Studies on chemical composition of extruded snack developed using skim milk powder, chickpea (Cicer arietinum L.) and fenugreek (Trigonella foecum-graecum L.) solids

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Abstract
The present investigation was carried to develop novel extruded snack by incorporating sprouted chickpea and sprouted fenugreek solids along with skim milk powder. Accordingly, four different treatments (T1, T2, T3 and T4) were prepared by the combining sprouted chickpea (@ 30, 25, 20 and 15%) and sprouted fenugreek (@ 0, 5, 10 and 15%) solids, respectively and skim milk solid was kept constant (46%). The extruded snack was analyzed for moisture, fat, protein, carbohydrate, ash, iron and calcium contents. The T1 sample had lowest protein (23.45%) and highest carbohydrate (64.55%), while T4 sample had the highest protein (26.95%) and lowest carbohydrate (51.31%), respectively. There was no significant difference in the moisture, fat and ash contents of all the samples. The iron content gradually increased from 0.1 mg/100g (T1) to 0.25 mg/100g (T4). The calcium contents of T1, T2 and T3 samples were at par with each other while, T4 sample had slight lower calcium content (0.6 mg/100g).

Keywords: Fenugreek, chickpea, extruded snack, sprouting

1. Introduction
Now a days majority of consumers want healthy, functionally and therapeutically rich foods. According to a UNICEF report 40-60% of children aged between 1 to 5 years are suffering from malnutrition and anemia [1]. Protein, Calcium and Iron rich foods are very important for preschool children for their proper growth and development. Lactating women needs more calorific foods that are rich in nutrients. There have been significant efforts over the past decade to improve the diet and much focus is given on healthy eating. Recently Corona virus disease (or COVID-19) has been declared as Pandemic by WHO [2]. The traditional medicines which include the use of herbs and spices (such as fenugreek, amla, ashwagandha, guduchi, tulsi, ginger, garlic etc) have shown to boost the human immunity [3]. As the scientists all over the world are working to find vaccine for COVID-19, these traditional medicines can help to manage the infections caused by Corona Virus. With the absence of vaccine, the AYUSH Ministry of India, ICMR and WHO are emphasizing the use of these traditional herbs and spices for COVID-19 patients which can improve the immunity of these patients [4]. With the increase in COVID-19 patients, nutritional awareness is also increasing. The nutritional deficiencies, health promoting and immune boosting aspects are fulfilled by supplementing, fortifying, blending or developing new products from naturally available food constituents such as wheat, oats, milk, fenugreek, chickpea etc.

Fenugreek (Trigonella foecum-graecum L.) is a herb that yields seeds which are hard, yellowish brown and angular in shape which are used to prepare extracts or powders for medicinal uses [3]. It contains 45-60% carbohydrates, mainly mucilaginous fiber (galactomannans); 20-30% proteins, high in essential amino acids like lysine, tryptophan arginine and histidine; 5-10% lipids; and other active ingredients like trigonelline (0.2-0.36%), choline (0.5%), saponins (0.6-1.7%); and rich in minerals that include calcium (0.16%), iron (0.065%), phosphorus (0.37%) and also high in vitamins- β-carotene, folic acid, and ascorbic acid 96, 84 and 19.8 (mg/100g) respectively [6, 7]. The pharmacological effects of fenugreek are antimicrobial, anti-cholesterolemic, carminative, febrifuge, restorative, uterine tonic,
expectoralt, galactogouge, anticarcinogenic, anti-inflammatory, antiviral, antioxidant, hypotensive etc. [8]. Chickpea (*Cicer arietinum L.*) is the 3rd important legumes in the world [9] and is a valuable source of proteins (essential amino acid), fatty acid, carbohydrates, minerals (iron, calcium, and potassium), vitamins, dietary fiber etc. [10]. Majority of the population in the developing countries depends on the low-priced foods based on chickpea for meeting their dietary requirements. Chickpea has been widely used in various dairy and non dairy food preparations that include Chickpea Yoghurt [11], Cotija type cheese [12], Infant food formulation [13], Temphe [14], pulse based papaya powder, high protein based noodles [15] etc. Skim milk powder (SMP) a good source of animal protein (35%) as well as carbohydrates (51.9%), vitamins (8.36%) and minerals (5.9%) have been widely used to incorporate in different food preparations but it is poor in iron (0.008%) [16, 17]. Ravindran and Gamlath (2007) [18] developed functional extruded rice and chickpea snack with acceptable physical and sensory properties by the incorporation of fenugreek seeds. Hegazy and Ibrahim (2009) [19] developed biscuits and studied the effect of partial replacement of wheat flour by different levels (5, 10, 15 or 20 per cent) of germinated fenugreek seed flours. The effect of supplementation of wheat flour with fenugreek flour at 5 to 20 per cent levels in bread making was studied by Hooda and Jood (2004) [20]. Shrivastava and Ali (2004) [21] prepared bread using germinated chickpea flour at 15-20 per cent level. Today consumers are demanding variety of snack foods. Extrusion has provided a means of manufacturing new and novel products which has revolutionized many conventional snack manufacturing processes. Extrusion process offers many basic advantages that results in minimizing time, energy and cost while at the same time introducing a degree of versatility, novelty and flexibility to the product that was previously not available. Literatures related to formulation and development of foods especially, snacks through incorporation of milk solids, fenugreek and chickpea are not available. Therefore, the present investigation is aimed to evaluate the chemical quality of developed extruded snack based on milk solids, fenugreek and chickpea.

2. Materials and Methods
The study was conducted at College of Dairy Science and Food Technology, Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Raipur (Chhattisgarh). Following materials and equipments were used for the development of extruded snack.

2.1. Materials
Skim Milk Powder (SMP) brand name “MANTHAN” (MPFL, Gwalior), Chickpea (*Cicer arietinum L.*), Fenugreek Seeds (*Trigonella faecum graecum L.*) were used as the major ingredients. Sodium-bi-carbonate (brand Weikfield), was used for soaking of chickpea and fenugreek seeds and baking purpose, ammonium bi-carbonate of (brand Weikfield), commercial grade used for baking of the product. Sugar was used as a sweetening agent in the product. Cocoa Powder (brand Eagle) was used as colouring and flavouring agent and Vanilla Flavour (brand EAGLE) were used as flavouring agent. The developed product was packaged in high density polyethylene pouches (90µm thickness). All ingredients were procured from the local market of Raipur.

2.2. Equipments
Phillips brand Mixture Grinder and LG brand Microwave Oven were utilized for grinding of sprouted (germinated) chickpea and fenugreek seeds and for baking of extruded product, respectively. Stainless Steel Hand Extruder of (brand- MAHARAJA) was used for extruding the blended mixture in to a particular shape. Atomic Absorption Spectrophotometer (Win Lab 32, Germany), was utilized for the estimation of iron from raw materials and final product.

Fig 1: Stainless steel hand extruder (Manual type)

Fig 2: Stainless Extruder (Assembled)

Fig 3: Dehulled Sprouted Chickpea

2.3. Method
2.3.1. Soaking and sprouting (germination) of Chickpea and Fenugreek Seeds
Clean and matured chickpea and fenugreek seeds were soaked separately in 0.5% Sodium bi-carbonate solution for 12 hours at 27°C. The seeds: water ratio (1:4) was kept for both fenugreek and chickpea seeds. The germination of the soaked chickpea and fenugreek seeds were carried out separately at 27°C for 48 hours [22]. Dehulling of sprouted (germinated) chickpea seeds was carried out manually under hygienic conditions. The dehulled sprouted chickpea and sprouted fenugreek seed are shown in Fig. 3 and 4 respectively.

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2.3.2. Preparation of Extruded Snack

Preliminary trials were conducted to screen out the level of various ingredients. The dehulled sprouted chickpea and sprouted fenugreek seeds were ground into paste like consistency in mixer grinder. The base material was prepared by blending the pastes of chickpea, fenugreek, skim milk solids with other ingredients as given in Table 1. The flow chart for the manufacturing of extruded snack is given in Fig. 5. The different base mixes (T₁, T₂, T₃ and T₄) were extruded and dried in the microwave in convection mode at 210°C/9 min.

Table 1: Proportion of ingredients for manufacture of Extruded Snack

| Ingredients                        | T1   | T2   | T3   | T4   |
|------------------------------------|------|------|------|------|
| SMP                                | 46.0 | 46.0 | 46.0 | 46.0 |
| Chickpea Paste                     | 30.0 | 25.0 | 20.0 | 15.0 |
| Fenugreek Paste                    | 00.0 | 05.0 | 10.0 | 15.0 |
| Sugar                              | 20   | 20   | 20   | 20   |
| Cocoa Powder                       | 2.3  | 2.3  | 2.3  | 2.3  |
| Vanilla Flavor                     | 0.2  | 0.2  | 0.2  | 0.2  |
| Sodium bi-carbonate                | 0.5  | 0.5  | 0.5  | 0.5  |
| Ammonium bi-carbonate              | 1.0  | 1.0  | 1.0  | 1.0  |
| Total                              | 100  | 100  | 100  | 100  |

2.4 Chemical Analysis

The raw materials viz., skim milk powder, raw and sprouted chickpea and fenugreek seeds as well as extruded snack were analyzed for moisture (A.O.A.C. 986.21, 1995) [23], fat (A.O.A.C. 905.02, 2000) [24], protein by the micro Kjeldahl method (A.O.A.C. 976.06, 1995) [23], carbohydrates by subtracting the estimated amount of protein, fat, ash and moisture from 100, ash by (A.O.A.C method 923.03, 2000) [24], iron and calcium by Atomic Absorption Spectrophotometry (A.O.A.C. 999.11A, 1995) [23].

3. Results and Discussion

The results pertaining to the composition of major raw materials viz., skim milk powder, raw as well as sprouted chickpea and fenugreek that were used in the study have been presented along with the effect of chickpea and fenugreek solids on chemical qualities of the extruded snack.

3.1. Chemical Composition

The major chemical constituents of raw fenugreek (RFG), sprouted fenugreek (SFG), raw chickpea (RCP), sprouted chickpea (SCP) and extruded snack were studied using Completely Randomized Design (CRD) statistical model. The analysis was done for 4 treatments with 4 replications. The experimental data were subjected to analysis of variance (ANOVA) as suggested by Snedecor and Cochran (1967) [25].
chickpea (SCP), skim milk powder (SMP) and extruded snack (ES) were estimated as per the standard procedures mentioned under the materials and methods.

3.1.1 Raw materials: The chemical composition of raw and sprouted (germinated) fenugreek, chickpea and skim milk powder is displayed in the Table 2.

### Table 2: Chemical composition of raw and sprouted chickpea, fenugreek and skim milk powder

| Materials          | Values in per cent | Values in mg/100g |
|--------------------|--------------------|-------------------|
|                    | Moisture | Protein | Fat    | Carbohydrates | Ash   | Iron | Calcium |
| Raw fenugreek      | 5.37     | 29.67   | 5.36   | 55.17        | 4.43  | 4.62 | 1.68    |
| Sprouted fenugreek | 6.58     | 32.55   | 4.94   | 51.98        | 4.23  | 5.46 | 1.60    |
| Raw chickpea       | 6.78     | 26.65   | 3.84   | 58.90        | 3.84  | 4.75 | 2.10    |
| Sprouted chickpea  | 6.96     | 27.87   | 3.64   | 57.85        | 3.68  | 4.63 | 2.00    |
| Skim milk powder   | 3.74     | 34.30   | 1.10   | 53.48        | 7.14  | 0.54 | 16.83   |

Values are average of 4 replications.

The table clearly indicated that the raw fenugreek had initially lower protein as well as iron content that simultaneously increased, while fat, ash, carbohydrate and calcium decreased upon sprouting. The increase in protein content of fenugreek seeds during sprouting may be attributed to the enzymatic synthesis of protein which was recorded by El-Shimi et al. (1984) [26] and Mansour and Al-Adawy (1994) [27] while sprouting these seeds. As per Kumar et al. (1978) [28], Reddy et al., (1978) [29] and El-Mahdy and El-Sebaiy (1994) [30], the increase in iron content of sprouted (germinated) fenugreek could be due to the reduction in phytates, tannins and other anti nutritional factors that bind minerals. The decrease of fat in fenugreek and chickpea after sprouting (germination) might be ascribed to its consumption as an energy source in the process of germination. Mansour and Al-Adawy (1994) [27] and El-Aal (1986) [31] reported that germination of fenugreek seeds decreased the total fat content. The decrease in carbohydrate content of SFG might be due to the reduction in total dietary fibre and insoluble dietary fibre as well as an increase in soluble dietary fibre as suggested by Neerja and Rajalakshmi (1996) [32] and Kavitha et al. (2001) [33] reported the increase in soluble dietary fiber after germination of wheat grains, while Udayasekhara Rao and Belavady (1978) [34] reported that the decrease in carbohydrate content of SCP probably be due to the action of enzymes like amylase, invertase which reduced the total sugar content during germination. There was minor decrease in the ash and calcium contents of SPF as compared to RFG and no major changes in the ash, iron and calcium contents of chickpea before and after sprouting.

The skim milk powder, a concentrated form of milk solids that had higher amount of protein, carbohydrate, ash and calcium contents, whereas it had the lowest iron content (0.54mg/100g) as compared to raw and sprouted fenugreek and chickpea which is in accordance with the values reported by Hui (1993) [35] and Gopalan et al. (2003) [36]. The average moisture, fat, protein, ash, carbohydrate, iron and calcium contents of raw and sprouted (germinated) chickpea and fenugreek as well as skim milk powder were found to be in accordance with the values reported by Ali and Kumar (2003) [39], Chavan et al., (2000) [14], Hira and Chopra (1995) [37], Akhtar (1990) [38], Salunkhe and Kadam (1989) [59], Gopalan et al. (2000) [36], Farrell (1999) [40], Mathur and Choudhary (2009) [22] and Hui (1993) [35], indicating that the raw materials used in this study were normal in composition.

### Table 3: Effect of different levels of sprouted chickpea and fenugreek solids on chemical composition of extruded snack

| Treatments | Values in per cent | Values in mg/100g |
|------------|--------------------|-------------------|
|            | Moisture | Protein | Fat    | Ash    | Carbohydrate | Iron | Calcium |
| T₁         | 4.70±0.16 | 23.45±0.21 | 2.85±0.05 | 4.50±0.048 | 64.55±0.21 | 0.16±0.018 | 0.7±0.01 |
| T₂         | 4.70±0.14 | 26.60±0.19 | 2.80±0.04 | 4.50±0.058 | 61.45±0.28 | 0.15±0.01 | 0.7±0.02 |
| T₃         | 4.70±0.17 | 26.60±0.20 | 2.80±0.05 | 4.50±0.060 | 61.40±0.29 | 0.23±0.015 | 0.7±0.02 |
| T₄         | 4.75±0.12 | 26.95±0.22 | 2.80±0.03 | 4.55±0.071 | 60.95±0.26 | 0.25±0.018 | 0.6±0.03 |
| F-Values   | 1.46±0.1 | 326.46* | 1.00 | 1.00 | 210.392* | 17.000* | 2.630* |
| SE(m)      | 0.1033 | 0.0853 | 0.0318 | 0.0316 | 0.0982 | 0.0424 | 0.036 |
| LSD/CD     | NS | NS | NS | NS | 0.214 | 0.092 | 0.079 |

* Indicate significant at 5 per cent level. Different superscripts in the table indicate treatments differ significantly (p< 0.05)
The level of incorporation of sprouted chickpea and fenugreek solids significantly (p≤ 0.05) influenced the iron content of the ES. The sample T1 had the lowest iron content of 0.1mg/100g that was significantly lower than rest of the samples, whereas, the sample T3 and T4 had significantly higher iron contents 0.23 mg/100g and 0.25 mg/100g respectively. The increased proportion of sprouted fenugreek solids incorporation improved the iron contents in the T2, T3 and T4 samples and this could be due to higher iron contents due to SCP (Table 3), whereas, the iron content was lower in T1 sample which might be ascribed to presence of more amount of SCP which inherently possessed lower iron content even after sprouting. Mathur and Choudhary, (2009) [18], Wam and Kumar, (2018) [42] reported increase in iron content in sprouted fenugreek seeds, while, Salunkhe and Kadam (1989) [39] recorded decrease in iron content in chickpea after sprouting. The level of incorporation of sprouted chickpea and fenugreek solids showed a significant change in the calcium content of the samples T1, T2 and T3 which had the same calcium content of 0.7mg/100g and were significantly higher than T4 sample that had significantly (p≤ 0.05) lower calcium content of 0.6mg/100g. As the amount of sprouted chickpea solids decreased and the amount of sprouted fenugreek solids increased, the calcium content drastically decreased only in the T4 sample and this decrease in the calcium content could be ascribed to the fact that the sprouted chickpea had initially higher calcium content of 0.20 per cent than sprouted fenugreek 0.16%, as indicated in Table 3. The incorporation of sprouted chickpea gradually decreased, while, the sprouted fenugreek increased in T1 to T4 samples which resulted in the decrease in calcium content.

4. Conclusion
From the present study, it can be concluded that the incorporation of sprouted form of chickpea and fenugreek solids improved the nutritional status of extruded snack, more specifically the protein and iron contents. Milk and milk solids are poor source of iron which could be enriched by admixing these solids. Furthermore, the inherent therapeutic value of these fenugreek and chickpea would improve the immunity and may help in preventing or fighting against various diseases.

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