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# Studies on chemical composition of extruded snack developed using skim milk powder, chickpea (*Cicer arietinum* L.) and fenugreek (*Trigonella feocum-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 ($T_1$, $T_2$, $T_3$ and $T_4$) 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 $T_1$ sample had lowest protein (23.45%) and highest carbohydrate (64.55%), while $T_4$ 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 ($T_1$) to 0.25 mg/100g ($T_4$). The calcium contents of $T_1$, $T_2$ and $T_3$ samples were at par with each other while, $T_4$ 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 boast 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 boasting 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 feocum-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 [5]. 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,

expectoral, 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], Tempeh [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" (MFPL, 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 (90 µm 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)

### 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 $27^0$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 $27^0$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.

**Fig 3:** Dehulled Sprouted Chickpea

**Fig 4:** Sprouted Fenugreek Seeds

### 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 ($T_1$, $T_2$, $T_3$ and $T_4$) were extruded and dried in the microwave in convection mode at 210 -240$^0$ C/9 min.

**Table 1:** Proportion of ingredients for manufacture of Extruded Snack

| Ingredients | Per cent | | | |
|---|---|---|---|---|
| | Treatments | | | |
| | 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 | 20.0 | 20.0 | 20.0 |
| 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 |

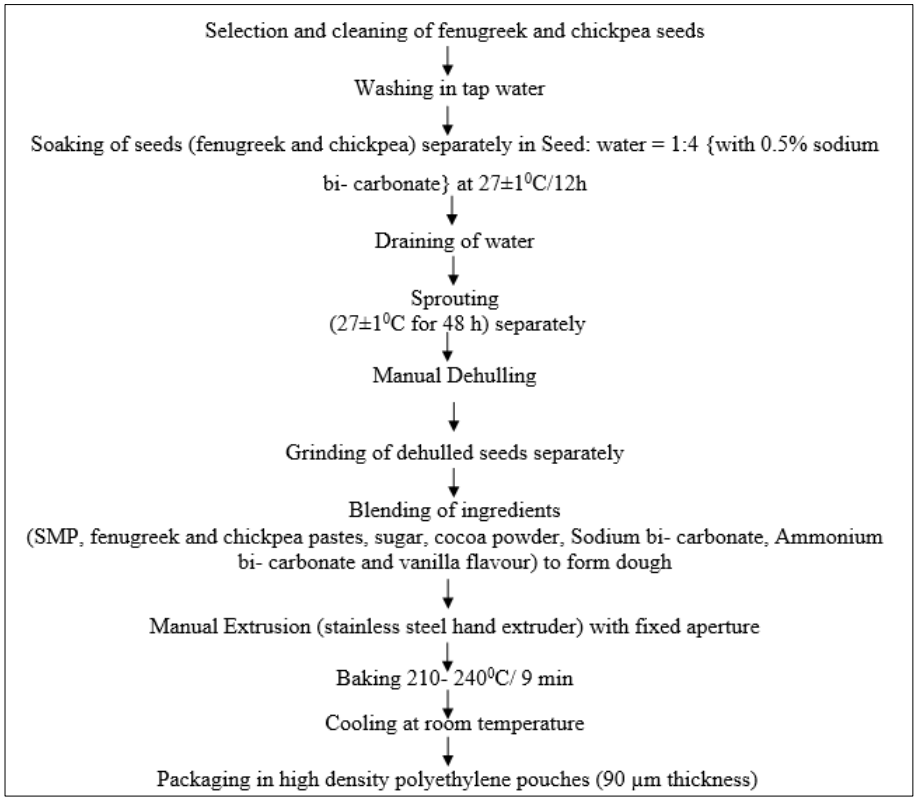


**Fig 5:** Flow chart for manufacture of extruded snack

### 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].

### 2.5. Statistical Analysis

The impact of different levels of incorporation of sprouted chickpea and fenugreek solids on the chemical composition of extruded snack was 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 Sendecor and Cochran (1967) [25].

## 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), 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 | Chemical Composition | | | | | | |
|---|---|---|---|---|---|---|---|
| | 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 SFG 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) [9], Chavan *et al*., (2000) [14], Hira and Chopra (1995) [37], Akhtar (1990) [38], Salunkhe and Kadam (1989) [39], 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 |
| $T_1$ | 4.70±0.16 | 23.45$^{a}$ ±0.21 | 2.85±0.05 | 4.50±0.048 | 64.55$^{a}$ ±0.21 | 0.1$^{a}$ ±0.018 | 0.7$^{a}$ ±0.01 |
| $T_2$ | 4.70±0.14 | 26.60$^{b}$ ±0.19 | 2.80±0.04 | 4.50±0.058 | 61.45$^{b}$ ±0.28 | 0.15$^{a}$ ±0.01 | 0.7$^{a}$ ±0.02 |
| $T_3$ | 4.70±0.17 | 26.60$^{b}$ ±0.20 | 2.80±0.05 | 4.50±0.060 | 61.40$^{b}$ ±0.29 | 0.23$^{b}$ ±0.015 | 0.7$^{a}$ ±0.02 |
| $T_4$ | 4.75±0.12 | 26.95$^{c}$ ±0.22 | 2.80±0.03 | 4.55±0.071 | 60.95$^{c}$ ±0.26 | 0.25$^{b}$ ±0.018 | 0.6$^{b}$±0.03 |
| F-Values | 1.463±0.1 | 326.468* | 1.000 | 1.000 | 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 | 0.186 | NS | NS | 0.214 | 0.092 | 0.079 |

* Indicate significant at 5 per cent level. Different superscripts in the table indicate treatments differ significantly ($p< 0.05$)

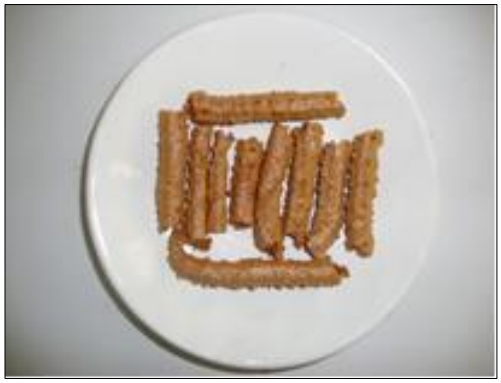

**Fig 6:** Extruded snack sample ($T_1$)

**Fig 7:** Extruded snack sample ($T_2$)

**Fig 8:** Extruded snack sample ($T_3$)

**Fig 9:** Extruded snack sample ($T_4$)

### 3.2 Extruded Snack (ES)

Effect of level of incorporating sprouted chickpea and fenugreek solids on the chemical composition of extruded snack (ES) is presented in the Table. 3 and in Figure 6, 7, 8 and 9. The level of incorporation of sprouted chickpea and fenugreek had a definite effect on the protein, carbohydrates, iron and calcium contents of the extruded snack (ES). As the proportion of sprouted chickpea and fenugreek variated, the protein content of the ES also changed. The treatment $T_1$ had the minimum protein content of 23.45% which was significantly lower ($p \leq 0.05$) than rest of the samples, while, treatment $T_4$ had the highest protein content of 26.95%. When the level of proportion of fenugreek solids increased, the protein contents of the samples also increased. The significant increase in the protein content in the treatments $T_2$, $T_3$ and $T_4$ than $T_1$ could be associated with increased incorporation sprouted fenugreek solids that ultimately elevated the protein contents in these samples, whereas, the lower protein content in $T_1$ sample might be ascribed to the higher proportion of sprouted chickpea that had basically lower protein content as compared to sprouted fenugreek. The results of present findings on protein content is in agreement with Hegazy and Ibrahium, (2009) [19] who reported that the protein content increased with increased replacement of wheat flour with fenugreek seed flour in the biscuits. Wam and Kumar (2018) [41] also reported that wheat flour supplemented with germinated fenugreek powder at 5-10% increased the total protein content.

The level of incorporation of sprouted chickpea and fenugreek solids had a definite effect on the carbohydrate content of the ES. Table 3 indicated that $T_1$ sample had 64.55% carbohydrates which was significantly ($p \leq 0.05$) higher than the rest of the samples, whereas, T4 sample had significantly ($p \leq 0.05$) lower carbohydrate content of 60.95%. The increased proportion of fenugreek incorporation simultaneously decreased the carbohydrate contents; however, the samples T2 and T3 were on par with each other w.r.t. carbohydrate content. The increase in carbohydrate content in $T_1$ sample may be due to the fact that it contained the highest proportion of sprouted chickpea solids (30%) which basically had higher carbohydrate content of 57.85% (Table 3), whereas, the sprouted fenugreek contained lower amount of carbohydrate (51.98%). Similar results were recorded by Hegazy and Ibrahium (2009) [19] while developing biscuits by partially replacing wheat flour with sprouted fenugreek.

It is evident from Table 3 that the level of incorporation of sprouted chickpea and fenugreek solids significantly ($p \leq 0.05$) influenced the iron content of the ES. The sample $T_1$ had the lowest iron content of 0.1mg/100g that was significantly lower than rest of the samples, whereas, the sample $T_3$ and $T_4$ 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 $T_2$, $T_3$ and $T_4$ samples and this could be due to higher iron contents due to SFG (Table 3), whereas, the iron content was lower in $T_1$ 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 $T_1$, $T_2$ and $T_3$ which had the same calcium content of 0.7mg/100g and were significantly higher than $T_4$ sample that had significantly ($p \leq 0.05$) 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 $T_4$ 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 $T_1$ to $T_4$ 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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