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Formulation Of Low Glycemic Index, High Fiber Enriched Pasta By Using Locally Available Product Millet, Cereal And Pulse Mix For Type II Diabetes

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ABSTRACT

Diabetes mellitus is a chronic metabolic disease which is characterized by high level of blood glucose which leads to serious damage of vital organs over period of time if not treated. The prevalence of type II diabetes has been raised dramatically last three decades in countries of low- and middle-income countries and there are greater risk of death and disability due uncontrolled blood sugar. Diet plays an important role in controlling blood glucose level. A high glycemic index (GI) food (low in fibre) will cause a more rapid or immediately increase in blood sugar level and a low GI food (high in fibre) will increase blood sugar levels more slowly. Pasta as a snack is very popular among new generation. Today, commercially available pasta is made from either refined flour (commonly available) or durum wheat (expensive and imported in India) Commercially available pasta has very low fiber content. Hence, we have a need to improve the fiber content in pasta, retain the acceptability and ensure that it has low GI and glycemic load (GL) value. Therefore, in present study three variations of low GI pasta were prepared by using roasted flour mix of cereal like whole wheat, maize, millets such as pearl millet, barnyard millet and pulses like bengal gram and

cow pea. All three variations of developed pasta were organoleptic evaluated on 30 normal subjects and checked their glycemic index and glycemic load.

The organoleptic evaluation of all variations of pasta shows that overall acceptability of Mix I Pasta was high compare to Mix –II and Mix-III variation pasta. The GI of three variations of pasta were Mix I pasta glycemic index were low (51.94 ± 1.60) Mix II (58.05 ± 1.80) and Mix III (57.96 ± 1.98). The glycemic load of mix I was 20.85, Mix II – 23.32 and Mix III was 23.30. Hence the developed pasta Mix-I from roasted mix flour of millet, cereal and pulses are low in glycemic index with high score of overall acceptability.

Keywords: Diabetes Mellitus, Roast, Glycemic Index, Glycemic Load, Organoleptic Evaluation, Millets and Pasta

INTRODUCTION

Diabetes mellitus is characterized by high level of blood sugar and high level of sugar in urine and considered as important growing health problems all over the world. Type II diabetes is the most common form of diabetes and its prevalence is also increasing rapidly. According to a report published by IDF 2013, the global prevalence of diabetes in adults was 8.3% (382 million people), with 14 million more men than women. The majority are between the age group of 40 and 59 years and the number are expected to rise beyond 592 million by 2035 with a 10.1% global prevalence. **(IDF 2013)**

Dietary modifications are a key driver of insulin resistance. Increased consumption of high calorie foods, meats, and different animal fats, exceptionally refined grains, and sugar-sweetened beverages, are a concept to play a quintessential role in the rising fees of type II diabetes globally. **(Mc Macken M, Shah S. 2017)**

The Glycemic Index (GI) ranks foods according to how they affect glucose in the blood stream. The glycemic index uses the amount of carbohydrate, the fibre content and serving size to calculate the rise or fall of bloods sugar level when the food is ingested. One of the most important factors that determine a food's glycemic index is how highly processed its carbohydrate are. Processing carbohydrate removes the fibre rich outer bran and the vitamin and mineral rich inner germ and leaves mostly the starchy endosperm. **(Schulze MB 2004)**

The GI of a food is calculated as an incremental area under the two-hour blood glucose response curve (iAUC) following a 12-hour fast and ingestion of a food with a certain quantity of available carbohydrate (usually 50 g). The average GI value is calculated from data collected in 10 healthy normal human subjects. The GI is ranked from 0 to 100 assigned to a food, with pure glucose arbitrarily given the value of 100, which represents the relative rise in the blood glucose level two hours after consuming that food. (**Glycemic Research Institute 2012)**

Many studies have shown that the efficacy of millets in improving glycemic control, decreasing fasting blood glucose level, and post-prandial rise in blood glucose level, reducing insulin index and insulin resistance and reducing the glycosylated haemoglobin (HbA1c) level. **(Singh 2020, Palanisamy T 2020, Geetha K, 2020)**

Recently, millets are receiving increasing spotlight in combating diabetes as a dietary option **(Henry and Kaur, 2014; Nambiar and Patwardhan, 2014; Muthamilarasana et al., 2016).** Millets provides high calories, high dietary fiber both soluble and insoluble, and protein with balanced amino acid profile, many essential minerals, some B complex vitamins, and antioxidants **(Suma and Urooj, 2012).** These play a substantial role in prevention of many human diseases such as Type II diabetes, cancer, cardiovascular, and neurodegenerative diseases **(Kannan, 2010; Shahidi and Chandrasekara, 2013**). Millets are a good source of food as they are gluten free and non- acid forming so is soothing and they are easy to digest. Millets are considered to be one of the least allergic grains.

Pulses are rich sources of low GI carbohydrates (carbohydrate, up to 65%), and protein with up to 25% of dry weight. **(Singh N, 2017).** The pulses contain phytochemicals compound such as catechins and procyanidins which suppresses the enzymatic activity of carbohydrate digestive enzymes including α-amylase and α-glucosidase thereby contributing towards improved post-prandial blood sugar control **(Padhi EMT, Ramdath D 2017)**
In the present study, we prepare a low GI pasta containing wheat, barnyard millets, pear; millet, maize, cowpea and bengal gram flour with the following objectives

OBJECTIVE OF THE STUDY

The objective of the present study is:

a. Formulation of low glycemic index mix Pasta,
b. Organoleptic evaluation of formulated Pasta, and
c. Estimate their glycemic index and glycemic load.

METHODOLOGY

Ethical approval

The study protocol was reviewed and approved by the Institutional Review Board under the approval number DAIRB_ TVL_21_05 having been approved by Dr. Agarwal's Eye Hospital (Institutional Review Board), No-10 Bypass Road, Vannarpettai Tiruneiveli 627003, Before conducting the experiment before feeding the food items and checking the blood glucose on human subjects.

Consent form

Potential participants were given an overview of the purpose of the research and the procedure of the test. Each willing participants were asked to fill and signed the consent form prior to blood test.

Procurement of raw material

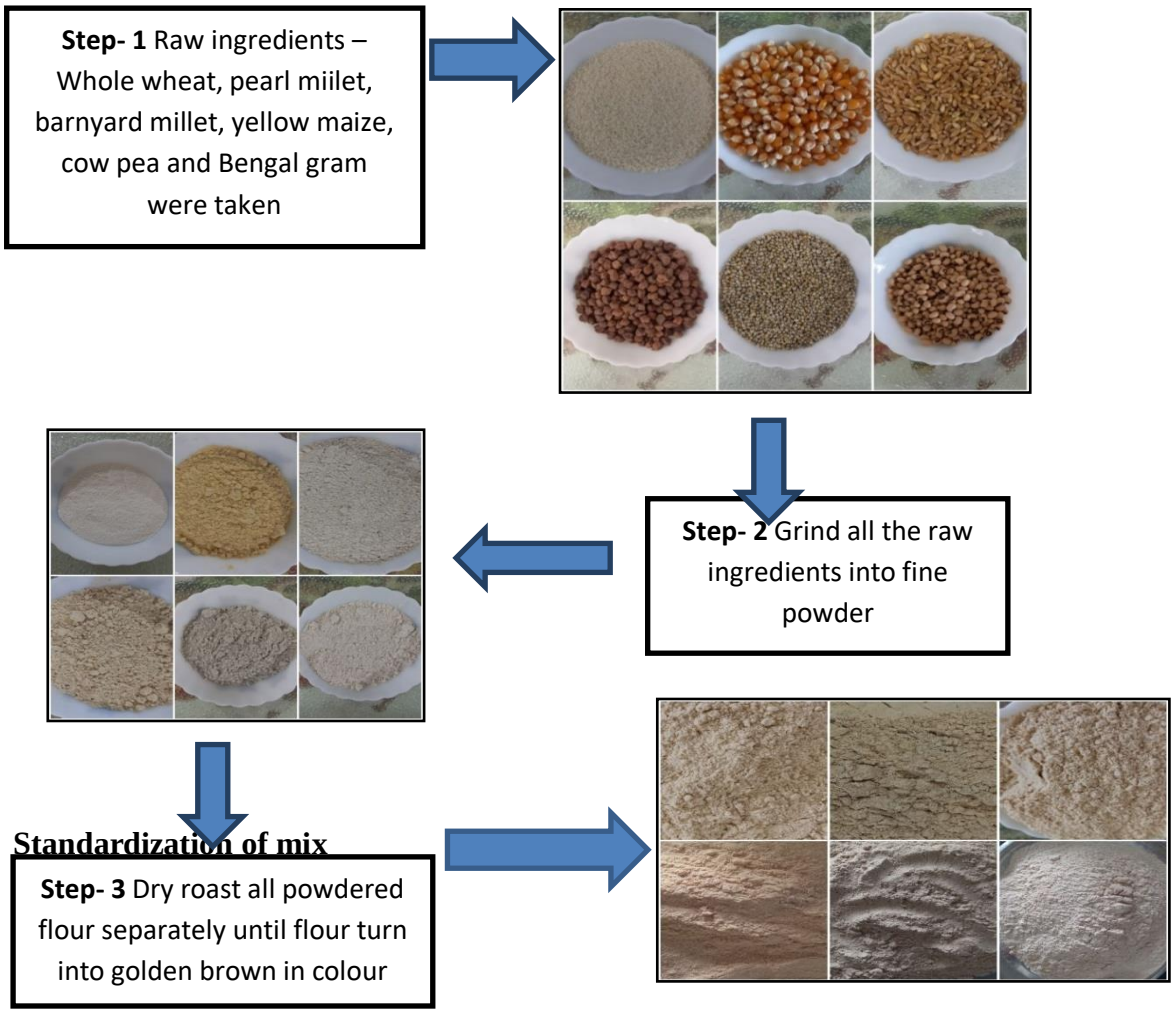
All the ingredients whole wheat, cow pea, barnyard millets, bengal gram, pearl millet, and yellow maize were purchased from the local market of Coimbatore (Kalapatti). All the samples were visually inspected for fungal infestation, foreign materials and samples were cleaned prior to use.

Selection of method of processing

Processing is commonly done to enhance the quality of the grains by converting them into edible form. Utilization of millets could be enhanced by processing them into various forms such as roasted, sprouting and fermented products (**Jaybhaye et al., 2014).** For this study, roasting method of processing was selected.

Roasting: All raw materials were cleaned for residue, stones and other impurities. These were then separately ground to fine powder in a flour mill. After that dry roast all ingredient in a pan till the flour turn into golden brown in colour.

FLOW CHART OF PREPARATION OF ROASTED MIX FLOUR



Three variations of mix roasted process were prepared and the mix is standardized for its various contents.

Table- 1 Standardization of Roasted Mix – 1kg

Ingredients	Mix I (g)	Mix II (g)	Mix III (g)
Whole wheat flour	500	500	500
Yellow maize flour	100	200	100
Pearl Millets	100	100	200
Barnyard millets	200	100	100
Bengal gram flour	50	50	50
Cow pea flour	50	50	50

In the above composition, whole wheat flour, bengal gram flour and cow pea flour is fixed in proportion. The remaining ingredients such as yellow maize flour, pearl millets and barnyard millets are changed in proportion.

Preparation of extruded product (Pasta)

Pasta is among one of the most favoured foods being consumed globally because of its affordable price, comfortable cooking, low GI and desirable taste. Pasta is usually made from semolina, which is rich in calories but poor in dietary fibres, minerals, vitamins, and essential amino acids **(Ghandehari Yazdi et al., 2020).**

Hence to improve its nutritional quality and therapeutic value, the cereal whole wheat, yellow maize, millet like barnyard millet, pearl millet and pulses bengal gram and cowpea based low glycemic index pasta product were formulated. Pasta is chosen as the product to be prepared for each of the variations above. In other words, three variations (Mix I, II and III) of pasta are prepared for each of the above mix described above roasting.

Preparation of pasta

Pasta was prepared as per the six combinations of wheat, pearl millet, barnyard millets, bengal gram, cow pea and yellow maize flour in prescribed proportions. Weighed amount of all roasted and sprouted flour separately were put into pasta making machine (Model no. Dolly Mini P3) Measured amount of water 200-220 ml was slowly added, mixed and kneaded into stiff, plastic and homogenous dough. The dough was extruded through the die into rotini (spiral) shape and cut into 4 cm length using a cutter attached to the pasta extruder. The extruded pasta was cooled and then sun dried in tray for 3-4 days and stored under ambient conditions (20–35 °C) in air tight plastic containers at room temperature for further analysis.

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Flow chart of preparation of pasta

Weighing of ingredients → Sieving and blending of all the flour → Mixing of flour for 5-7 minutes in pasta making machine → Extrusion- single screw → Dicing to desirable shapes → Cool the pasta for 3-4 hrs. → Drying pasta for 2-3 days in sunlight → Packing the pasta in airtight container / polythene bag

After that prepared pasta were sundried for 4-5 days, till all moisture removed. Then store pasta in an air tight container.

Three Variation of (Roasted mix flour) Pasta

Cooking of Pasta for organoleptic evaluation

Pasta sample (25 g) was cooked in 250 ml of boiling water until the centre core disappeared (checked by pressing between two glass slides). It took 4 min and 30 s to cook the pasta completely. The pasta was subsequently drained using a stainless-steel sieve. Take out strained pasta in plate add salt if required were given to participants for organoleptic evaluation to collect score.

Organoleptic evaluation of developed product

The three variations of developed pasta were evaluated organoleptic by a panel of 30 subjects comprising of semi trained panellist and faculty of department of food and nutrition Dr. N.G.P arts and science college, Coimbatore. The panellist was asked to score the sample for colour, appearance, flavour, taste and overall acceptability by using a 1-5 score card. (1- Very Poor, 2- Poor, 3-Fair, 4-Good, 5- very good) Finally, an overall acceptability is calculated for each product variation.

Calculation of Glycemic Index and Glycemic Load

Glycemic Index

To calculate Glycemic Index and Glycemic Load, 10 non-diabetic subjects are selected in the department of food and nutrition Dr. N.G.P arts and science college, Coimbatore. On the day before the test, subjects were asked not to smoke, consume alcohol and to undertake any vigorous physical activity. One day, a subject blood sugar after 12 hr. of overnight fasting is taken, then the subjects are made of eat the boiled pasta containing 50 g of carbohydrate, further four blood sugar level were noted with an interval of 30 minutes, 60, 90, 120 mins. Next day, the same steps were repeated on the same subjects but with 50 g. of glucose**.** 50 gm of dextrose (glucose monohydrate) dissolves in 200 ml water were used as the reference food (Glucon D) glucose powder, Heinz India Pvt, Ltd. Mumbai India.

$$\boldsymbol{Glycemic\ Index = \frac{Area\ under\ the\ test\ food\ curve * 100}{Area\ under\ the\ reference\ food}}$$

The GI is a ranking of foods based on how quickly they raise blood glucose levels. The reference foods such as glucose have a GI of 100.

Foods with carbohydrate that are digested, absorbed and utilized quickly are referred to as high glycemic index food (GI ≥70). Those absorbed moderately (56-69) are referred to as medium GI foods while those that are digested, absorbed and utilized slowly are referred to as a low GI (GI ≤ 55) food.

The glycemic index was calculated using incremental is method under the blood glucose response curve (iAUC). The area under curve is calculated by the formula:

$$L = \frac{\Delta 30t}{2} + \Delta 60t + \frac{(\Delta 30 - \Delta 60)t}{2} + \Delta 90t + \frac{(\Delta 60 - \Delta 90)t}{2} + \Delta 120t + \frac{(\Delta 90 - \Delta 120)t}{2} + \Delta 150t + \frac{(\Delta 120 - \Delta 150)t}{2}$$

Note:

L= the area under the curve

T= Time interval of blood taking (30 min)

Δ 30= the blood difference of glucose level 30 min after fasting

Δ 60= the blood difference of glucose level 60 min after fasting

Δ 90= the blood difference of glucose level 90 min after fasting

Δ 120= the blood difference of glucose level 120 min after fasting

Δ 150= the blood difference of glucose level 150 min after fasting

Glycemic load represents the product of the GI and the total available carbohydrate content in a specified portion of food divided by 100.

From the Glycemic Index we calculate the Glycemic Load.

$$\boldsymbol{Glycemic\ Load = \frac{Glycemic\ Index\ * Available\ Carbohydrate}{100}}$$

Glycemic load of 20 or more is high a glycemic load is 11 to 19 (both inclusive) is medium and a glycemic load of 10 or less is very low.

RESULTS

The result of the formulated three variations of pasta

The texture, colour, and taste are the important features for admissibility

Table-2 Mean of organoleptic evaluation of Roasted Mix-I, Mix-II and Mix-III Pasta

Roasted	Mix I		Mix II		Mix III	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Appearance	4.37	0.615	4.00	0.788	4.13	0.776
Taste	4.00	0.695	3.73	0.640	3.97	0.718
Flavour	4.00	0.695	3.67	0.711	3.90	0.662
Texture	4.13	0.819	4.00	0.587	4.13	0.681
Overall	4.40	0.563	3.80	0.664	4.20	0.610

Figure- 1 Mean Organoleptic Evaluation of Roasted flour Pasta Mix-I, Mix-II, Mix-III

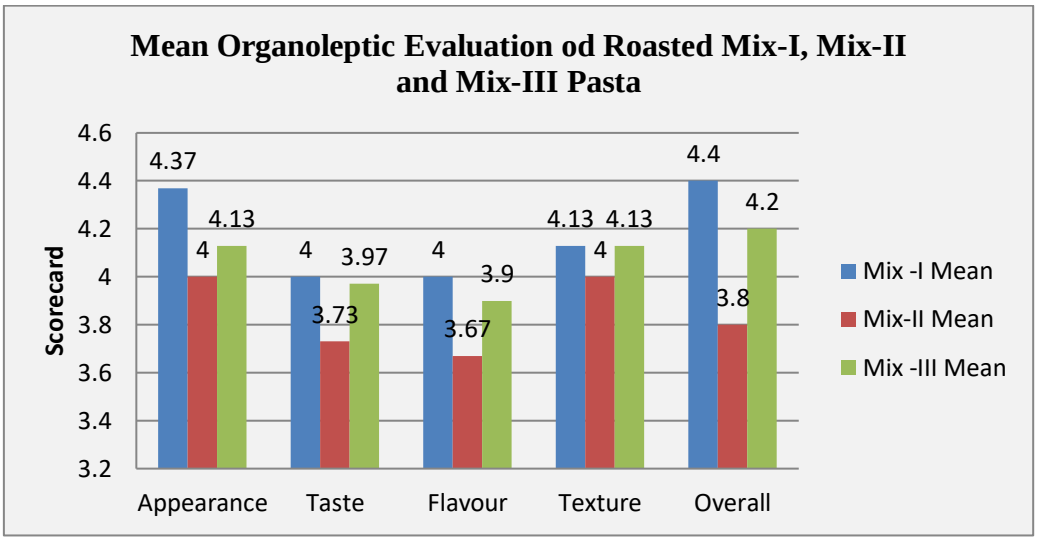


Table- 3 Mean of Organoleptic Evaluation of roasted Mix Pasta (ANOVA)

Organoleptic evaluation	Sources of variation	Sum of Squares	df	Mean Square	F	P
Appearance	Between 5Groups	2.067	2	1.033	1.936	0.150
	Within Groups	46.433	87	0.534		
	Total	48.500	89			
Taste	Between Groups	1.267	2	0.633	1.349	0.265
	Within Groups	40.833	87	0.469		
	Total	42.100	89			
Flavour	Between Groups	1.756	2	0.878	1.846	0.164
	Within Groups	41.367	87	0.475		
	Total	43.122	89			
Texture	Between Groups	0.356	2	0.178	0.360	0.699
	Within Groups	42.933	87	0.493		
	Total	43.289	89			

Overall	Between Groups	5.600	2	2.800	7.427	0.001
	Within Groups	32.800	87	0.377		
	Total	38.400	89			

GLYCEMIC INDEX AND GLYCEMIC LOAD OF FORMULATED ROASTED MIX FLOUR PASTA

Figure-2 Glycemic Index of Mix- I Pasta

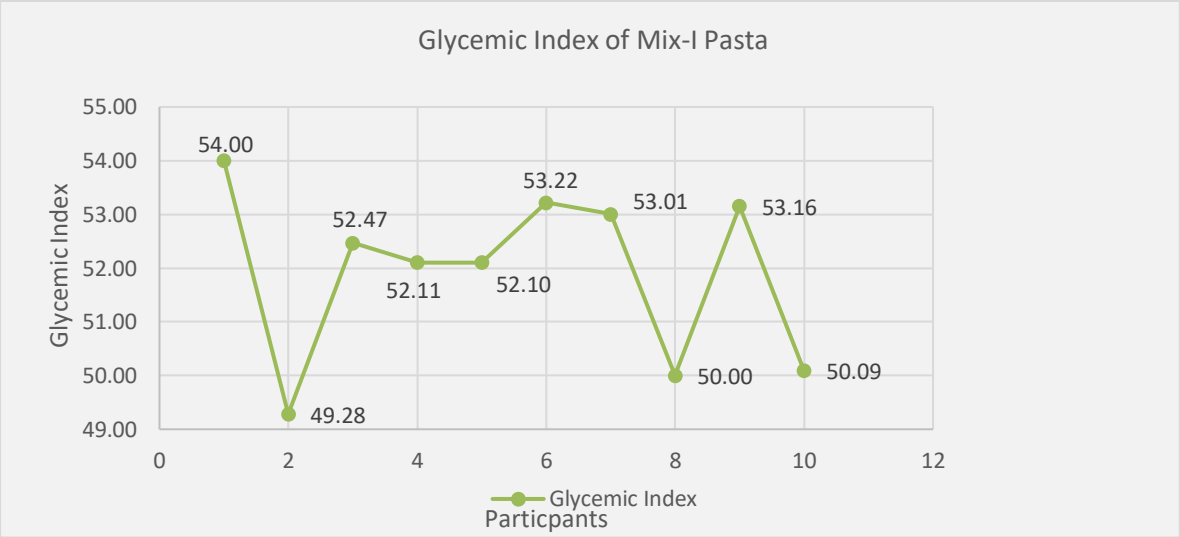


Figure-3 Glycemic Index of Mix- II Pasta

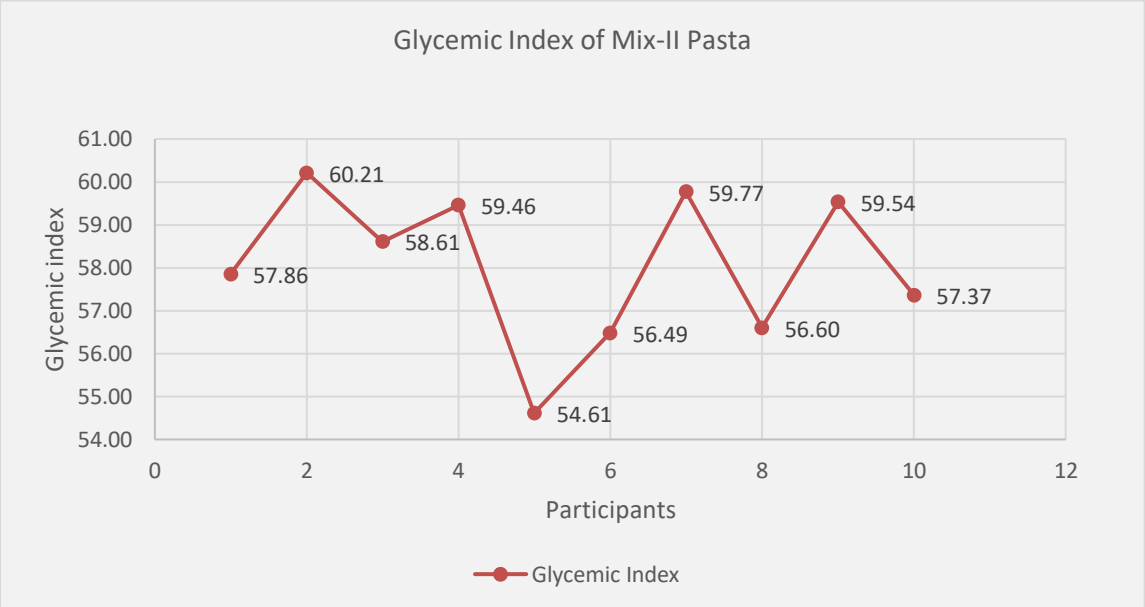


Figure- 4 Glycemic Index of Mix- III Pasta

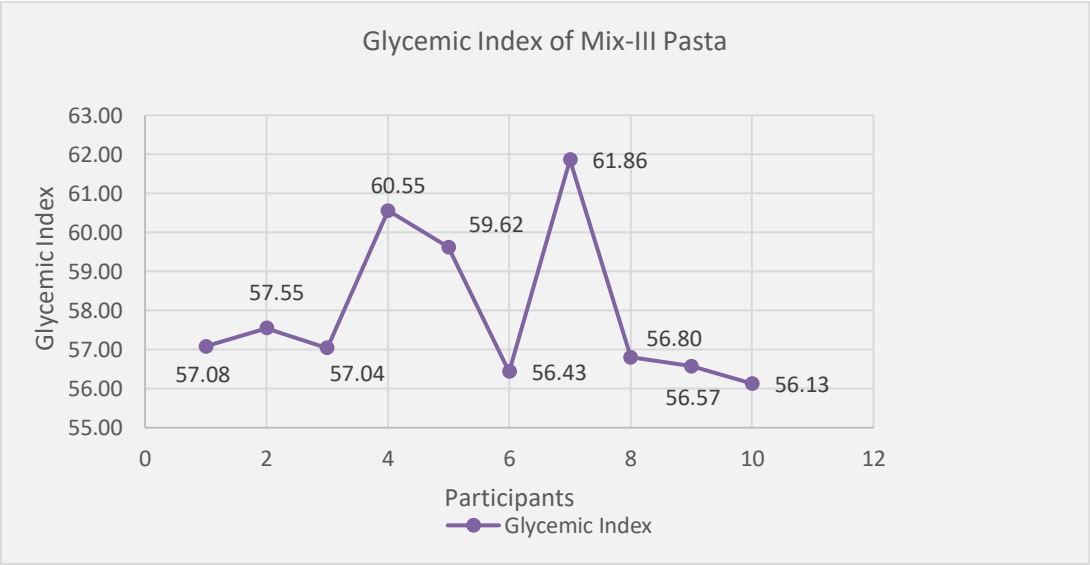


Table- 4 Glycemic Index of roasted flour of Mix- I, Mix –II, Mix -III

Roasted Mix Flour -I			**Roasted Mix flour –II**			**Roasted Mix flour- III**		
Sl no.	Participants	GI	Sl. no.	Participants	GI	Sl. No	Participants	GI
1.	Participant-1	54.00	1.	Participant-1	57.86	1.	Particpant-1	57.08
2.	Participant-2	49.28	2.	Participant-2	60.212	2.	Particpant-2	57.55
3.	Participant-3	52.47	3.	Participant-3	58.61	3.	Particpant-3	57.04
4.	Participant-4	52.11	4.	Participant-4	59.46	4.	Particpant-4	60.55
5.	Participant-5	52.10	5.	Participant-5	54.61	5.	Particpant-5	59.62
6.	Participant-6	53.22	6.	Participant-6	56.49	6.	Particpant-6	56.43
7.	Participant-7	53.01	7.	Participant-7	59.77	7.	Particpant-7	61.86
8.	Participant-8	50.00	8.	Participant-8	52.60	8.	Particpant-8	56.80
9.	Participant-9	53.16	9.	Participant-9	59.54	9.	Particpant-9	56.57
10.	Participant-10	50.09	10.	Participant-10	57.37	10.	Particpant-10	56.13
Mean Glycemic index		51.94	Mean Glycemic Index		58.05	Mean Glycemic Index		57.96
Std. Deviation		1.60	Std. deviation		1.80	Std. deviation		1.98

Available Carbohydrate	40.15		40.16		41.16
Glycemic Load	20.85		23.32		23.85
p- value	0.9327		0.9978		0.9963
Null hypothesis at 10%, 5% and 1 % Significance	Don't Reject		Don't Reject		Don't Reject

Figure-6 Mean Glycemic Index of Roasted Mix-I. Mix-II and Mix-III Pasta

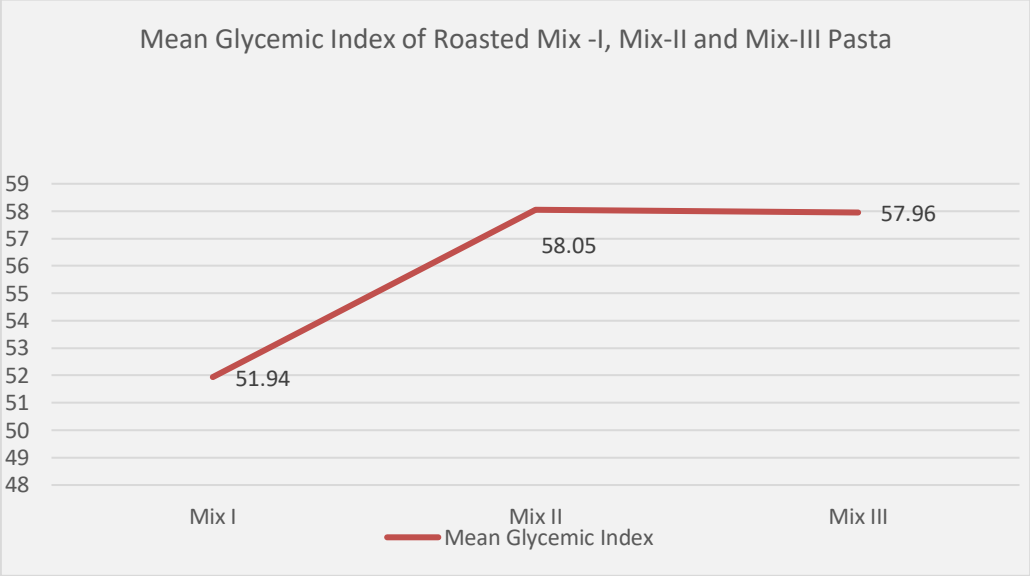
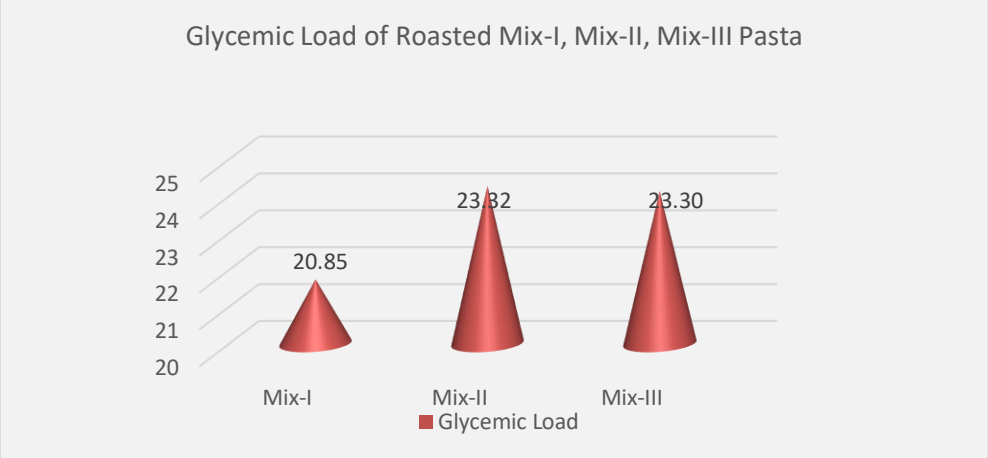


Figure-7 Glycemic Load of Roasted Mix-I, Mix-II, Mix-III Pasta



DISCUSSION

Table 2 shows the mean and standard deviation of mix I, mix II and mix III in appearance, taste, flavour, texture and overall acceptability using roasting method. In Mix I, the mean for appearance is 4.37, mean for taste and flavour is 4, mean for texture is 4.13 and for overall acceptability the mean is 4.40. In Mix II, the mean score for appearance is 4, the mean score for taste is 3.73, the mean score for flavour is 3.67, the mean score for texture is 4, and the mean score for overall acceptability is 3.80.In Mix III, the mean for appearance is 4.13, 3.97 for taste, 3.90 for flavour, 4.13 for texture, and 4.20 for overall acceptability.

Table 3 presents the results of ANOVA computed to compare the acceptability among three mixes by roasting. There is significant difference between groups on overall acceptability at 0.01 levels. Moreover, no other statistical significance is found.

Table 4 illustrate that the mean glycemic Index of roasted mix flour –I is 51.94 ± 1.60, which comes under low glycemic index, the mean glycemic index of roasted mix flour-II is 58.05 ± 1.80 which comes under medium glycemic index and the mean glycemic index of roasted mix flour-III is 57.96 ± 1.98 which comes under medium glycemic index value respectively and glycemic load of roasted mix flour –I was 20.85 the glycemic load of roasted mix flour-II was 23.32 and the glycemic load of roasted mix flour-III was 23.85 respectively which comes under high glycemic load value. Since p-value > 0.05, the null hypothesis is correct and there is no difference in the mean glycemic index of the population.

STATISTICAL ANALYSIS

The final data was compiled and analysed using suitable statistical methods. The results were presented as descriptive statistics such as mean, standard deviation, ‘t’test and one way (ANOVA). A level of p-value <0.05 is considered as significant differences among the sample.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

CONCLUSION

The conclusion of my study is that preparation of roasted flour of multi grain mix-I pasta of three variations exhibited good organoleptic evaluation. Thus illustrates that the best organoleptic qualities of value added products could be manufactured by mixing cereal, millet, and pulses blended flour. (50% wheat, 20% barnyard millet, 10% pearl millet, 10 % maize, 5% Bengal gram and 5% cowpea). And formulated three variation of pasta of which mix I variation pasta has GI value **51.94 ± 1.60** is which comes under low GI and GL of formulated pasta is **20.85** which comes under slightly high GL value. The low GI developed

product pasta is beneficial for diabetic patients, pre diabetics and obese and it is helpful in reduction of blood sugar level and prevention of several diseases.

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