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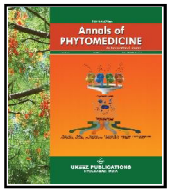

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Nutrient milieu of products developed for prediabetic population using fenugreek seeds debittered by traditional techniques

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Abstract

Fenugreek seeds have been known to possess antidiabetic properties, however endowed with a bitter taste, therefore its potential is underutilized. Fenugreek seeds were debittered while soaking overnight in milk, germinating seeds and a combination of both. Biscuit, cake, laddoo and namakpara were prepared using 10 per cent of either debittered, germinated, and debittered, followed by germinated fenugreek seeds. Developed products were evaluated for various sensory attributes and nutritional parameters. All three types of biscuits and cake were adjudged by the judges as liked moderately however, laddoo and namakpara were adjudged as liked very much. The contents of moisture, protein, fat, crude fiber, ash, total soluble sugars, reducing sugars, non-reducing sugars, soluble, insoluble and total dietary fiber were found to be increased significantly (p<0.05) in products prepared with germinated fenugreek seed powder (GFSP), debittered fenugreek seed powder (DFSP), and debittered followed by germination seed powder (DGFSP) except for fat content in products prepared with GFSP and for starch in products prepared using fenugreek seeds, treated in all three ways. Products prepared with DFSP contained maximum amounts of protein and fat, whereas products prepared with GFSP contained maximum crude fiber and ash. It may be concluded that the germination and overnight soaking in milk has not only improved the taste rather completely debittered the fenugreek seeds. Germinated and overnight milk-soaked fenugreek seeds powder could be incorporated upto 10 per cent successfully for the development of fenugreek-based products without compromising important sensory attributes. Products developed using debittered fenugreek seeds powder (germinated, overnight milk-soaked, and a combination of both) had better nutrient profiles than control products. Debittering and germination can be easily done at the household level to maximize the utilization of fenugreek wonder seeds having antidiabetic effect.

1. Introduction

Prediabetes is a serious health condition where blood sugar level is higher than normal, but not high enough yet to be diagnosed as type-2 diabetes. It is a term used extensively to describe people with impaired glucose tolerance and or impaired fasting glucose. It indicates a higher risk of developing type-2 diabetes with an annualized conversion rate of 5-10 per cent. In 2021, 541 and 319 million adults worldwide, are estimated to have impaired glucose tolerance (IGT) and impaired fasting glucose (IFG), respectively and that is projected to increase to 730 and 441 million by 2045 (IDF, 2021).

Type-2 diabetes is a metabolic disorder characterized by chronic hyperglycaemia either because the pancreas does not produce sufficient insulin or the peripheral target tissues are incapable to retort to the normal concentration of insulin (Yibru *et al*., 2015). Generally, the onset of type-2 diabetes occurs after 30 years however, in recent years, there has been a steady increase in the number of younger individuals even less than 20 years of age. Worldwide, 537 million adults (20-79 years) are suffering from diabetes, and predicted to rise to 643 million by 2030 and 783 million by 2045. The recently released figures by the International Diabetes Federation (IDF) placed India in the second spot only behind China by having a staggering number of 74 million diabetic patients with a rise of 16% in the last two years (IDF, 2021).

Various factors contribute to type-2 diabetes, but the main ones are lifestyle, diet, genetics, obesity, and age. A sedentary life style with negligible physical exercise, followed by unhealthy dietary habits invites the onset earlier. Generally, diabetic people have a 7 years shorter life expectancy and are more prone to develop coronary artery disease, limb amputations, end-stage renal disease, and blindness.

Herbal remedies are being used since time immemorial to treat type-2 diabetes. Many non-codified herbal medicines are prescribed by the faith herbal healers through their ancestors from ancient times that are tested by the time of their valuable knowledge (Tiwari and Rana, 2015; Bhatt *et al*., 2019). One of the best herbal products is fenugreek seed (FGS) which help in lowering glucose levels in the blood. FGS contains chemicals that have antidiabetic activity like fiber, saponins, antioxidants (Pant *et al*., 2017), andamino acids in abundance. Fiber such as galactomannan helps to decrease the sugar levels in the blood by delaying the absorption of carbohydrates, 4-hydroxyisoleucine stimulates the secretion of insulin in the pancreas

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which helps to lower glucose absorption, saponins inhibit the enzymes that break down disaccharides into monosaccharides and antioxidants by reducing oxidative stress which plays a major part in the pathogenesis of diabetes. Diosgenin is a major aglycone of saponin in fenugreek, and its recorded hypoglycemic action include renewal of pancreatic β-cell and insulin secretion stimulation and the promotion of insulin dependent glucose uptake and adipocyte differentiation promotion. Fenugreek seeds have been found to be a promising alternative for diabetes management, indeed leads to improved glycemic regulation in type-2 diabetes mellitus patients (Singh and Singh, 2021).

The bitter taste of fenugreek seeds limits its utilization as an independent ingredient in the recipe, therefore processing becomes necessary before its consumption. Overnight soaking in milk followed by grinding and roasting by adding saturated fat (ghee) and mixing with other ingredients such as roasted chickpea flour and sugar was observed as a traditional practice of debittering and utilizing fenugreek seeds. Sprouting and overnight soaking in glucose water was observed as another popular traditional practice to debitter fenugreek.

Intake of debittered and processed fenugreek seeds powder (5 g) twice a day before meals delayed the onset of diabetes in subjects with prediabetes. Hence, fenugreek powder was useful to lower blood glucose in prediabetes (Gaddam *et al*., 2015). They strongly suggested that the hypoglycaemic effect of fenugreek seeds was due to the insulinotropic effects of alkaloids present in fenugreek. Fenugreek seeds also possessed hypo-cholesterolemic effects by reducing LDLc levels and without affecting the serum TG, and HDLc levels. In this study, efforts were made to develop products for the prediabetic population using fenugreek seeds debittered by traditional techniques.

2. Materials and Methods

2.1 Procurement of processing of grains

The seed samples of fenugreek (Hisar Suvarna) and wheat (WH-1127) were procured from Department of Genetics and Plant Breeding, Chaudhary Charan Singh Haryana Agricultural University, Hisar. In treatment-I (GFSP), cleaned fenugreek seeds were soaked in lukewarm distilled water for 8 h and germinated in sterile petri dishes lined with wet filter paper for 48 h at 37ºC with frequent watering. In treatment-2 (DFSP), seeds were soaked in milk:water (3:1) for 8 h to debitter. In treatment-3 (DGFSP), seeds were soaked in milk:water (3:1) for 8 h to debitter, washed properly, and then germinated in sterile petri dishes lined with wet filter paper for 36 h at 37ºC with frequent watering. The sprouted, debittered and debittered, followed by sprouting seeds were rinsed in distilled water and dried at 50-55ºC till no further reduction in moisture content. All three types of dried and processed seeds were ground to get fine powder which was passed through 60 mesh sieve and stored in low-density polyethylene (LDPE) bags till further use in product development.

2.2 Development of products

Control biscuits, cake, and *namakpara* were developed using whole wheat flour (100%), whereas *laddoo* was developed using wheat and chickpea flour in the 3:1 ratio. Fenugreek-supplemented value-added biscuits, cakes, *laddoo*, and *namakpara* were prepared by substituting 10 per cent of germinated, debittered, and debittered followed by germinated fenugreek seed powder with the control formulation. Biscuits were prepared using the creaming method. Flour (150 g) was sieved thrice with baking powder (1 tsp) and baking soda (1/4 tsp). Ghee (100 g) was creamed with powdered sugar (100 g) by adding ammonia (1/4 tsp). Flour was added to creamed ghee to get a fine mixture by adding milk (50 ml). Small balls were prepared and kept in a greased tray with a slight press and baked at 160^0C in preheated oven. The cake was prepared by whipping milkmaid (200 g) and oil (100 g), added sieved flour (125 g), baking powder (1 tsp) and baking soda (1/4 tsp), and whipped for a while, added lukewarm water to get a perfect consistency. Poured into the greased cake mould and kept at 160^0C in preheated oven. For *laddoo*, flour (150 g) was roasted in ghee (100 g) until it turned golden brown and rested aside to get cold, added crushed sugar (100 g) and prepared beautiful round balls. For namakpara, flour (100 g) was sieved with salt to taste, rubbed with oil (10 g), kneaded with luke warm water and kept aside for about half an hour. Round balls were flattened with the help of rolling pin, flattened roti was punched with fork, cut into a 1-inch width and 2.5 inch length strips, fried into hot oil till turned golden brown. Developed products were subjected to sensory and nutritional evaluation. Sensory evaluation of developed products was performed with respect to color, appearance, aroma, texture, taste and overall acceptability by a panel of 10 semi trained judges, using 9 points hedonic scale.

2.3 Nutritional analysis

Moisture, crude protein, crude fat, crude fiber and ash content was determined by using method of AOAC (2010). Moisture was analysed using automatic moisture analyser (ANDMX-50, Japan), Nitrogen content was digested and distilled using Kjeldahl Kel Plus (KES06LR, Pelican, Chennai, India), ether extraction to analyse fat content was conducted using Socs Plus (SCS08RTS, Pelican, Chennai, India), crude fiber as acid and alkali resistant and dietary fibre constituents were investigated using enzymatic with Fibra plus (FES08A DLS TS, Pelican, Chennai, India) and ash was estimated in muffle furnace (KHERA Instruments, India). Total carbohydrate was calculated by difference.

Sample for reducing sugar, total sugar and starch was extracted using 80 per cent ethanol and the contents were estimated using the methods mentioned earlier by Verma *et al.* (2022). Non-reducing sugar was calculated as a difference between total soluble and reducing sugar.

For dietary fiber analysis, defatted sample (2.0 g) was extracted in 200 ml of 0.005 N HCl and boiled for 20 min. The suspension was then cooled down to **6ºC**, 0.3 g of disodium EDTA was added and then adjusted to pH 5.0-6.5 with 12 ml of phosphate buffer pH 10. The extraction was continued for an additional 40 min at **6ºC** to ensure the extraction of pectins with minimal degradation. Soluble and insoluble dietary fibre constituents in extracted samples were determined by the enzymatic method mentioned earlier by John *et al.* (2020). The sum of insoluble dietary fibre and soluble dietary fibre content was calculated as total dietary fiber.

2.4 Statistical analysis

The data obtained were subjected to statistical analysis for analysis of variance in a complete randomized design using SPSS software version 20.

3. Results

3.1 Sensory acceptability of processed fenugreek products

Results of sensory acceptability of germinated, debittered and debittered, followed by germinated fenugreek seed powder supplemented products indicated that the control products prepared using wheat flour in case of biscuits, cake and *namakpara* and using wheat and chickpea (75:25) flour in case of *laddoo* were adjudged by the panellist as 'liked very much' as per the scores of colour, aroma, appearance, texture, taste and overall acceptability.

As the level of germinated, debittered and debittered and germinated seed powder was incorporated upto 10 per cent, the scores of various sensory characteristics were decreased slightly; however, all the developed products were found acceptable. As per the scores given by the panelist biscuits and cake were adjudged as 'liked moderately' and the *laddoo* and *namakpara* were adjudged between 'liked very much' to 'liked moderately' (Figure 1).

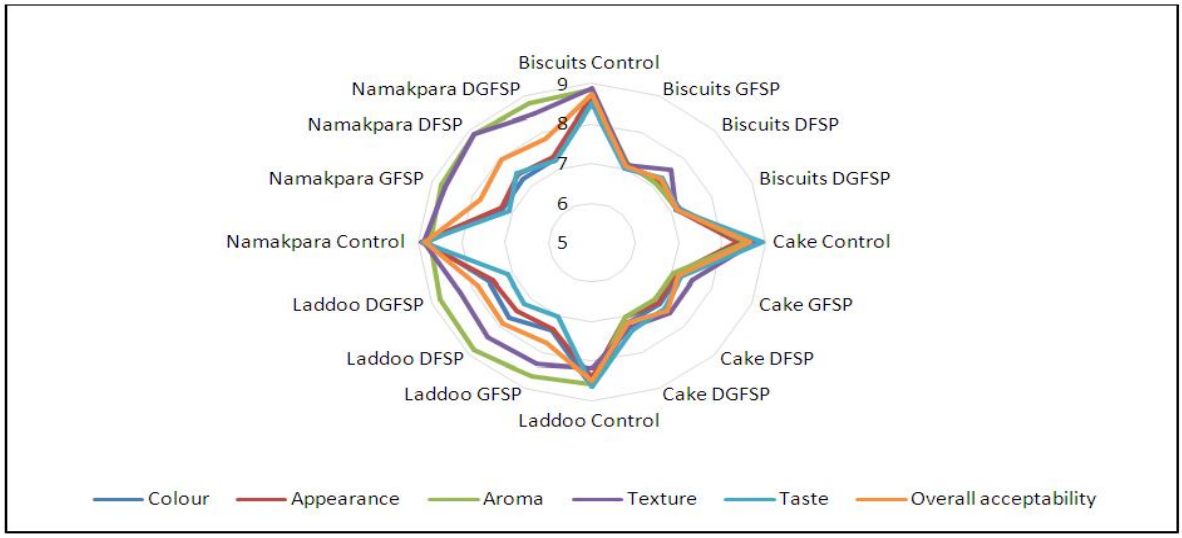

Figure 1: Sensory acceptability of germinated, debittered, and debittered followed by germinated fenugreek seed powder-supplemented products.

Table 1: Proximate composition of processed fenugreek supplemented products (%, on dry weight basis)

Types of flour	Total soluble sugars	Reducing sugars	Non-reducing sugars	Starch
		Biscuits		
Control	25.40 ± 0.17	1.16 ± 0.09	24.24 ± 0.16	30.18 ± 0.08
GFSP	29.67 ± 0.11	2.52 ± 0.07	27.15 ± 0.28	24.36 ± 0.07
DFSP	27.67 ± 0.10	1.32 ± 0.17	26.35 ± 0.10	26.05 ± 0.10
DGFSP	28.62 ± 0.30	2.01 ± 0.15	26.61 ± 0.07	24.85 ± 0.07
CD ($p \leq 0.05$)	210	0.46	1.45	1.65
		Cake		
Control	38.24 ± 0.09	1.56 ± 0.05	36.68 ± 0.04	24.53 ± 0.07
GFSP	41.46 ± 0.08	2.15 ± 0.08	39.31 ± 0.07	20.51 ± 0.08
DFSP	38.98 ± 0.04	1.81 ± 0.08	37.17 ± 0.09	22.83 ± 0.04
DGFSP	40.13 ± 0.08	1.93 ± 0.03	38.20 ± 0.08	21.75 ± 0.08
CD ($p \leq 0.05$)	0.73	0.24	0.45	1.66
		Laddoo		
Control	26.20 ± 0.06	1.45 ± 0.08	24.75 ± 0.02	29.10 ± 0.10
GFSP	28.08 ± 0.08	2.80 ± 0.05	25.28 ± 0.05	24.22 ± 0.08
DFSP	26.95 ± 0.08	1.87 ± 0.07	25.08 ± 0.08	26.95 ± 0.07
DGFSP	27.63 ± 0.06	2.27 ± 0.08	25.36 ± 0.08	25.48 ± 0.24
CD ($p \leq 0.05$)	0.27	0.09	1.39	1.01

		Namakpara		
Control	3.31 ± 0.09	0.77 ± 0.02	2.54 ± 0.07	36.12 ± 0.15
GFSP	4.64 ± 0.07	1.12 ± 0.07	3.52 ± 0.09	33.22 ± 0.18
DFSP	4.03 ± 0.09	0.85 ± 0.06	3.18 ± 0.08	30.65 ± 0.08
DGFSP	4.35 ± 0.06	0.98 ± 0.08	3.37 ± 0.09	30.82 ± 0.11
CD ($p \leq 0.05$)	0.28	0.04	1.46	1.07

Values are mean ± SE of three independent determinations; Control (100% refined flour for biscuits, cake and *namakpara* and wheat and chickpea flour @ 75:25 for *laddoo*); GFSP: Germinated fenugreek seed powder @ 10%; DFSP: Debittered fenugreek seed powder @ 10%; DGFSP: Debittered and germinated fenugreek seed powder @ 10%

Table 2: Sugars and starch content of processed fenugreek seed powder supplemented biscuits and cake (%, on dry weight basis)

Types of flour	Total soluble sugars	Reducing sugars	Non-reducing sugars	Starch
		Biscuits		
Control	25.40 ± 0.17	1.16 ± 0.09	24.24 ± 0.16	30.18 ± 0.08
GFSP	29.67 ± 0.11	2.52 ± 0.07	27.15 ± 0.28	24.36 ± 0.07
DFSP	27.67 ± 0.10	1.32 ± 0.17	26.35 ± 0.10	26.05 ± 0.10
DGFSP	28.62 ± 0.30	2.01 ± 0.15	26.61 ± 0.07	24.85 ± 0.07
CD ($p \leq 0.05$)	210	0.46	1.45	1.65
		Cake		
Control	38.24 ± 0.09	1.56 ± 0.05	36.68 ± 0.04	24.53 ± 0.07
GFSP	41.46 ± 0.08	2.15 ± 0.08	39.31 ± 0.07	20.51 ± 0.08
DFSP	38.98 ± 0.04	1.81 ± 0.08	37.17 ± 0.09	22.83 ± 0.04
DGFSP	40.13 ± 0.08	1.93 ± 0.03	38.20 ± 0.08	21.75 ± 0.08
CD ($p \leq 0.05$)	0.73	0.24	0.45	1.66
		Laddoo		
Control	26.20 ± 0.06	1.45 ± 0.08	24.75 ± 0.02	29.10 ± 0.10
GFSP	28.08 ± 0.08	2.80 ± 0.05	25.28 ± 0.05	24.22 ± 0.08
DFSP	26.95 ± 0.08	1.87 ± 0.07	25.08 ± 0.08	26.95 ± 0.07
DGFSP	27.63 ± 0.06	2.27 ± 0.08	25.36 ± 0.08	25.48 ± 0.24
CD ($p \leq 0.05$)	0.27	0.09	1.39	1.01
		Namakpara		
Control	3.31 ± 0.09	0.77 ± 0.02	2.54 ± 0.07	36.12 ± 0.15
GFSP	4.64 ± 0.07	1.12 ± 0.07	3.52 ± 0.09	33.22 ± 0.18
DFSP	4.03 ± 0.09	0.85 ± 0.06	3.18 ± 0.08	30.65 ± 0.08
DGFSP	4.35 ± 0.06	0.98 ± 0.08	3.37 ± 0.09	30.82 ± 0.11
CD ($p \leq 0.05$)	0.28	0.04	1.46	1.07

Values are mean ± SE of three independent determinations; Control (100% refined flour for biscuits, cake and *namakpara* and wheat and chickpea flour @ 75:25 for *laddoo*); GFSP: Germinated fenugreek seed powder @ 10%; DFSP: Debittered fenugreek seed powder @ 10%; DGFSP: Debittered and germinated fenugreek seed powder @ 10%.

3.2 Proximate composition of products

Results indicated that the biscuits prepared with GFSP, DFSP and DGFSP contained 2.81-3.14 per cent of moisture, 7.65-8.92 per cent of crude protein, 28.39-29.62 per cent of crude fat, 3.82-4.15 per cent of crude fiber and 1.90-2.60 per cent of ash.Whereas, the contents of same in control cake were observed as 22.29-22.59 per cent, 13.75-15.85 per cent, 12.35-13.55 per cent, 3.75-4.05 per cent and 1.98-2.73 per cent, respectively (Table 1).

The GFSP, DFSP and DGFSP supplemented *laddoo* contained 12.24-12.40 per cent of moisture, 9.55-10.75 per cent of crude protein, 26.52-27.29 per cent of crude fat, 3.65-3.95 per cent of crude fiber and 1.82-2.52 per cent of ash. The contents of moisture, crude protein, crude fat, crude fiber and ash of GFSP, DFSP and DGFSP supplemented *namakpara* were observed as 5.59-5.75 per cent, 8.82-10.22 per cent, 16.65-18.34 per cent, 3.49-3.82 per cent and 2.16-2.42 per cent, respectively.

The contents of moisture, protein, fat, crude fiber and ash found to be increased significantly ($p<0.05$) in products prepared with GFSP, DFSP, and DGFSP except for fat content in products prepared with GFSP. Products prepared with DFSP contained maximum amounts of protein and fat whereas products prepared with GFSP contained maximum crude fiber and ash (Table 1).

3.3 Carbohydrate profile of products

Regarding carbohydrate profile of developed products, it was found that total soluble sugars, reducing sugars, non-reducing sugars and starch content of control and processed fenugreek seed powder supplemented biscuits ranged from 25.40 to 29.67 per cent, 1.16 to 2.52 per cent, 24.24 to 27.15 per cent and 24.36 to 30.18 per cent, respectively.

Germinated fenugreek seed powder (GFSP) supplemented biscuits contained maximum contents of total soluble sugars, reducing sugars and non-reducing sugars, followed by DGFSP and DFSP supplemented biscuits. A similar trend was followed for total soluble sugars, reducing sugars, non-reducing sugars, and starch contents of cake and *laddoo*.

The contents of same for cake were ranged from 38.24 to 41.16 per cent, 1.56 to 2.15 per cent, 36.68 to 39.21 per cent and 20.51 to 24.53 per cent, respectively, whereas the *laddoo* contained 26.20 to 28.08 per cent of total soluble sugars, 1.45 to 2.80 per cent of reducing sugars, 24.75 to 25.36 per cent of non- reducing sugars and 24.22 to 29.10 per cent of starch. In contrast to sweet products, namakpara had 3.31 to 4.64 per cent of total soluble sugars, 0.77 to 1.12 per cent of reducing sugars, 2.54 to 3.52 per cent of non- reducing sugars and 30.65 to 36.12 per cent of starch (Table 2).

As a result, total soluble sugars, reducing sugars and non-reducing sugars increased significantly ($p \leq 0.05$) with 10 per cent supplementation of germinated, debittered and debittered and germinated fenugreek seed powder, whereas the content of starch was decreased significantly in comparison to control products.

3.4 Dietary fibre profile of products

Results presented in Figure 2 indicated that the soluble dietary fibre of germinated, debittered and debittered followed by germinated seed powder-supplemented products ranged from 2.49 to 4.01 per cent that was found highest in *laddoo* prepared with germinated fenugreek seed powder however lowest in cake prepared with control formulation. A similar trend was followed for insoluble and total dietary fiber in biscuit, cake, *laddoo* and *namakpara*. The insoluble and total dietary fiber were ranged from 2.80 to 5.60 per cent and 5.29 to 9.61 per cent, respectively among all four types of products.

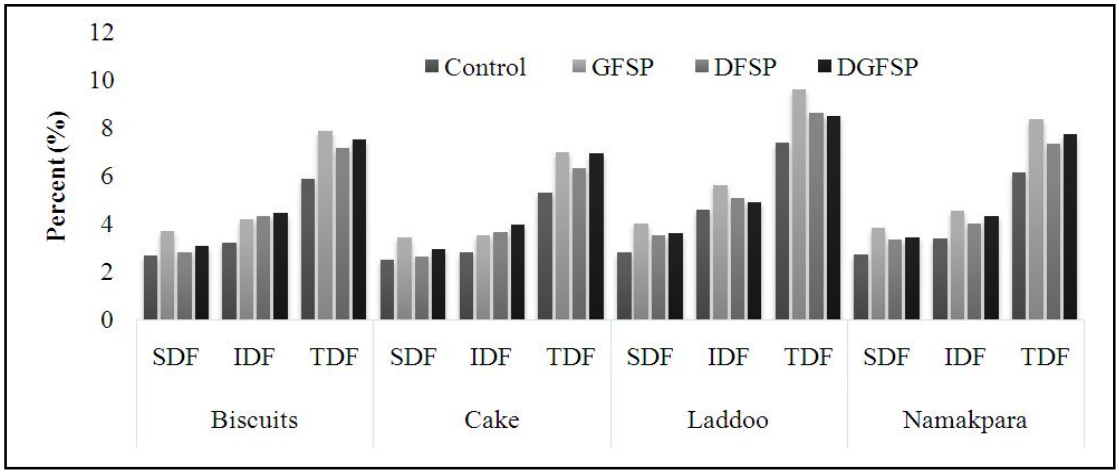

Figure 2: Dietary fibre content (%) of processed fenugreek supplemented products.

4. Discussion

In present study, it was observed that products prepared with debittered fenugreek seed powder (DFSP) had higher scores than the products prepared with germinated fenugreek seed powder (GFSP) that might be because during soaking in milk saponin content which contributes to bitterness getting disintegrated and milk added sweet taste (Chaubey *et al*., 2017) additionally, saponins probably have formed a complex with one of the constituents of milk. In a similar study, Chaubey *et al*. (2017) observeda similar reaction while soaking fenugreek seeds in curd and curd is made up of milk so that makes sense that there is something in milk that during soaking reduce the saponins and therefore bitterness, future research should be focused in this direction to find out this relationship.

Results of sensory acceptability of germinated, debittered, and debittered followed by germinated fenugreek seed powder supplemented biscuits, cake, *laddoo* and *namakpara* have been found

in close agreement with those of earlier workers who had incorporated processed fenugreek (soaked, debittered and germinated) seed powder upto 10 per cent in the development of bread (Chaubey *et al*. 2017) biscuits (Mahmoud *et al*., 2012; Agrawal and Syed, 2017) dhokla (Lakshmi, 2017) muffins (Srivastava *et al*., 2012). Contrary to present study, *chapatti* and *idli* developed by incorporating 20 and 30 per cent level of germinated fenugreek seed flour, respectively, were found acceptable (Pandey and Awasthi, 2015). Lakshmi (2017) revealed that *kozhukattai* prepared with 25 per cent of fried fenugreek seed powder were found acceptable.

A low proportion of supplementation of fenugreek seed powder than the present study was observed in the development of roti (5, 4 and 3 per cent) by Singh andSaha (2015) and 1 to 2.5 per cent in the development of biscuits by Lalit and Kochhar (2018). Products prepared beyond the mentioned level were not found acceptable by them however, it was noticed that both of them used raw fenugreek rather processed.

Biscuits, cake, *laddoo* and *namakpara* prepared with all three treatments GFSP, DFSP DGFSP had significantly (p<0.05) higher contents of moisture, protein, fiber and ash. Similar results for proximate composition of fenugreek supplemented products have been observed by Mahmoud *et al*. (2012), Srivastava *et al*. (2012), Chaubey *et al*. (2017), Agrawal and Syed (2017) and Bandyopadhyay *et al*. (2019). An increase in protein during germination might be due to the reduction of seed nitrates into protein or ammonium compound or it might have been due to the enzymatic synthesis of proteins. The reduced crude fat in germinated fenugreek products might have happened due to its consumption as an energy source during the germination of fenugreek grains. Fenugreek supplementation contributed excellent amounts of protein, fiber and ash within developed products and increased ash is a further indication of its rich mineral density.

Increased contents of total soluble sugars, reducing sugars and non-reducing sugars in the products developed with 10 per cent supplementation of germinated, debittered and debittered and germinated fenugreek seed powder might have happened due to their higher concentration in germinated, debittered and debittered and germinated fenugreek seed than the unprocessed wheat grain. Furthermore, during germination, the carbohydrate constituents in seeds get influenced by many factors such as amount of oxygen and other constituents in steep medium, temperature, and the procedure of hydration from dry seed. These factors probably affect the respiration, breakdown, and synthesis of seed carbohydrates (Atlaw *et al*., 2018). An increase in sugar content during germination might have happened due to the mobilization and hydrolysis of seed polysaccharides. It may be hypothesized that soaking in milk during debittering have also contributed towards sugars. Reduction of starch component may happen since during the early phase of germination, gibberellin, a hormone in the scutellum, moves into the outermost endosperm layer and stimulates the activity of hydrolytic enzymes which catalyze the breakdown of starch into glucose (Delouche, 2021).

In present study, results of dietary fiber contents of processed fenugreek supplemented products showed that biscuits, cake, *loddoo* and *namakpara* prepared with 10 per cent substitution of control flour with germinated, debittered and debittered and germinated fenugreek seed powderhad increased the contents of total, soluble and insoluble dietary fiber significantly (p<0.05) in all four products (Figure 2). Other workers also found an increase in the total, soluble and insoluble dietary fiber contents of products prepared using soaked, germinated and debittered fenugreek seed flour (Srivastava *et al*., 2012). Fenugreek has been known as an excellent source of dietary fiber that further increased during germination. A similar trend ofthe dietary fibre of fenugreek seeds during germination was observed by Mabrouki *et al*. (2015), Pandey and Awasthi (2015) and Chaubey *et al*. (2017).

5. Conclusion

It may be concluded that the germination and overnight soaking in milk has not only improved the taste rather completely debittered the fenugreek seeds. Germinated and overnight milk-soaked fenugreek could be incorporated upto 10 per cent successfully for the development of fenugreek-based products without compromising important sensory attributes. Furthermore, biscuit, cake laddoo and namakpara prepared with 10 per cent supplementation of either germinated, overnight milk soaked or a combo of both had significantly higher contents of protein, dietary fiber, ash, sugars than the control products. The development of such therapeutic products would provide a wide rainbow of varieties to consumers who have been looking for healthier alternatives so that consumers can make a judicious selection of food items while preparing their plates. Debittering and germination can be easily done at the household level to maximize the utilization of fenugreek a wonder legume. Besides being an excellent source of protein, fiber, and minerals, it possesses a strong antidiabetic effect. Making consumers aware of debittering of fenugreek and further fenugreek-based products may be a healthier approach to controlling prediabetic at this stage and not converting into diabetics.

Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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