01	23.04 ± 0.62
Fiber (g)	2.89 ± 0.01	3.93 ± 0.02
Carbohydrate (g)	53.0	51.5
Energy (kcal)	520	458
Iron (mg)	3.15 ± 0.02	2.90 ± 0.43
Copper (mg)	1.04 ± 0.02	0.46 ± 2.30
Manganese (mg)	1.98 ± 0.03	0.37 ± 0.61
Zinc (mg)	2.07 ± 0.02	1.74 ± 0.02

The glycaemic index of developed snacks in the normal subjects is given in Table 6. The results indicated that glycaemic index value of *Lentflax mix* and *khastapuri* was found to be 34.8 and 31.3. Significant difference in the glycaemic index of *Lentflax mix* and *khastapuri* was noticed. In conclusion it can be said that both the products recorded low glycaemic index value. A study conducted on development and evaluation of Khakhra using low glycaemic index ingredients by Sugantha and Raajeswari (2013)¹³ indicated 56.8 value of glycaemic index for Khakhra which is more than found in developed snacks. On the other hand, *Heartdiabocare* functional snack developed by shinde (2018) had 26.77 low glycaemic index.

The Mean score for overall acceptability of *Lentflax mix* stored in refrigerator and at room

temperature for varying period are presented in the Table 7. The mean scores of overall acceptability of *lentflax mix* stored for varying period at room temperature were ranging from 8.5 to 7.35 and at refrigerator temperature from 8.5 to 7.8. It was found that as the period of storage increased mean score of overall acceptability was significantly decreased. Though the score reduced, it was in the category of like moderately (7.0) in both the samples. From the results it can be inferred that *Lentflax mix* can be stored up to 60 days in an air tight container at room and refrigerator temperature. Even *Heartdiabocare* functional snack developed by shinde (2018) found to be in good condition after a period of 90 days storage.

The mean score for overall acceptability of *khastapuri* stored in refrigerator and at room

Table 5: Mean blood glucose response values of formulated snacks in the selected normal subjects

Particular	Blood glucose response values Mean \pm SD (mg/100 ml)				
	0 hrs.	½ hrs.	1 hrs.	1½ hrs.	2 hrs.
Glucose	94.83 \pm 5.11	149 \pm 34.7	125.33 \pm 15.0	113.33 \pm 17.7	100.41 \pm 18.87
<i>Lentflax mix</i>	95.41 \pm 3.42	100.33 \pm 7.24	95.66 \pm 4.53	93.00 \pm 7.56	94.08 \pm 7.78
<i>Khastapuri</i>	95.16 \pm 4.87	109.5 \pm 10.11	104.58 \pm 12.48	100.08 \pm 12.34	93.16 \pm 7.22
CD	-	-	8.94	9.23	9.44
SE \pm	-	-	3.03	3.03	3.04
F- value	NS	NS	5.88**	12**	5.60**

NS - Non-Significant ** - Significant at 1 per cent level

Table 6: Mean glycaemic index values of developed snacks

Name of the snacks	Glycaemic index (%)
<i>Lentflax mix</i>	34.8
<i>Khastapuri</i>	31.3
CD	11.75
SE \pm	3.9
F- value	13.90**

** - Significant at 1 per cent level

Table 7: Mean scores for overall acceptability of *Lentflax mix* stored at room temperature and at refrigerator temperature for varying periods

S. No.	Storage period	Mean scores of overall acceptability for <i>Lentflax mix</i>	
		Room temperature Mean	Refrigerator temperature Mean
1	Initial	8.5	8.5
2	15 days	8.1	8.3
3	30 days	8.0	8.0
4	45 days	7.75	7.9
5	60 days	7.35	7.8
	CD	0.40	0.40
	SE \pm	0.14	0.14
	F-value	8.83**	4.01**

** - significant at 1 % level

Table 8: Mean scores for overall acceptability of khastapuri stored at room temperature and at refrigerator temperature for varying period

S. No.	Storage period	Mean scores of overall acceptability of <i>Khastapuri</i>	
		Room temperature Mean	Refrigerator temperature Mean
1	Initial	8.4	8.4
2	15 days	8.4	8.4
3	30 days	8.2	8.2
4	45 days	7.9	8.0
5	60 days	7.7	7.8
	CD	0.40	0.31
	SE ±	0.14	0.11
	F-value	4.25**	6.20**

** - significant at 1 % level

Table 9: Microbial content of developed snacks

Name of product	Bacterial count				Yeast and mould count			
	Room Temperature		Refrigeration Temperature		Room Temperature		Refrigeration Temperature	
	Initial	2 months	Initial	2 months	Initial	2 months	Initial	2 months
<i>Lentflax mix</i>	2.9×10^4	3.89×10^4	2.9×10^4	3.62×10^4	Nil	Nil	Nil	Nil
<i>Khastapuri</i>	2.64×10^4	3.59×10^4	2.64×10^4	3.33×10^4	Nil	Nil	Nil	Nil

temperature for varying period are presented in the (Table 8). Result indicated that a significant decline in the overall acceptability score of *Khastapuri* from initial to 60th day of storage at room temperature and at refrigerator temperature was noticed. However, *khastapuri* was well accepted up to 60 days of storage period as it scored more than 7.0 for overall acceptability.

The Microbial analysis was done for total bacterial count for the developed snacks at initial and on 60th day of storage period at the refrigerator and at room temperature conditions (Table 9). It was observed that the lowest bacterial count was in *Khastapuri* (3.33×10^4 cfu) stored at refrigeration temperature and the highest bacterial count was observed in *Lentflax mix* stored at room temperature (3.89×10^4 cfu). Though there was increase in bacterial count of stored sample, it did not exceed the safe level for consumption. On the other hand, the yeast and mould count were not noticed. The results are in line of the study conducted by Langote (2017)⁹ on formulation of snacks with incorporation of maize flour and its safety aspects.

Conclusion

On the whole, results indicated that developed *Lentflax mix* and *Khastapuri* had good acceptability.

Glycaemic index value of *Lentflax mix* and *Khastapuri* was 34.8 and 31.3 and it can be stored up to 60 days. Therefore, it may be suggested for the consumption by the diabetic subjects as these were found to have low glycaemic index values.

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