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DEVELOPMENT OF LOW GLYCEMIC INDEX DIABETIC FRIENDLY BISCUITS

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ABSTRACT

Biscuits are the most widely sold products in the food industry market and most of them are high in carbohydrates as they are made of refined flours and are unsuitable for daily consumption especially by a diabetic individual. Therefore, a sincere attempt has been made to produce a low glycemic index biscuit using a combination of flours that diabetics can snack on without worrying about it increasing the blood levels. The aim of the study was to develop cereal and legume-based biscuits (wheat flour+ barley flour +soy flour) and analyse sensory and nutritional properties of the biscuits. And also, to assess glycemic index and glycemic load of the developed biscuits. For this, 3 samples of zeera biscuits were developed using different ratios of flour combinations. All products were analyzed by a 50 membered sensory panel for its organoleptic properties. The highly acceptable sample was further evaluated for its nutritional content and its glycemic index was determined. For evaluating the glycemic index 10 subjects between the age group of 18-25 years participated in the study. Results obtained suggested that biscuits made from these cereal legume combinations were highly acceptable and were chosen for nutritional analysis. The results of nutritional analysis showed increased protein (7.8 g/100 g), crude fibre (3.4 g/100 g) and ash content (4.0 g/100 g) and decreased content of carbohydrates (56.2 g/100 g) in blend containing wheat flour, barley and soy flour (25:50:25). Glycemic index of the acceptable and highly nutritious blend (wheat flour, barley and soy flour 50:25:25) was 36.4, whereas for control salty biscuits, it was 68.9 making the biscuit suitable for consumption by the diabetic population.Therefore, it can be concluded that the combination of flours in the production of biscuits can help maintain the blood sugar levels for the diabetic population making it a very suitable snacking option.

Keywords: Barley; Glycemic index; Glycemic load; Soy flour; Type 2 diabetes mellitus, Type 1 diabetes mellitus, Gestational diabetes, Wheat flour.

Introduction

India, a country sharing almost 17.5% of the total world population also carries a considerable share in the global diabetes burden. Asia is considered the epicenter of the epidemic of diabetes.**Invalid source specified.** According to the International Diabetes Federation (IDF)463 million people in the world have diabetes and 88 million people live in the Southeast Asia region. Out of this 88 million people, 77 million belong to India which accounts for 11.8 % of the total world diabetes burden with both men and women equally affected **Invalid source specified.**. India is currently regarded as the diabetic capital of the world as the country has the highest number of diabetic patients in the world.**Invalid source specified.**. Diabetes is India's one of the fastest-growing endocrine disorder. The chronic burden of diabetes has an extensive impact on the health and well-being of the individual as well as the nation. It is estimated that by 2030 the prevalence of diabetes is expected to rise to 552 million people globally.**Invalid source specified.**. According to the World Health Organization, an estimated 1.6 million deaths were caused directly by diabetes in the year 2016.

Diabetes is a chronic metabolic and endocrine disease characterized by elevated blood sugar levels with disturbances in the metabolism in carbohydrates, fat, and proteins resulting from an abnormality in the pancreas causing a defect in insulin secretion, insulin action, or both. This disorder is often associated with long term complications of organs like eyes, heart, kidneys, nerves, and blood vessels.**Invalid source specified.**

Biscuits are the most commonly consumed bakery products in the market, they are usually found to be high in calories, carbohydrates, and fats but are low in vitamins, minerals, and proteins making them unfit for daily consumption. Some biscuits available in the market are specifically formulated for the consumption by diabetic patients most of them developed from whole wheat flour alone. These biscuits are usually found to be high in fibre and resistant starch. But research suggests that cereal and pulse or legume mixed food products have a lower glycemic index than only whole wheat flour food products. The primary objective of the study is to develop a cereal and legume-based diabetic-friendly biscuits using wheat flour, barley flour, and soy flour.

Barley (Hordeum Vulgare L.) is an underutilizedfunctional grain because it contains β-glucan, vitamin B-complex, tocotrienols, tocopherols and has significantantioxidant properties. Barleyhas a higher amount of phenolic compounds and antioxidantactivity when compared to the most widely consumed cereals, wheat, and rice. Health effects of β-glucans are to lower plasma cholesterol, improve lipid metabolism, reduce glycemic index, and boost the immune system, etc. In barley, most of the free phenolics are flavanols and tocopherols, whereas the bound phenolics are mainly phenolic acids are ferulic acid and coumaric acid.

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Therefore, it is a beneficial cereal crop from a nutritional point of view. Many researches have shown that barley can be successfully incorporated in a wide array of products such as different types of bread, Asian noodles, bars, muffins, biscuits, and cookies. **Invalid source specified.**

Soybean (Glycine max) is an excellent source of protein. It contains 35-45% protein with all essential amino acids required for proper growth, repair, and maintenance of the body. It is also rich in vitamin, mineral, and antioxidant like Isoflavones which help in lowering cholesterol levels, prevent cancer and regulation of menopause. Wheat is deficient in essential amino acid lysine. However, soybean is rich in lysine and can be added to wheat in order to enrich the biscuit with all the essential amino acids. Soybean protein is the best source of plant protein. Research by Shakuntale b. Masum, 2008 found that enrichment of defatted soy flour improved the nutritional quality of the food product by 20% without affecting its taste, textural and overall acceptability of the product. **Invalid source specified.**.

Cumin (Cuminum cyminum) is a flowering plant belonging to family Apiaceae, commonly known as jeera. It is a common ingredient found in Indian kitchens.They are oblong, longitudinally ridged, and grey-brown in color.It is rich in anti-inflammatory antioxidants and has antibacterial and antiseptic properties. Due to its numerous medicinal properties, jeera is one of the main ingredients in many home remedies and ayurvedic preparations. The strong aroma of jeera or cumin seeds is due to the presence of compound cumin aldehyde. Cumin is widely used in Ayurvedic medicine as a stimulant, carminative, and astringent and for the treatment of dyspepsia. It is effective against digestive problems, relieves nausea, bloating, and constipation. The phytochemical cumin aldehyde helps reduce the glucose levels and inhibits glycosylated haemoglobin, creatinine, blood urea nitrogen and improves the serum insulin and glycogen. Cumin seeds have anti-hyperglycaemic properties and are beneficial in dealing with secondary complications associated with diabetes. A study on the anti-hyperglycaemic effect of cumin seeds on rabbits revealed that cumin seeds significantly decrease the incremental area under the glucose tolerance curve and the hyperglycemic peak.**Invalid source specified.**

There are many studies where the benefits of wheat flour and pulse combinations in production of different products has been studied but very little information and research is available on the benefits of cereals and legume combination food products. Keeping in mind the enormous benefits of legumes this study has been designed to evaluate the glycemic index of cereal and legume combinations. A sincere attempt has been made to develop the traditional zeera biscuits by incorporating soy flour and barley flour in the biscuits which can help in maintain and improving glycemic control in the diabetic population of the world.

Materials and methods

RAW MATERIALS

The raw materials include whole wheat flour, barley flour, soy flour, butter, salt, milk, cumin seeds, and baking powder. Three different blends are prepared from whole wheat flour, soy flour, and barley flour. The four different combinations of flours are as given in the table 1.

BLENDS	WHEAT FLOUR (gms)	BARLEY FLOUR (gms)	SOY FLOUR (gms)
CONTROL	100	-	-
BLEND 1	25	50	25
BLEND 2	50	25	25
BLEND 3	-	50	50

Table 1 Combination of flours

PROCUREMENT OF RAW MATERIALS

All the required raw materials for development of the zeera biscuit were obtained from Ratnadeep Super market, Hyderabad. Procurement details of all ingredients are listed below in table.2

S. No	INGREDIENTS	SOURCE
1.	Wheat flour	Ratnadeep Super Market, Hyderabad
2.	Barley flour	Ratnadeep Super Market, Hyderabad
3.	Soybean	Ratnadeep Super Market, Hyderabad
4.	Butter	Ratnadeep Super Market, Hyderabad

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5.	Baking powder	Ratnadeep Super Market, Hyderabad
6.	Cumin seeds	Ratnadeep Super Market, Hyderabad
7.	Milk	Ratnadeep Super Market, Hyderabad
8.	Salt	Ratnadeep Super Market, Hyderabad

Table 2: Procurement of Raw Materials

METHOD OF PREPARATION
DEVELOPMENT OF SOY FLOUR

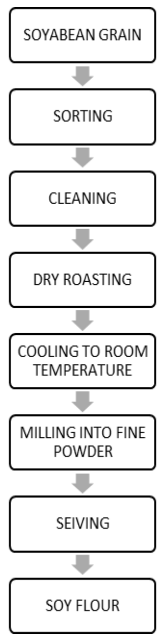

Figure 1 The process of developing soy flour from soy grains

The store brought soybean grain is sorted and cleaned thoroughly. Any kind of dirt is eliminated in the process of sorting. The grains are washed under running tap water allowing tiny dust particles to be washed off. These grains are furthered dried using a paper towel which absorbs the excess water from the grain. Then these seeds are dry roasted in a pan to allow the total loss of moisture. Then the grains are allowed to cool at room temperatures and later ground into fine powder. Thereby, producing the soy flour. The process of developing soy flour is outlined in the Figure 1.

PROCESS OF BISCUIT MANUFACTURING:
Wheat flour, soy flour, and barley flour are taken in the respective quantities according to the blend. The flours are sifted twice. To the mixture 1 gram of salt, 2g of baking powder and 5g of cumin seeds are added. To this 50 g of soft butter is added and mixed together using the rub in method. Once the butter has mixed completely 75ml of milk is added to form a soft dough. The dough was allowed to rest for 1 hour in the refrigerator. Later the dough was rolled out and cut in circular shapes using the cookie cutter. Each biscuit weighed 10 gms. The biscuits were baked at 160 degrees for 18 minutes in a preheated oven, cooled at room temperature and sealed in air-tight containers.

S No.	INGREDIENTS	TEST SAMPLE 1	TEST SAMPLE 2	TEST SAMPLE 3
1.	Wheat flour	25g	50g	0g
2.	Barley flour	50g	25g	50g
3.	Soy flour	25g	25g	50g
4.	Butter	50g	50g	50g
5.	Baking powder	2g	2g	2g
6.	Cumin seeds	5g	5g	5g
7.	Milk	75ml	75ml	75ml
8.	Salt	1g	1g	1g

Table 3 List of ingredients used in making zeera biscuits

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Figure 2 Control Sample


Figure 3 Test Sample 1


Figure 4 Test Sample 3


Figure 5 Test Sample 4

1. **SENSORY ANALYSIS**
   The developed biscuits were analyzed for their organoleptic properties by a panel comprising of 50 subjects. The panelists were asked to score the samples for colour, appearance, flavour, texture, taste, and overall acceptability by using a scorecard of 9-point Hedonic Rating Scale.
2. **NUTRITIONAL EVALUATION**
   The cereal and pulse blend test sample with the highest overall acceptability was analysed for its energy, protein fat, carbohydrate, total dietary fibre, soluble fibre, insoluble fibre, saturated fat, and unsaturated fat content using standard estimation techniques in a food analysis lab.
3. **ASSESSMENT OF GLYCAEMIC INDEX AND GLYCEMIC LOAD**
   The glycaemic index of the biscuits was evaluated through a scientific approach by determining the glucose response in healthy subjects via a meal tolerance test. 10 healthy subjects in the age group of 18-24years were chosen and their glycaemic response was analysed by taking one drop of blood on the glucose test strip using Glucometer.
4. **GLUCOSE TOLERANCE TEST**
   The test sample with the highest overall acceptability is taken and the glycaemic index is estimated in the following manner.
   Day 1:
   Fasting blood glucose levels are evaluated after 8 to 10 hours of fasting using a glucometer. Then each subject is given 50 g of glucose diluted in 200ml water and the postprandial blood glucose levels are estimated at regular intervals of 0min. 30mins, 60 mins, 90mins, 120mins. Glucose was provided from Glucon- D tangy orange flavour.
   Day 2:
   Fasting blood glucose levels are evaluated after 8 to 10 hours of fasting using a glucometer. Then each subject is given the control sample containing 50g of carbohydrate. After which the postprandial blood glucose levels are estimated at regular intervals of 0min. 30mins, 60 mins, 90mins, 120mins.
   Day 3:
   Fasting blood glucose levels are evaluated after 8 to 10 hours of fasting using a glucometer. Then each subject is given test sample biscuits containing 50 gms of carbohydrates. After which the postprandial blood glucose levels are estimated at regular intervals of 0min. 30mins, 60 mins, 90mins, 120mins.

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With the data obtained a graph is plotted between the mean blood glucose levels and the time for each of the test samples to obtain the blood glucose response curves. From which the area under each of the incremental is calculated using MS Excel. The results obtained are substituted in the glycemic index formula which is given by Wolever and Jenkins;

GI = ($iAUC_{test\ food}$/$iAUC_{reference\ food}$) × 100

- iAUC= Incremental area under the curve
- Reference food= glucose (50g)

The Glycemic Load (GL) was calculated based on the quantity of the recipe per serving and the respective available carbohydrate content. The following formula was used:

Glycemic Load = GI x Carbohydrate (g) content per portion ÷ 100.

5. **STATISTICAL ANALYSIS**
The results of organoleptic scores, nutritional analysis, and glycemic index are statistically analyzed using analysis of variance (non-Parametric test) technique with the aid of the Microsoft statistical analysis tool pack.
6. **ETHICAL ISSUE**
Informed consent was obtained before conducting the experiment before feeding food items and checking the blood glucose of human subjects. The privacy rights of human subjects will always be observed.

Results and discussion

SENSORY EVALUATION OF THE BISCUITS

Organoleptic or Sensory evaluation of the biscuits depend on its colour, appearance, flavour, texture, taste and overall acceptability of the sample.

	Control	Test Sample 1	Test Sample 2	Test Sample 3	P Value
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Colour	7 (1.78)	6.66 (1.85)	7.1 (1.42)	6.38 (1.48)	0.049*
Appearance	6.9 (1.83)	6.76 (1.66)	6.64 (1.66)	6.36 (1.44)	0.127
Flavour	7.16 (1.65)	6.34 (1.45)	6.36 (1.61)	5.78 (1.27)	0.000**
Texture	6.64 (1.64)	7.1 (1.11)	6.74 (1.4)	6.12 (1.33)	0.002*
Taste	7.24 (1.88)	6.24 (1.59)	6.52 (1.78)	5.9 (1.31)	0.000**
Overall Acceptability	7.06 (1.36)	6.76 (1.22)	6.9 (1.47)	5.68 (1.42)	0.000**

Table 4 Sensory scores of developed blends of zeera biscuits. Means in the same row differ significant at *P<0.01, **P<0.001 (non-parametric test used to verify the existence of significant differences in preference among the samples)

Sensory analysis is carried out by using experienced panelists to measure sensory characteristics like senses of sight, smell, taste, touch and acceptability of food product. Table no 4 represents the mean scores for sensory evaluation.

- **Colour Acceptability:**The mean scores of sensory evaluations for the attribute colour ranges between 6.38 to 7.1. Table 4 shows that the test sample 2 has the highest mean value (7.1) where as it is observed that test sample 1 had the lowest mean value (6.66). On the other hand, the mean score of colour for the control sample was 7. Statistical analysis exposed that use of different flour ratios has significantly (P=0.049 [P<0.05]) influenced the colour of the biscuits. The colour of the biscuits became lighter with increasing ratio of soy flour and barley flour and their acceptability decreased significantly as seen in test sample 1 (WF:BF: SF=25:50:25) and test sample 3 (WF:BF: SF=0:50:50) whose mean scores are 6.66 and 6.38 respectively.
- **Appearance:**The highest mean score for the attribute appearance was observed in the control sample followed by test sample 1, test sample 2, test sample 3 with mean values 6.9, 6.76, 6.64 and 6.36 respectively. Statistical analysis expressed that there was no significant difference in the appearance of the biscuit (P=0.127).
- **Flavour:**In case of flavour the mean value decreased with the increase in substitution of soy flour and barley flour. The mean score obtained for control, test sample 1, test sample 2, test sample 3 are 7.16, 6.34, 6.36 and 5.78 respectively. P value = 0.002 indicates a significant difference in the flavours of the biscuits. The mean value of flavour has decreased significantly with the increased substitution with barley flour and soy flour. This may be due to the beany flavour of soy flour**Invalid source specified.**. Soybeans undergo enzymatic break down by lipoxygenases or autoxidation of linoleic and linolenic acid produces

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hydroperoxides such as ketones, aldehydes and alcohols that may be responsible for the beany-flavour which discourages soy consumption.**Invalid source specified.**

- **Texture:**The 7.1 texture rating of test sample 1 biscuit was significantly superior to the 6.64 of the wheat flour biscuit (control). The grainy matrix of the soy flour and barley flour must have resulted in a crispy bake, and the crispiness can be complementary to desirable textural property of biscuit.
- **Taste:** The mean score of taste for control, test sample 1, test sample 2 and test sample 3 are 7.24, 6.24, 6.9 and 5.68 respectively. It is seen that with increasing substitution of barley and soy flour the mean value of taste has decreased significantly. The slight astringent taste observed in the test samples could be due to the development of bitter substances, because of the presence of tannins in barley.**Invalid source specified.**. Statistical analysis suggested that there is a significant difference in the test samples(p=0.000).
- **Overall Acceptability:**The mean score of overall acceptability was found to be highest for the control sample (WF=100). Among the test samples, test sample 2 (WF:BF: SF=50:25:25) had the highest mean score, indicating that it was the most liked ratio of soy and barley flour combination. Test sample 1 and test sample 3 had a relatively lower mean score of 6.76 and 5.68 respectively. Statistical analysis shows a different flour blends in test samples have significantly affected the overall likeness of the zeera biscuits(p=0.000).

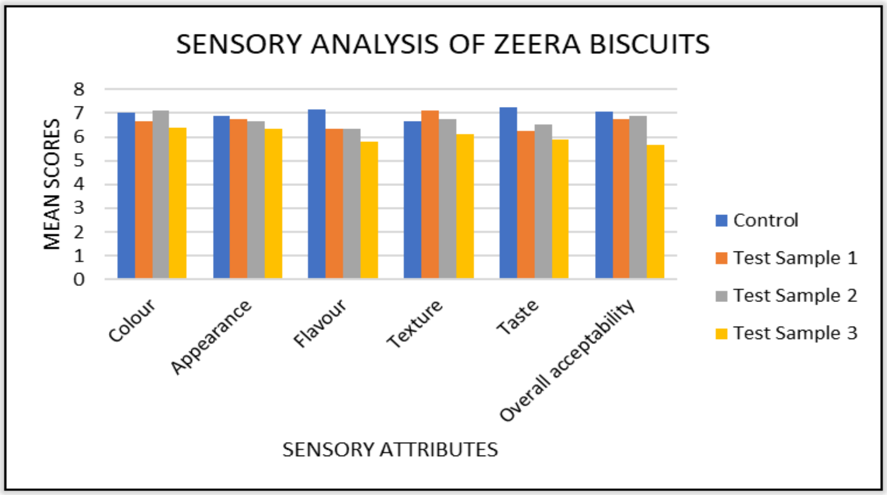

Figure 6 Sensory analysis scores of zeera biscuits

On the basis of overall acceptability, it can be concluded that the highest acceptable and liked product is the test sample 2 with a flour combination in the ratio WF:BF: SF=50:25:25. This sample was further evaluated to estimate the nutritional composition and also to determine the glycaemic index of the sample.

NUTRITIONAL ANALYSIS OF THE BISCUITS

The control and test sample with the highest overall acceptability (test sample 2) was selected for nutritional analysis. The nutrient analysis was performed using the methods of assessment available in the book of FSSAI – Manual of methods of Analysis of Foods (Cereal and Cereal products)**Invalid source specified.** The results of nutritional analysis are given in the tables below:

S.No.	PARAMETERS	UNITS	CONTROL (WF:BF:SF=100:0:0)	TEST SAMPLE 2 (WF:BF:SF=50:25:25)
1.	TOTAL MOISTURE	g/100g	2.4	2.8
2.	TOTAL ASH	g/100g	3.6	4.0
3.	CRUDE FIBRE	g/100g	3.2	3.4
4.	CRUDE FAT	g/100g	24	26.4
5.	TOTAL CARBOHYDRATES	g/100g	59.0	56.2
6.	PROTEINS	g/100g	7.2	7.8
7.	ENERGY	Kcal/100g	483.2	491.2

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Table No. 5: Nutritional Composition of control and highly acceptable test sample

Table no 5 shows the nutrient composition in the control and test sample. Zeera biscuits made with soy flour and barley flour substitution were found to be nutritionally superior. The total moisture content was found to be 2.8g/100g in the test sample 2 (WF:BF: SF=50:25:25) and 2.4g/100g in control (WF=100). This increase in moisture content maybe attributed due to the inclusion of soy flour and barley flour which have a high-water binding capacity because off their high fibre content **Invalid source specified.**. Ash content represents the total mineral content in the foods. The ash content is also increased in the test sample when compared to the control from 3.6 to 4.0 there by indicating an improved mineral content in the zeera biscuit composed of a combination of flours.

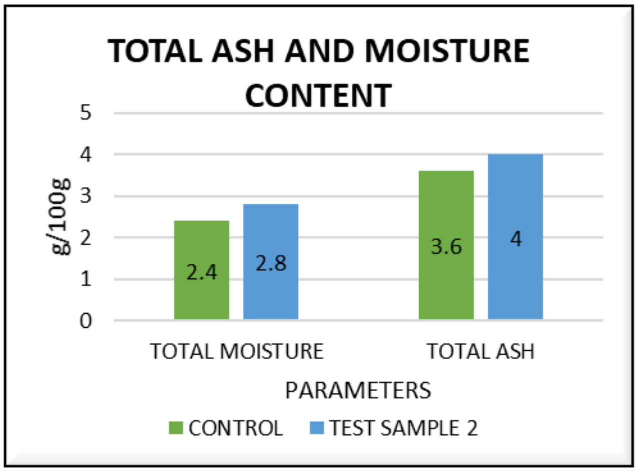

Figure 7 Graphical Representation of Total Ash and Moisture content per 100g of control and test sample 2

The crude fibre content of the control and test sample was 3.2 and 3.4 respectively due to a high fibre content of soy flour and barley flour. There was only a small increase in total fibre content with the inclusion of soy flour and barley flour.

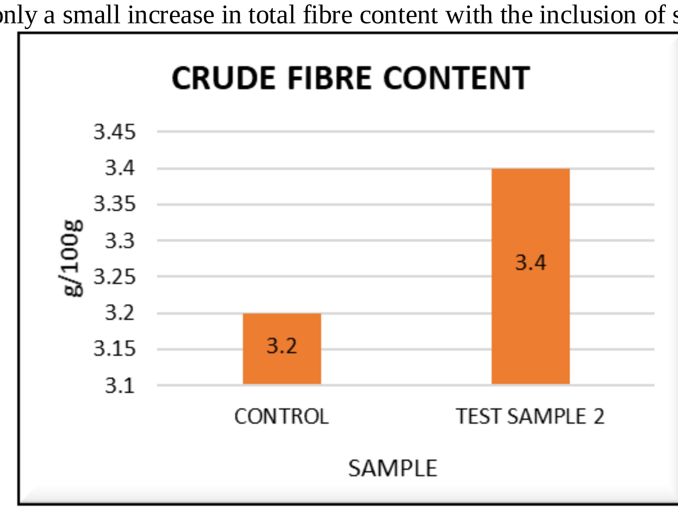

Figure 8 Graphical Representation of Total Fibre content per 100g of control and test sample 2

Substitution with barley flour and soybean flour significantly increased the fat content (26.4g) when compared to the control (24g). Yakoob S et al in a similar study observed an increase in the fat content with the substitution of wheat flour with barley and sprouted barley flour**Invalid source specified.**.

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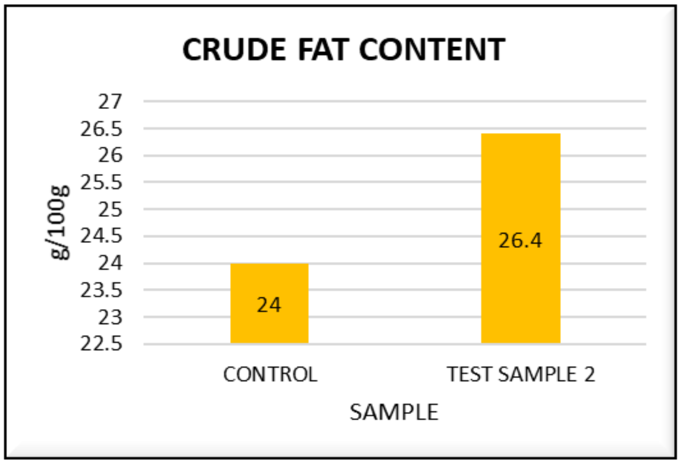

Figure 9 Graphical Representation of Crude Fat content per 100g of control and test sample 2

The protein content of the test sample (7.8g) was significantly higher when compared to the control sample (7.2g). This is due to the high protein content of soy and barley flours. Alka V et al in a study on barley cookies revealed similar results indicating that substitution with barley and soyflour can help develop nutritionally better biscuits**Invalid source specified.**.

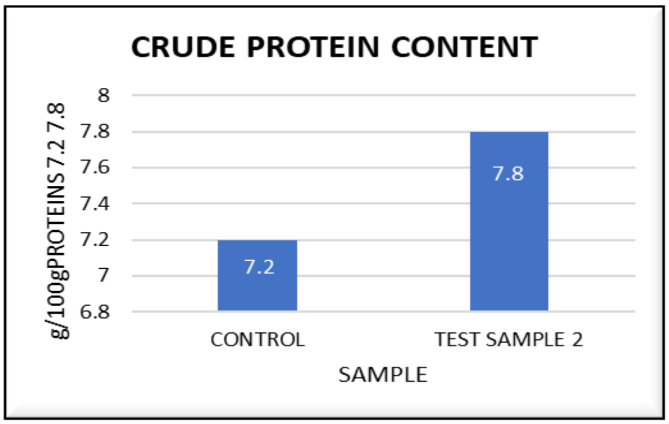

Figure 10 Graphical Representation of Crude Protein Content per 100g of control and test sample 2

The total carbohydrate content of the control sample is 59g which is comparatively higher to the test sample, which has a carbohydrate content of 56.2g. The low carb content is due to the low carbohydrate content of soy flour.

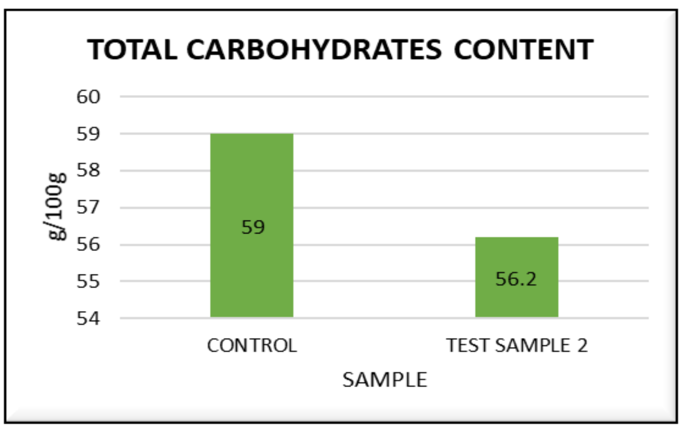

Figure 11 Graphical Representation of Total Carbohydrate content per 100g of control and test sample 2

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The total calorific content of control sample is 483.2 kcal whereas for the test sample is 491.2 kcal. Though the calorific value is higher for the test sample it must be noted that the increased calories are contributed from the proteins.

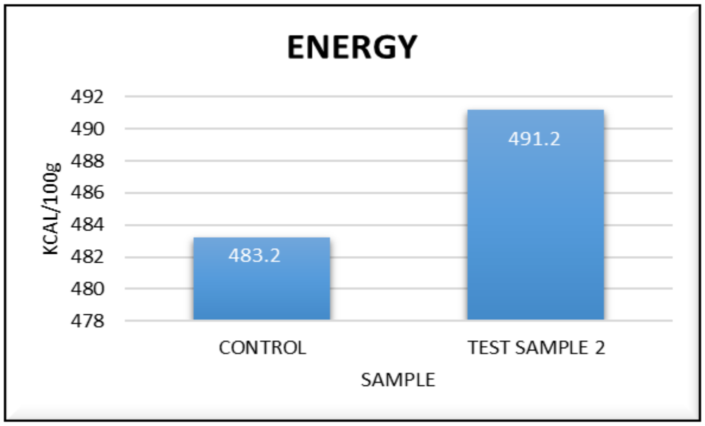

Figure 12 Graphical representation of Energy per 100g of test and control sample biscuit

GLYCEMIC INDEX

The test sample 2 comprising of whole wheat flour, barley flour and soy flour in the ratio 50:25:25 was chosen for assessment off glycaemic index because of its high overall acceptability and nutritional composition. The glycemic index for the test and control sample have been presented in the table no 6. The fasting blood glucose levels of the subjects ranged between 64 to 88. The rise in blood glucose after consuming 50g of carbohydrates as glucose at 30 mins, 60 mins, 90 mins and 120 mins ranged from 119 to 163, 108 to132, 99 to127 and 62 to 77 respectively in case of reference glucose. For the control biscuit sample, the blood glucose level rise at 30 mins, 60 mins, 90 mins and 120 mins are 97 to 119, 103 to 133, 90 to127, 62 to 97 respectively. And for the test sample 2 (WF:BF: SF=50:25:25) the values at 30 mins, 60 mins, 90 mins and 120 mins range as following 87 to 123, 80 to 115, 77 to 104 and 63 to 91 respectively (Figure 13).

The glycemic index was calculated for control and test sample using the formula which is given by Wolever and Jenkins:

$GI = (iAUC_{\text{test food}}/iAUC_{\text{reference food}}) \times 100$

- iAUC= Incremental area under the curve
- Reference food= glucose (50g)

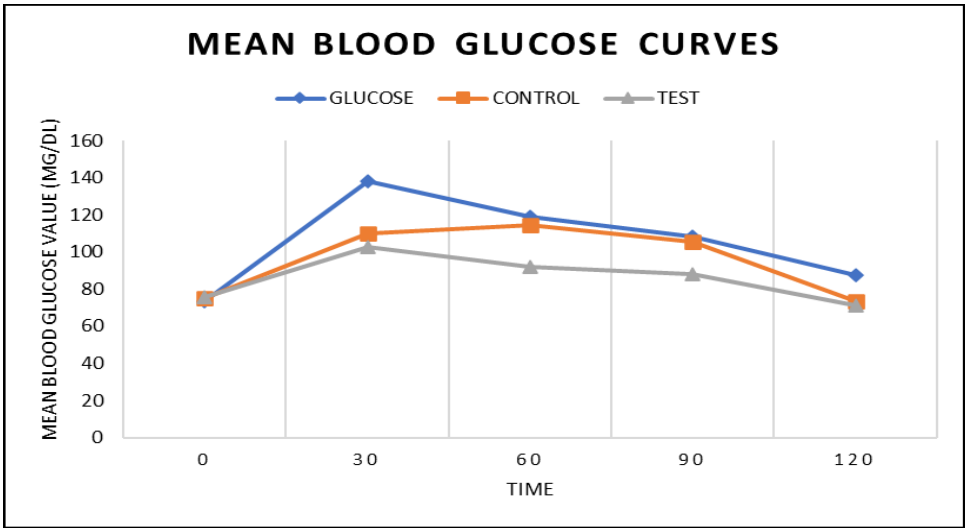

Figure 13 Mean blood glucose curves after consumption of glucose, test salty biscuits and controlsalty biscuits containing 50 g carbohydrates

The glycemic index of the test sample 2 was found to be 36.4 which was comparatively lower to the that of the control which was found to be 68.9 (table no 6). According to the classification of World Health Organization (WHO), any food with GI value of 70

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or more is a high GI food, moderate GI foods ranged from 56 to 69 and low GI foods have scores from 0 to 55 **Invalid source specified.**. Therefore, we can conclude that the test sample has a low GI. Increased protein and crude fibre content and low carbohydrate content in the test sample have contributed to its low glycemic index.

The lowering of glycemic index in biscuits can be as a result of the addition of legumes which contains 5-10% more amylose compared to cereal grains and this amylose is more resistant to digestion. With the incorporation of legumes, the protein content had improved and higher amount of proteins may physically encapsulate starch, preventing the enzyme access thereby, slowing the process of digestion. Apart from proteins and amylose content the crude fiber had also increased significantly in the test sample. Dietary fiber hinders the starch digestibility by increasing the viscosity of intestinal contents and thereby slowing the absorption of carbohydrates from the food. **Invalid source specified.**

The beta glucan obtained from the barley flour further help in lowering the glycemic index of foods. The efficient property of beta glucans is their ability to significantly slower the absorption and digestion of carbohydrates from the intestine by increasing the viscosity of the stomach and intestinal contents and also forming a protective layer in the gut for incorporating readily digestible carbohydrates.**Invalid source specified.**

PRODUCT	QUANTITY ADMINISTERED	GLYCEMIC INDEX	GI CATEGORY
Zeera biscuit (Control)	85g	68.9	Moderate
Zeera biscuit (Test Sample 2)	88g	36.4	Low

Table no 6: Glycemic index of test and control samples

Table no 7 represents the glycaemic load of the control and test sample per biscuit (10g). The glycemic load of the control was found to be 4.06 which was comparatively higher than that of the test sample which was found to be 2.03.

PRODUCT	GLYCEMIC INDEX	SERVING SIZE PER BISCUIT (g)	AVAILABLE CARBOHYDRATES (g)	GLYCEMIC LOAD
Zeera biscuit (Control)	68.9	10	5.9	4.06
Zeera biscuit (Test Sample 2)	36.4	10	5.62	2.03

Table no 7 Glycemic load of test and control samples

1. **References**
2. Aleem Zaker MD, G. T. (2012). Effects of Defatted Soy Flour Incorporation on Physical, Sensorial and Nutritional Properties. Journal of food Processing and technology, 3(4). doi:10.4172/2157-7110.1000149
3. Anwar Hussain, R. K. (2018). Development of healthy multigrain biscuits from buckwheat-barley compositeflours. AGRICULTURAL RESEARCH COMMUNICATION CENTRE, 37(2), 120-125. doi:10.18805/ajdfr.DR-1328
4. Damayanti Korrapati, S. M. (2018, September). Development of Low Glycemic Index Foods and Their Glucose Response in Young Healthy Non-Diabetic Subjects. Preventive nutrition and food science, 23(3), 181–188. doi: 10.3746/pnf.2018.23.3.181
5. FOOD SAFETY AND STANDARDS AUTHORITY OF INDIA. (2015). Manual of methods of Analysis of foods (cereal and cereal products). New Delhi: FOOD SAFETY AND STANDARDS AUTHORITY OF INDIA. Retrieved from https://old.fssai.gov.in/Portals/0/Pdf/Draft_Manuals/CEREALS_AND_PRODUCTS.pdf
6. Foster-Powell K, H. S.-M. (2002, July). International table of glycemic index and glycemic load values: 2002. Am J Clin Nutr., 76(1), 5-56. doi:10.1093/ajcn/76.1.5.
7. Gadadharan Vijayakumar, S. M. (2019). Incidence of type 2 diabetes mellitus and prediabetes in Kerala, India: results from a 10-year prospective cohort. BMC Public Health. doi:https://doi.org/10.1186/s12889-019-6445-6
8. Ganesan Radhika, C. S. (2010). Glycaemic index of Indian flatbreads (rotis) prepared using whole wheat flour and 'atta mix'-added whole wheat flour. Br J Nutr, 103(11), 1642-1647. doi:10.1017/S0007114509993680
9. Indian Council of Medical Research. (2018). Resource center: Indian Council of Medical Research. Retrieved from Indian Council of Medical Research: https://main.icmr.nic.in/content/guidelines-0

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10. International Diabetes Federation. (2020, march 3). South East Asia Members: International Diabetes Federation. Retrieved from International Diabetes Federation website: https://idf.org/our-network/regions-members/south-east-asia/members/94-india.html
11. Kaur, K. (2020). Nutritional composition and glycemic response of Mathi developed from cereal pulse blends. Journal of Pharmacognosy and Phytochemistry, 9(5), 2698-2703. Retrieved from https://www.phytojournal.com/archives/2020/vol9issue5/PartAL/9-5-484-195.pdf
12. Kaur, K., Kaur, H., & Bains, K. (2017). Development and Nutritional Evaluation of Cereal and Pulse Based Biscuits for Diabetic Patients. British Journal of Applied Science & Technology , 25(1), 1-8. doi: 10.9734/BJAST/2017/34139
13. Malik, R. (2016, January 28). Economic Times. Retrieved from Health world: https://health.economictimes.indiatimes.com/news/diagnostics/india-is-the-diabetes-capital-of-the-world/50757875
14. Mishra, N. &. (2012). Development of functional biscuit from soy flour & rice bran. . Mishra, Neha & Chandra, R.. (2012). Development of International Journal of Agricultural and Food Science., 2(1), 14-20. Retrieved from https://www.researchgate.net/publication/313406474_Development_of_functional_biscuit_from_soy_flour_rice_bran
15. Mohammed E. Hefni, A. T. (2020). Bread making with sourdough and intact cereal and legume grains – effect on glycaemic index and glycaemic load. International Journal of Food Sciences and Nutrition. doi: 10.1080/09637486.2020.1769568
16. Natsuki Fujiwara, C. H. (2017, January 4). Development of Low Glycemic Index (GI) Foods by Incorporating Pulse Ingredients into Cereal-Based Products: Use of In Vitro Screening and In Vivo Methodologies. Cereal Chemistry, 94(1), 110-116. doi:10.1094/CCHEM-04-16-0119-FI
17. Ndife, J. &. (2011). Ndife, Joel & Evaluation of the nutritional and sensory quality of functional breads produced from whole wheat and soya bean flour blends. African Journal of Food science, 5(8), 466-472. Retrieved from https://www.researchgate.net/publication/268299572_Evaluation_of_the_nutritional_and_sensory_quality_of_functional_breads_produced_from_whole_wheat_and_soya_bean_flour_blends
18. Neha Mishra, R. C. (2012, february 25). Development of functional biscuit from soy flour &rice bran. International Journal of Agricultural and Food Science , 2(1), 14-20. Retrieved from https://www.researchgate.net/publication/313406474_Development_of_functional_biscuit_from_soy_flour_rice_bran
19. Pariyarath S. Thondre, C. J. (2009). High-molecular-weight barley β-glucan in chapatis (unleavened Indian flatbread) lowers glycemic index. Nutrition Research Journal, 480-486. Retrieved from http://www.vitawithimmunity.com/wp-content/uploads/2014/11/PariyarathNutRes2009.pdf
20. Roman-Ramos, R., Flores-Saenz, J. L., & Alarcon-Aguilar, F. J. (1995, August 11). Anti-hyperglycemic effect of some edible plants. Journal of ethnopharmacology, 48(1), 25-32. doi:10.1016/0378-8741(95)01279-m.
21. U. V. Mani, J. P. (2009, August). Glycaemic index of a cereal-pulse mix (diabetic mix) in non insulin dependent diabetes mellitus (NIDDM) subjects. International Journal of Food Sciences and Nutrition, 45(2), 141-145. doi:10.3109/09637489409166153
22. Vasan Alka, B. P. (2017). Grab a healthy bite: Nutritional evaluation of barley based cookies. AGRICULTURAL RESEARCH COMMUNICATION CENTRE, 36(1), 76-79. doi:10.18805/ajdfr.v36i01.7464
23. Whiting, D., Weil, C., Guariguata, L., & Shaw, J. (2011, November). IDF Diabetes Atlas: Global estimates of the prevalence of diabetes for 2011 and 2030. Diabetes research and clinical practice, 94(3), 311-321. doi: 10.1016/j.diabres.2011.10.02
24. Yaqoob Sabeeha, W. N. (2017). Effect of sprouting on barley flour and cookie quality. NutraFoods, 16, 175-183. doi:10.17470/NF-017-1002-3
25. Yoshimoto, J., Kato, Y., Ban, M., Kishi, M., Horie, H., Yamada, C., & Nishizaki, Y. (2020). Palatable Noodles as a Functional Staple Food Made Exclusively from Yellow Peas Suppressed Rapid Postprandial Glucose Increase. Nutrients, 12(6). doi:10.3390/nu12061839