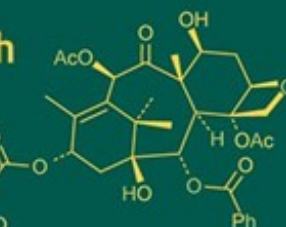
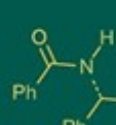


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
Indexing: Embase
IJABR 2026; SP-10(10): 374-384
www.biochemjournal.com
Received: 28-07-2026
Accepted: 19-09-2026
Published: 03-10-2026

Priyanshi Patel

M. Tech. Scholar Student
(Agril. Engg.), College of
Agricultural Engineering and
Technology, Navsari
Agricultural University,
Gujarat (India)

SN Singh

Principal & Dean, College of
Agricultural Engineering and
Technology, Navsari
Agricultural University,
Gujarat (India)

Ayush Patel

M. Tech. Scholar Student
(Agril. Engg.), College of
Agricultural Engineering and
Technology, Navsari
Agricultural University,
Gujarat (India)

RG Burbade

Assistant Professor,
Department of Processing and
Food Engineering, College of
Agricultural Engineering and
Technology, Navsari
Agricultural University,
Navsari, Gujarat, India

**Corresponding Author:
Priyanshi Patel**

M. Tech. Scholar Student
(Agril. Engg.), College of
Agricultural Engineering and
Technology, Navsari
Agricultural University,
Gujarat (India)

Studies on physical properties and nutritional composition of green chickpea based value added burfi product

Priyanshi Patel¹, SN Singh², Ayush Patel³, RG Burbade⁴

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i10Se.10307>

ABSTRACT

Consumers are looking for functional foods that have health promoting properties with the intent to prevent disease. Therefore, there is an increased demand for healthy dietary products, which contain added functional health values. Two nutrient rich crops, namely green chickpea (*Cicer arietinum* L.) and finger millet (*Eleusine coracana*), which are widely grown in South Gujarat region were chosen for the development of value-added dairy confectionery. Burfi's were developed with different proportions of green chickpea pastes (12–20 %), khoa (50 %) and sugar (30 %) and roasted finger millet flour (0–8 %). Standard analytical methods were used to evaluate the developed products for physical and nutritional properties. The highest values of physical properties, namely length, width, thickness, weight, volume and true density were recorded as 39.61 mm (T_2), 36.64 mm (T_4), 13.37 mm (T_1), 17.15 g (T_1), 17.58 cm³ (T_1) and 1.29 g/cm³ (T_9) respectively. The highest nutritional values for protein, crude fibre, fat, ash, reducing sugar and energy were 30.32 % (T_1), 10.16 % (T_9), 49.88 % (T_9), 11.49 % (T_1), 3.14 % (T_9) and 342.32 kcal/100 g (T_9) respectively, while the lowest moisture content was 25.46 % (T_9). The nutritional evaluation showed that the treatment, T_9 , had the best overall acceptability, followed by T_1 and T_2 . The formulation with 50 % khoa, 30 % sugar, 12 % finger millet flour and 8 % fresh green chickpea paste was found to be the optimum formulation and was recommended for making a nutritious value-added burfi.

Keywords: Green chickpea, Finger millet, Value addition, Nutritional, Physical characteristics

1. Introduction

The need for value added and functional food products has risen significantly in the last few years due to the growing consumer awareness of the relationship between diet and health. Foods are increasingly being developed to contain nutrients, as well as provide other physiological value such as reducing the risk of chronic diseases and improving overall well-being (Singh *et al.*, 2020) [1]. Hence the preparation of nutraceutical and functional foods with the addition of bioactive molecules has been an important research field in food. Malnutrition and micronutrient deficiencies are widespread public health issues especially in developing countries. Protein, iron, calcium, zinc and vitamin A deficiencies have a negative impact on physical growth, cognitive development and immune function. Local use of nutrient-rich crops is viewed as one way to achieve dietary diversification and to enhance nutritional security (West *et al.*, 1999) [2]. Proteins, dietary fibre, minerals, vitamins and phytochemicals are excellent nutrients and functional properties of legumes and millets which are increasingly used in value added food products.

Burfi is one of the most favorite indigenous khoa based dairy products of India owing to its delicious taste, creamy texture and nutritional value. The common ingredients for the preparation of burfi are khoa and sugar, but it is comparatively devoid of dietary fibres and some micronutrients. In recent years, consumers became conscious of the need of a healthy diet and this has led to the development of functional and value-added dairy products containing cereals, legumes and millets, which not only improves the nutritional value but also preserves the sensory properties of the dairy product (Bodyfelt *et al.*, 1999; Aneja *et al.*, 2002; De, 2006) [4, 3, 5].

Chickpea (*Cicer arietinum* L.) is one of the most important pulse crops and is widely used due to its nutritional value and versatility in food processing applications. Chickpea is a rich source of protein, carbohydrates, dietary fibre, minerals, vitamins and bioactive compounds and hence, it is considered an important plant-based source of nutrients (Jukanti *et al.*, 2012; Kaur *et al.*, 2021; Wang *et al.*, 2021) [6]. Recent studies have also highlighted the protein functionality, fibre, phytochemicals and techno-functional properties of chickpea, such as its water- and oil-binding, emulsification and texture-forming capacities (Ghribi *et al.*, 2015; Jukanti *et al.*, 2012 [6]; Bouchenak and Lamri-Senhad, 2013; Kaur *et al.*, 2021; Dhull *et al.*, 2022;

Garg *et al.*, 2022). Recent studies also show that chickpea has great potential to be used in value-added foods and new food formulations (Wang *et al.*, 2021; Kaur *et al.*, 2024; Kumar *et al.*, 2025) [7].

Fresh green chickpea is picked at an immature stage and is sweeter tasting, more tender and higher in vitamins, antioxidants and carotenoids compared to the mature dried chickpea. Low in saturated fat and sodium, it's high in protein, dietary fibre, folate, vitamin C and provitamin A carotenoids. Although fresh green chickpea is very nutritious yet due to its seasonal availability and perishability, it has limited commercial utilization in India. The treatment of fresh green chickpeas with value added products can extend the shelf life, increase the nutrient bioavailability and improve consumers' acceptance of chickpeas (Hirdyani, 2014; Parmar *et al.*, 2016) [8, 9].

Finger millet (*Eleusine coracana*), commonly known as ragi, is one of the most nutritious millets as it contains a high level of dietary fibre, iron, essential amino acids and natural antioxidants. Finger millet is also a good source of polyphenols and slowly digestible starch, has a low glycaemic index and health promoting properties. A number of researchers reported the incorporation of finger millet flour in bakery, dairy and traditional food products to significantly enhance the nutritional profile and functional properties of the food products without affecting the desirable sensory quality of the food products (Chethan *et al.*, 2007; Devi *et al.*, 2014; Sharma *et al.*, 2021; Malleshi *et al.*, 2026) [10, 11, 12, 13].

Legumes and millets use in traditional dairy products has gained a lot of interest due to their complementary nutritional properties. Animal protein and fat is good in milk while green chickpea is rich in plant protein, dietary fibre, vitamins and antioxidants. This is a balanced functional food with the addition of finger millet, which enhances the calcium, iron, dietary fibre and phenolic compounds, resulting in an increased nutritional value. In the past, the use of cereals, pulses and millets for value added dairy products such as burfi, peda, kheer and khoa has proved to be successful and improved nutritional values and consumer acceptability were observed (Aneja *et al.*, 2002; De, 2006; Kamble *et al.*, 2019; Kamble *et al.*, 2025) [3, 5, 14, 15].

The use of Green Chickpea and Finger millet in the production of burfi provides a potential for the production of functional dairy product while enriching its protein, dietary fibre, mineral and antioxidant content as well as enhancing its nutritional quality. But little information is available about the use of fresh green chickpea paste together with finger millet flour in burfi making. Hence, it was decided to prepare a value-added burfi from fresh green chickpea paste and finger millet flour and evaluate the physical and nutritional properties of the prepared value-added burfi. the nutritional composition (moisture, protein, fat, ash, fibre, carbohydrate and energy value) provides scientific evidence to confirm the nutritional improvement achieved by the addition of ingredients (AOAC, 2019) [16].

The use of chickpea and finger millet for the development of value-added foods including cookies, biscuits, extruded snacks, composite flour, dairy products and traditional Indian sweets have been reported to be successful (Jukanti *et al.*, 2012; Sharma *et al.*, 2021; Kumar *et al.*, 2025; Malleshi *et al.*, 2026) [6, 13, 7, 11]. But there is not much information available on the use of both the green chickpea flour and finger millet flour in the preparation of burfi and its effect on the physical properties and nutritional profile of burfi. Therefore, the present study aimed to formulate a nutritionally enriched green chickpea and finger millet flour-based burfi and to evaluate the physical characteristics and nutritional profile of the developed burfi for making a functional traditional dairy product.

2. Materials and Methods

2.1 Selection of raw material

Packed Amul Gold milk containing 6% fat and 9 % SNF was procured from the local market of Dediapada, Gujarat. The milk was heated to 80 ± 5 °C with continuous stirring at 25 – 30 rpm to prepare

khoa, which was obtained at the dough stage with a moisture content of about 31 %. Food-grade sugar was also purchased from the local market of Dediapada and powdered using a mixer grinder. Finger millet flour was obtained from Krishi Vigyan Kendra (KVK), Dediapada, Gujarat. Fresh green chickpea was collected from the experimental field of chickpea at the College of Agricultural and Technology, Dediapada and used as the main raw material for burfi preparation.

For preparation of khoa, a stainless steel karahi of 31 cm diameter and 8.5 cm depth with a capacity of three liters of milk was used, along with a khunti having a flattened end with a sharp edge and long handle for stirring. Heating was carried out using an induction stove available in the Department of Processing and Food Engineering (PFE), College of Agricultural Engineering and Technology, Navsari Agricultural University (NAU), Dediapada, Gujarat. For burfi preparation, stainless steel trays of dimensions 45 cm × 25 cm × 2 cm were used for setting the burfi blocks. A weighing balance was employed for weighing samples, ingredients and chemicals during the analysis.

2.2 Treatment details

Treatment details of the burfi preparation are shown in Table 1.

2.3 Experimental procedure

The fresh milk was accepted and pre-heated to 38-40 °C for further processing. The milk was preheated and filtered and then sent to an open pan for khoa making. To ensure even heating and to prevent scorching when boiling the milk was raised in the presence of constant stirring and scraping. The milk was concentrated to a semi-solid mass (khoa) through the heating process. Once the formation of khoa, green chickpea paste and roasted finger millet flour were added as per the treatment combinations. The ingredients were added and the mixture was well stirred and cooked over a low fire for about 5–8 minutes to make it homogenous and ensure even cooking of added ingredients. Later sugar was added according to the treatment and the mixture was stirred and cooked further for 2-3 minutes till a smooth and uniform mixture was obtained for preparing burfi. The hot mass of burfi was then evenly spread on a clean stainless-steel tray to get an even thickness and left to set. The product was allowed to cool at room temperature for 10-12 hours to ensure that the product solidified and developed the desired texture properly. When the set burfi was completely cooled, they cut it into even pieces of the desired size and form. The ready-made samples of the burfi were kept in the transparent food grade plastic boxes to avoid any external contamination that might affect the product quality. Finally, the packaged samples were kept under suitable condition and later evaluated for physical, nutritional and sensory analysis to check the quality and acceptability of the value-added burfi products developed.

2.4 Physical properties of burfi product

2.4.1 Length, width, thickness

The digital vernier caliper was used to determine the respective length, width and thickness of the developed burfi products.

2.4.2. Weight

The weight of pasta was measured with the help of weighing balance.

2.4.3 Volume

The volume was determined by the following formula.

Volume = Length (l) × Width (b) × Thickness (t)

2.4.4 True density

The true density of the developed burfi products was determined by the following formula:

True Density = $\frac{\text{Weight}}{\text{Volume}}$

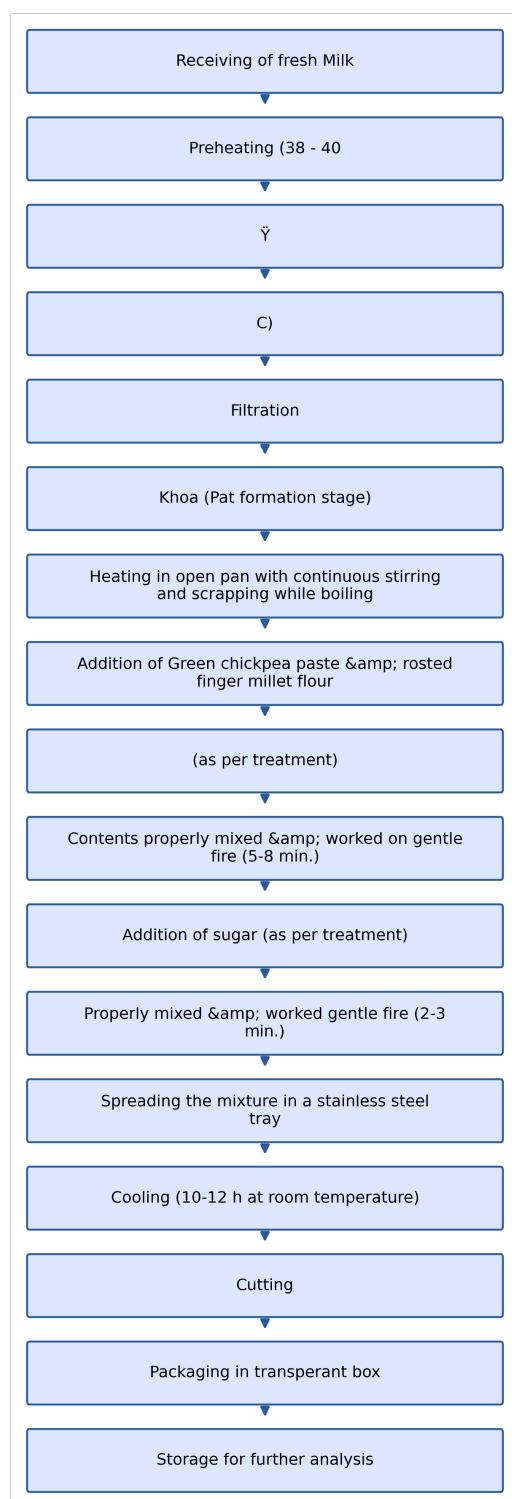


Figure 1. Flow chart for preparation of burfi products

2.5 Nutritional properties of burfi product

2.5.1 Determination of moisture content

Moisture content of fresh palmyra palm pulp, jellies and toffees were determined in accordance with standard procedures in a hot air oven AOAC method (Association Official Analytical Chemists, 2019) [16]. For each treatment, three samples of product each weighing 5 g was measured on an electronic weighing balance and taken as fresh weight. The samples were then kept in hot air oven at a temperature of 105 °C for 24 hours until the dried weight was constant during two successive weighing made at an interval of nearly one hour. The weight of dried sample was then measured. The moisture content was calculated on wet basis as equation 3.5:

$$\text{Moisture Content} = \frac{\text{Fresh weight} - \text{Dry weight}}{\text{Fresh weight}}$$

2.5.2 Determination of protein content

Reagents:

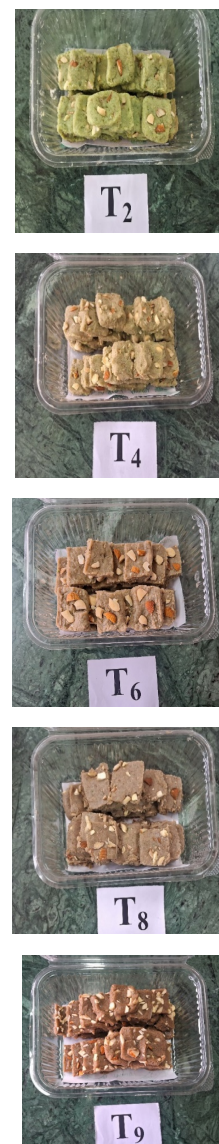
1. Solution-A: 2% Na_2CO_3 in 0.1 N NaOH
2. Solution-B: 0.5% $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ in 1% Sodium Potassium Tartrate
3. Solution-C: Mix 50 ml of solution-A with 1 ml of Solution-B.
4. Folin-Ciocalteu Reagent (FCR): Dilute commercial FCR with an equal amount of water.
5. Stock Standard Protein Solution: 50 mg bovine serum albumin in 50 ml of water.
6. Working Standard Protein Solution: Dilute 10 ml of the stock solution to 50 ml

of water (200 μg protein/ml).

Procedure:

Extraction of protein from sample: Grind 0.5 g of the sample with water in mortar and pestle. Centrifuge and use the supernatant. Estimation of protein from sample: Pipette out 0.2, 0.4, 0.6, 0.8 and 1.0 ml of working standard solution in series of test tubes. Pipette out 0.1 and 0.2 ml of sample extract into other test tubes. Make up volume to 1 ml with water. A tube with 1 ml of water will serve as blank.

Photo. Burfi Product



Add 5 ml of solution-C, mix well and incubate for 10 ml at room temperature. Add 0.5 ml of FCR, mix well and incubate for 30 min in dark. Read the absorbance at 660 nm against blank. Draw a standard graph, calculate the amount of protein in the sample and express the results as mg/g or mg/100 g sample or percentage.

2.5.3 Determination of crude fibre

Reagents:

1. Sulfuric acid (1.25 %) (12.5 ml H₂SO₄ (concentrate) dissolve in 1000 ml)
2. Sodium hydroxide (12.5 gm of NaOH in 1000 ml)
3. Ether

$$\text{Crude Fiber (\%)} = \frac{(W_2 - W_1) - (W_3 - W_1)}{\text{Weight of the sample}} \times 100$$

2.5.4 Determination of total carbohydrates

(Anthrone method)

Reagents:

1. 2.5 N HCl: 208 ml of HCl dissolve in 1 lit of distilled water.
2. Na₂CO₃
3. Anthrone reagent: Dissolve 200 mg Anthrone in 100 ml of ice-cold 95% H₂SO₄.
Prepare fresh before use.
4. Standard glucose: stock-Dissolve 50 mg of D-glucose in 50 ml water.
5. Standard glucose: Working- Dilute 1 ml of stock solution in 50 ml water.

Procedure:

Weight 100 mg of the sample into a boiling tube. Hydrolyses by keeping it in a boiling water for three hours with 5 ml of 2.5 N HCL and cool to room temperature. Neutralize it with solid sodium carbonate until the effervescence ceases. Make up the volume to 50 ml and centrifuge. Collect the supernatant and take 0.5 and 1 ml aliquots for analysis. Prepare the standards by taking 0, 50, 100, 150, 200 µl of the glucose standard. '0' serves as a blank. Make up the volume to 1 ml in all the tubes including the sample tubes by adding distilled water and add 4 ml of Anthrone reagent. Heat for 8 minutes in a boiling water bath. Cool rapidly and read the green to dark green colour at 630 nm. draw a standard graph by plotting concentration of the standard on the X-axis versus absorbance on the Y-axis.

Calculation:

From the graph calculate the amount of carbohydrate present in the sample tube.

$$\text{Carbohydrate presents in 100 mg of the sample} = \frac{\text{mg of the glucose} \times 100}{\text{volume of test sample}}$$

2.5.5 Determination of fat

The fat content of the samples was determined by the Soxhlet extraction method following the procedure described by AOAC (2019) [16]. Approximately 2–5 g of the dried sample was accurately weighed and transferred into a cellulose extraction thimble. The thimble was placed in the Soxhlet apparatus and petroleum ether (boiling point 40–60 °C) was used as the extraction solvent. The extraction was carried out continuously for 6–8 h to ensure complete removal of fat from the sample. After extraction the solvent was recovered by distillation and the extraction flask containing the fat residue was dried in a hot air oven at 105 ± 2 °C, cooled in a desiccator and weighed. The fat content was calculated and expressed as percentage on a wet weight basis using the following equation.

$$\text{Fat (\%)} = \frac{W_2 - W_1}{W} \times 100$$

4. Methanol

Procedure:

Weight 2 g of sample. Extracted with ether to remove fat. Keep it for some-time and allow to dry. Take dry material in beaker, add 200 ml of reagent 1. Boil it for 30 min (Boiling water bath), cool it. Filter it with muslin cloth, wash with distilled water and take sample in beaker. Add 200 ml of reagent 2, boil it for 30 min (boiling water bath), cool it. Filter with muslin cloth, wash with 25 ml H₂SO₄, then 50 ml distilled water and then 25 ml Methanol. Transfer the ample from muslin cloth to pre-weighted porcelain dishes (W₁). Dry the sample in oven for 2 h at 130 °C, cool and weigh (W₂). Ignite for 30 min at 600 ± 15 °C. Cool weigh (W₃). (A.O.A.C. 2000)

Calculation :

where,

W₁ = Weight of empty extraction flask (g)

W₂ = Weight of extraction flask after fat extraction (g)

W = Weight of sample taken for analysis (g)

2.5.6 Determination of ash/minerals content

Ash in the sample was estimated by employing the standard method of analysis (AOAC, 2000).

Procedure: Five grams of dried sample was taken in a weighed crucible and ignited until no charred particles remained in the crucible and then the crucible was put in muffle furnace (550 °C) for 6 h or until a white ash was obtained. Thereafter, the crucible was cooled in a desiccator and reweighed

Calculations:

$$\text{Ash Content (\%)} = \frac{\text{Weight of ash after ignition (final weight)} \times 100}{\text{Initial weight of sample used}}$$

2.5.7 Determination of total reducing sugar (Lane and Eynon method)

Reagents

1. 40% NaOH
2. 40% Lead Acetate
3. 22% Potassium Oxalate
4. Methylene Indicator
5. 50 % HCl
6. **Fehling's A** - Dissolve 63 g of copper sulphate crystals distilled water and
make up to 3 litre.
7. **Fehling's B** - Dissolve 352 g of potassium sodium tartrate (Rochell salt) and

154 g of sodium hydroxide in water and make the sodium up to 1 litre.

Procedure:

Take known amount of the sample in 250 ml flask and add 100 ml of water. Add 1 drop of indicator (Phenolphthalein), Neutralize with 40% NaOH (drop by drop). Add 2 ml of 45 % lead acetate and keep for 30 min. Add 5 ml (22 %) Potassium oxalate. make volume 250 ml and filter it. Take 100 ml dd filtrate in flask and add 5–20 ml 50 % HCl. Keep over night for inversion of sugar. Add 1 drop of indicator (Phenolphthalein) & neutralize drop by drop with 40 % NaOH, take it in burette. Take the 10 ml mixture (5 ml Fehling's - A + 5 ml Fehling's - B) in flask. Add 1 -2 drop of methylene blue indicator. Titre (Keep boiling continue Fehling's mixture) till end point (Blue to brick red colour). Note the end point (Titre)

Calculation:

$$\text{Total Sugar (\%)} = \frac{\text{Factor (0.052)} \times \text{Dilution} \times 100}{\text{Titre} \times \text{Wt of Sample}}$$

2.5.8 Energy value (kcal/100g)

The energy value was found by the following formula.

$$\text{Energy value} = 4(\text{protein content} + \text{carbohydrate content}) + 9(\text{fat content})$$

3. Results and Discussions

3.1 Physical properties

The results of the different physical properties such as length, width, thickness, weight, volume and true density of developed burfi products were presented in Table 2 and Table 3. The results were shown in Fig 2 to 5 and discussed in the subsequent paragraphs.

3.1.1 Length, width, thickness of developed burfi products

The length, width and thickness of the different burfi products in three replications were measured and their average values were presented in Table 2 and graphically represented in Fig 2.

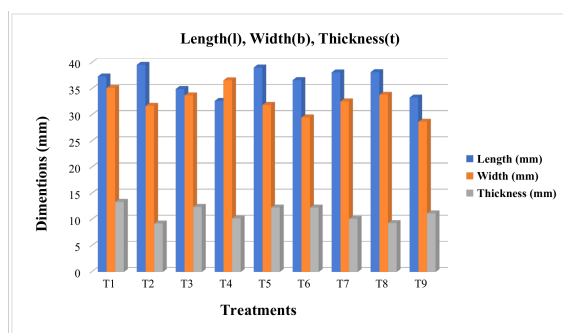


Figure 2. Effect on length, width and thickness of green chickpea-based value-added burfi product

On the basis of Table 2 and Fig 2. The maximum length was observed in T₂ (39.61 ± 0.16 mm), while the minimum length occurred in T₉ (33.35 ± 0.21 mm). In terms of width, the highest value was recorded for T₄ (36.64 ± 0.32 mm) and the lowest for T₉ (28.70 ± 0.52 mm). Regarding thickness, the maximum was found in T₁ (13.37 ± 0.30 mm), whereas the minimum was observed in T₇ (10.13 ± 0.07 mm). Overall, treatment T₂ exhibited the greatest length, while T₉ showed the smallest dimensions in both length and width, indicating noticeable variation among treatments in physical measurements.

3.1.2 weight of developed burfi products

The weight of the different burfi products in three replications and average values of results were presented in Table 3 for burfi graphically represented in Fig 3.

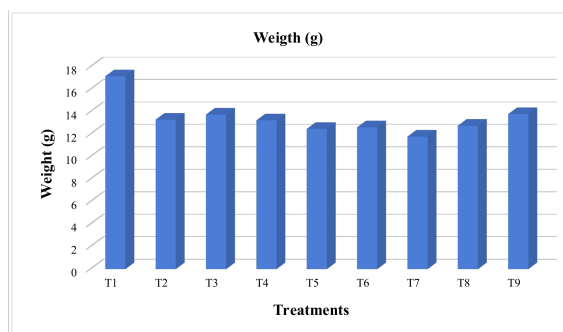


Figure 3. Effect of green chickpea, khoa and ragi flour on weight of green chickpea-based value-added burfi product

On the basis of Table 2 and Fig 3, the maximum value of weight of developed burfi products were found 17.15 g for sample T₁ and mini-

mum value was found 11.80 for sample T₇.

3.1.2 Volume (cm³) of developed burfi products

The volume of the different burfi products in three replications and average values of results were presented in Table 3 and graphically represented in Fig 4.

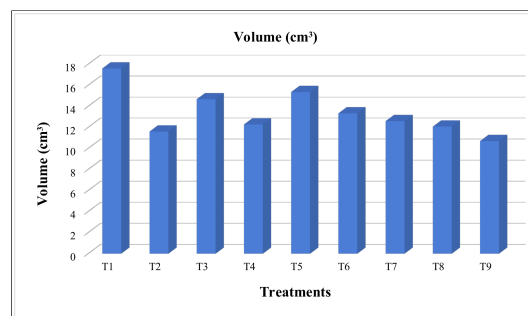


Figure 4. Effect of green chickpea, khoa and ragi flour on volume of green chickpea-based value-added burfi product

On the basis of Table 3 and Fig 4, the maximum value of volume of developed burfi products were found 17.58 cm^3 for sample T₁ and minimum value was found 10.70 cm^3 for sample T₉.

3.1.3 True density (g/cm³) of developed burfi products

The true density of the different burfi products in three replications and average values of results were presented in Table 3 graphically represented in Fig 5 for burfi.

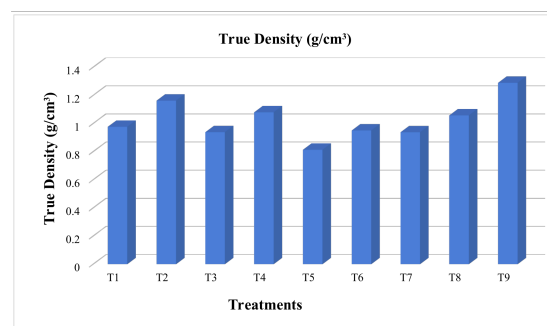


Figure 5. Effect of green chickpea, khoa and ragi flour on density of green chickpea-based value-added burfi product

On the basis of Table 4.4 and Fig. 4.4, the maximum value of true density of developed burfi products were found 1.29 g/cm^3 for sample T₉ and minimum value was found 0.81 g/cm^3 for sample T₅.

3.2 Nutritional properties

The results of the different nutritional properties such as moisture content, protein content, crude fiber, carbohydrate, fat content, ash content, reducing sugar and energy value of developed burfi products were presented in Table 4 and 5. The results were shown in Fig 6 to 13 and discussed in the subsequent paragraphs.

3.2.1 Moisture content (%)

The moisture content of the developed green chickpea-based value-added burfi products was determined by the hot air oven method and the average values were presented in Table 4 and graphically represented in Fig 6.

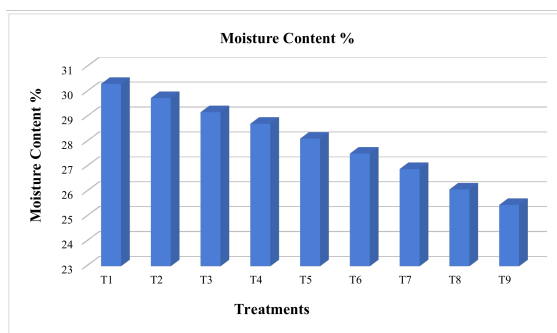


Figure 6. Effect of green chickpea, khoa and ragi flour on Moisture Content of green chickpea-based value-added burfi product

The moisture content differed significantly among the treatments and ranged from 25.46 to 30.32 %. The minimum moisture content (25.46 %) was observed in T₉, while the maximum moisture content (30.32 %) was recorded in T₁. None of the treatments were at par with T₁. The significant variation in moisture content may have been due to differences in the proportion of green chickpea paste, khoa and finger millet flour used in the different treatment combinations. The moisture content of khoa-based dairy products is also influenced by the quantity of milk solids, added ingredients and the extent of heating during preparation (Aneja *et al.*, 2002; De, 2001) [3].

The higher moisture content observed in T₁ could be attributed to the higher proportion of green chickpea paste, which contained considerable amounts of moisture. In contrast, the lower moisture content observed in T₉ could be related to the lower proportion of green chickpea paste and relatively higher incorporation of finger millet flour, which contributed more dry matter and could have resulted in greater moisture binding during processing. Similar variations in moisture content of value-added dairy products have been associated with differences in ingredient composition and processing conditions (Goyal and Samsher, 2007; Patel *et al.*, 2014).

The moisture content gradually decreased from 30.32 % in T₁ to 25.46 % in T₉, indicating that increasing the proportion of dry ingredients and reducing the proportion of moisture-rich green chickpea paste influenced the final moisture level of the burfi. Moisture content is an important quality parameter of burfi because it affects texture, softness, shelf life and overall acceptability. Higher moisture generally produces a softer product, whereas lower moisture may result in a firmer and more compact texture (Aneja *et al.*, 2002) [3]. The obtained results were therefore consistent with the expected effect of ingredient composition on the moisture content of khoa-based sweets.

3.2.2 Protein content %

The protein content of the developed green chickpea-based value-added burfi products was determined by standard analytical methods, and the average values were presented in Table 4 and Fig 7.

The protein content varied from 9.97 to 10.16 %, with a mean value of 10.06 %. A significant variation was observed among the different treatments. The maximum protein content (10.16 %) was recorded in T₉, whereas the minimum (9.97 %) was recorded in T₁. The treatments T₈, T₇, T₆ and T₅ were statistically at par with T₉.

A gradual increase in protein content was observed from T₁ to T₉. This increase could be attributed mainly to the higher proportion of finger millet flour and green chickpea, both of which contributed protein to the developed product. Chickpea is a good source of plant protein, containing approximately 18–22 % protein on a dry basis (Jukanti *et al.*, 2012) [6], while finger millet also contributes appreciable protein and other nutrients (Shobana *et al.*, 2013; Devi *et al.*, 2014) [12]. In addition, khoa and milk proteins contributed to the overall protein content of the burfi (Aneja *et al.*, 2002) [3].

The highest protein content in T₉ could therefore be attributed to its higher incorporation of finger millet flour, along with the protein contribution from green chickpea and khoa. Conversely, the lower value in T₁ may have resulted from the lower proportion of finger millet flour. Similar increases in protein content have been reported in ce-

real-based products supplemented with pulses and millets (Boye *et al.*, 2010; Saleh *et al.*, 2013) [17]. Thus, incorporation of green chickpea and finger millet flour improved the protein content of the developed burfi and enhanced its nutritional quality.

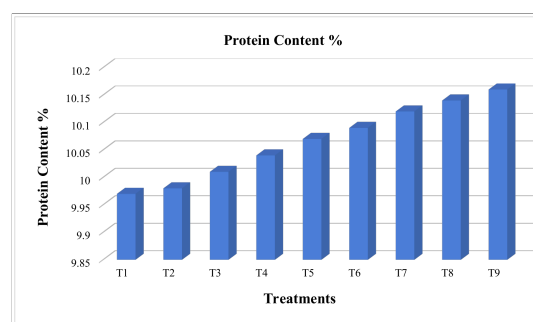


Figure 7. Effect of green chickpea, khoa and ragi flour on protein content of green chickpea-based value-added burfi product

3.2.3 Crude fibre content %

Crude fibre is an important nutritional component of food products and is mainly contributed by plant-based ingredients. The crude fibre content of the developed green chickpea-based value-added burfi products was determined by standard analytical procedures and the average values were presented in Table 4 and Fig 8.

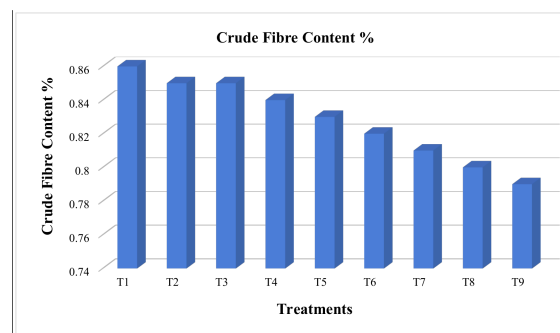


Figure 8. Effect of green chickpea, khoa and ragi flour on crude fibre content of green chickpea-based value-added burfi product

The crude fibre content was within the range of 0.79 to 0.86 % and the mean was 0.83 %. T₁ (0.86 %) had the highest crude fibre content while T₉ (0.79 %) had the lowest. The higher value of T₁ due to its higher percentage of green chickpea paste which has significant dietary fibre and other cell-wall component content (Jukanti *et al.*, 2012) [6]. Finger millet flour was also incorporated in the fibre content as finger millet is a good source of dietary fibre (Saleh *et al.*, 2013; Devi *et al.*, 2014) [17, 12]. This may be attributed to the lower relative contribution of green chickpea paste and higher relative contribution of fibre-poor ingredients like khoa and sugar in T₉. While there were differences between the treatments, the difference in crude fibre content was not significant with CD at 5 % being 0.0517 (NS). The C.V value of 3.6439 % was low, which means that there was relatively little variation among the observations. The overall results indicated that green chickpea and finger millet were responsible for increased crude fibre content of the developed burfi, though the treatment effect was not significant.

3.2.4 Carbohydrate content (%)

The carbohydrate content of the developed value-added green chickpea-based burfi was obtained by following the standard procedure and the average values were presented in Table 4 and Figure 9.

The carbohydrate content was in the range of 45.23 to 49.88 % and the average value was 47.43 %. The lowest carbohydrate content was found in T₁ (45.23 %) and the highest was found in T₉ (49.88 %). There was a gradual increase in the carbohydrate content from T₁ to T₉. The higher carbohydrate content in T₉ could mainly be attributed

to its higher proportion of finger millet flour. Finger millet has high carbohydrate content, mainly starch and hence the higher content of this in the final product can lead to higher carbohydrate content (Saleh *et al.*, 2013; Devi *et al.*, 2014) [17, 12]. The same was concluded by Saleh *et al.*, (2013) [17] who reported that the millet grains are mainly composed of carbohydrates, of which starch is the major component. In contrast, T₁ had the lowest carbohydrate content (45.23 %) which may be attributed to the comparatively higher percentage of green chickpea paste and lower percentage of finger millet flour. Chickpea has a higher proportion of protein and dietary fibre than cereals, so the use of a higher proportion of chickpea-based ingredients can affect the carbohydrate proportion of the final product (Jukanti *et al.*, 2012) [6]. This variation could also be due to the proportion of khoa, green chickpea pastes, finger millet flour and sugar in the various formulations. The CD at 5 % was 0.3636, meaning that the differences between the treatments were statistically significant. The S.E.m $\pm$ was 0.1224 and the C.V. was 0.4469 %, which meant that the experimental variation was low. The carbohydrate content was significantly highest in T₉ treatment which was not comparable with the other treatments. In value added food products similar increase in carbohydrate content with higher percentage of cereal based ingredients have been reported (Devi *et al.*, 2014; Saleh *et al.*, 2013) [12, 17].

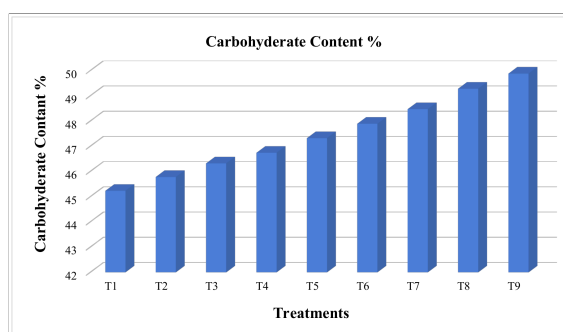


Figure 9. Effect of green chickpea, khoa and ragi flour on carbohydrate content of green chickpea-based value-added burfi product

In general, the results showed that the higher the percentage of finger millet flour, the higher the carbohydrate content of the product, and the higher the percentage of green chickpea paste, the lower the carbohydrate content of the product was compared to the others. Hence, the developed burfi had a significant effect on the carbohydrate composition due to the incorporation of green chickpea and finger millet.

3.2.5 Fat content %

The fat content of various green chickpea-based value-added products of burfi were determined with Soxhlet apparatus and average values were given in Table 5 and Fig 10.

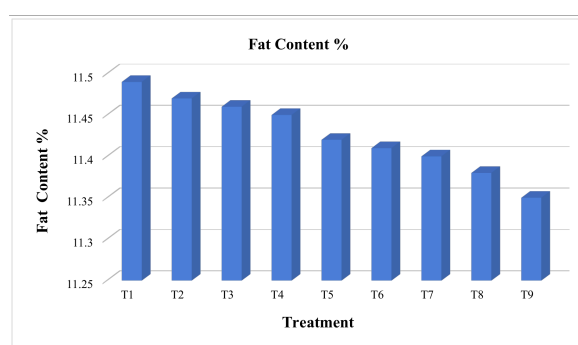


Figure 10. Effect of green chickpea, khoa and ragi flour on fat content of green chickpea-based value-added burfi product

The fat content ranged from 11.35 to 11.49 %, with a mean value of 11.42 %. The highest fat content was found in T₁ (11.49 %) while the lowest fat content was found in T₉ (11.35 %). This slight drop in fat content (T₁ to T₉) might be due to the variation in the ratio of green chickpea paste and finger millet flour in the formulations. The difference in fat content between the two could be related to the higher percentage of green chickpea paste in T₁. Chickpea has a small but significant amount of lipid, primarily unsaturated fatty acids, that may be used to add to the fat content of the product (Jukanti *et al.*, 2012) [6]. However, the high proportion of finger millet flour in the formulations could have led to a slight decrease in the total fat content as finger millet has relatively low fat content (Saleh *et al.*, 2013) [17]. The fat content was also significantly affected by the khoa used as a major ingredient in all the treatments. The amount of khoa was not much different in the different formulations, so there was not much difference in the total fat content. The uniformity of fat distribution in the product could also have been due to the processing conditions such as heating and mixing during the preparation of burfi. The present findings were similar to the observations reported for dairy products incorporated with plant based ingredients where slight variation in fat content was observed with the varying level of cereal flour or legume flour (Devi *et al.*, 2014; Jukanti *et al.*, 2012) [12, 6]. There were differences between the treatments, but the CD at 5 % was found to be non-significant (NS) at 0.0975. Thus, the differences in fat content between T₁ and T₉ were not significantly different and multiple mean comparison was not necessary. The S.E.m $\pm$ (0.0328) and low C.V. (0.4977 %) showed good consistency among the observations. The overall results showed that slight variations in fat content of the developed burfi were observed with the addition of green chickpea paste and finger millet flour. The highest value in T₁ and the lowest value in T₉ indicated that the fat content was slightly lowered with increasing proportion of finger millet flour and decreasing proportion of green chickpea paste. However, the effect was not statistically significant.

3.2.6 Ash content %

The ash content of various value-added burfi products made from green chickpea was measured using the muffle furnace and the average ash content was shown in Table 5 and Fig 11.

The ash content ranged from 3.00 to 3.14 %, with a mean value of 3.07 %. T₁ had the lowest ash content (3.00 %) while the highest ash content was recorded for T₉ (3.14 %). Ash content was found to increase with a gradient from T₁ to T₉. This increase in ash content in T₉ could be due to the higher percentage of finger millet flour used in this treatment. Finger millet contains high minerals like calcium, phosphorus, potassium, magnesium and iron; hence, more and more incorporation of finger millet in the final product (Devi *et al.*, 2014; Saleh *et al.*, 2013) [12, 17] increases the mineral (ash) content of the final product. This has been reported in other studies that added finger millet to food products, the mineral and ash content increased (Devi *et al.*, 2014) [12]. The lower ash content in T₁ (3.00 %) may be due to its relatively lower percentage of finger millet flour. The mineral matter content of the products increased with the increase in finger millet content because khoa and sugar contain less mineral matter than finger millet. These treatments were significantly different with respect to ash content, the CD for 5 % being 0.0341. The experimental variation was low as the S.E.m $\pm$ was 0.0115 and the C.V. was 0.6481 %. The treatments, T₉ had the highest ash content (3.14 %) followed by T₈ (3.13 %) and T₇ (3.11 %) which were not significantly different from T₉. In general, showed that the ash content of burfi increased with the higher percentage of finger millet flour. This increase was mainly associated with the higher mineral content of finger millet. Hence, the inclusion of finger millet flour not only resulted in formulation modification but also enhanced the mineral-rich fraction of the value-added burfi made from green chickpea.

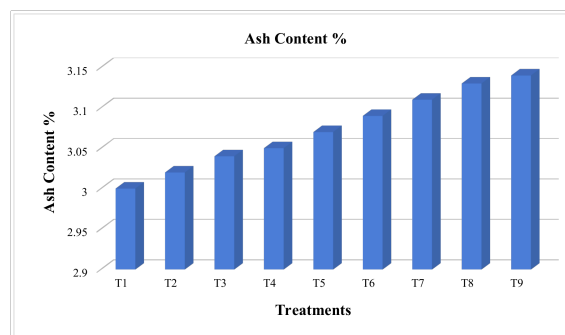


Figure 11. Effect of green chickpea, khoa and ragi flour on ash content of green chickpea-based value-added burfi product

3.2.7 Reducing sugar content %

The standard procedure was used to determine the reducing sugar content of different value-added burfi products made from green chickpeas and the average values were shown in Table 5 and Fig 12.

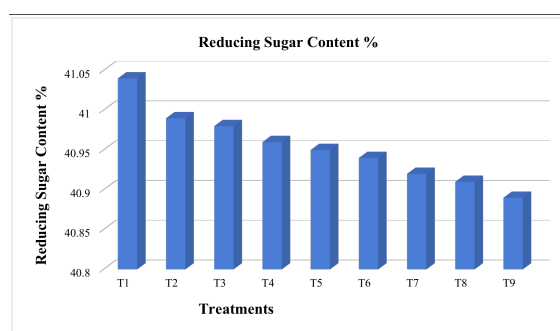


Figure 12. Effect of green chickpea, khoa and ragi flour on reducing sugar Content of green chickpea-based value-added burfi product

The reducing sugar content value was found to be between 40.89 and 41.04 % and the mean value was 40.95 %. The highest reducing sugar

$$\text{Energy value} = 4(\text{Protein} + \text{Carbohydrate}) + 9(\text{Fat})$$

The average energy values of different treatments were presented in Table 5 and Fig 13.

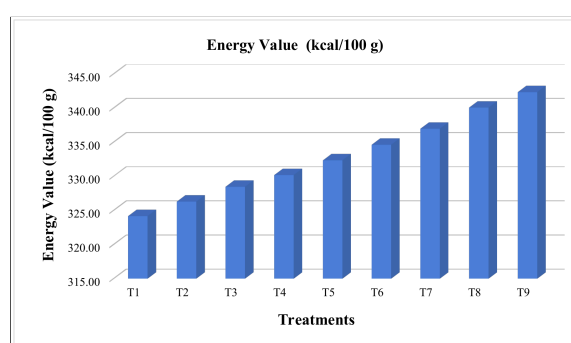


Figure 13. Effect of green chickpea, khoa and ragi flour on energy of green chickpea-based value-added burfi product.

The energy value ranged from 324.16 to 342.32 kcal/100 g, with a mean value of 332.82 kcal/100 g. The lowest energy value was measured in T₁ (324.16 kcal/100 g) while the highest was measured in T₉ (342.32 kcal/100 g). There was a gradual increase in energy value from T₁ to T₉. The increase in energy value in T₉ may be due primarily to the high percentage of finger millet flour used, which led to a higher carbohydrate content. As each gram of carbohydrate adds about 4 kcal to the product, a higher carbohydrate content will directly increase the energy value of the product. The energy value has increased from 45.23 % (T₁) to 49.88 % (T₉) with the increase of car-

bohydrate. Finger millet is mainly a carbohydrate, especially starch and its use can enhance the energy contribution of cereal based food products (Saleh *et al.*, 2013; Devi *et al.*, 2014) [17, 12]. The lower energy value of T₁ (324.16 kcal/100 g) might be related to its relatively lower carbohydrate content and higher green chickpea paste content. Chickpea is a source of protein, fibre and other nutrients, but the carbohydrate content was lower than in the finger millet treatments in this formulation (Jukanti *et al.*, 2012) [6]. The same has been observed in the studies on millet-based products, which found that the higher the amount of millet incorporated into the foods, the higher the energy value of the products calculated (Saleh *et al.*, 2013) [17]. The energy value was also affected by the contribution of fat and protein, which is approximately 9 kcal/g and 4 kcal/g respectively. The energy increase in the present study, however, seemed to be correlated with the increased carbohydrate content, since the fat content only slightly decreased from 11.49 % in T₁ to 11.35 % in T₉. The calculated energy value was thus also similar to the carbohydrate content. The differences among the treatments were statistically significant with the CD at 5% of 1.63. The S.E.m. $\pm$ was 0.55 and the C.V. was 0.29 %, which meant that there was low variation among the experimental observations. The findings revealed that as the amount of finger millet flour was increased, the amount of energy value of the prepared burfi also increased significantly. In general, the results showed that the energy value of T₉ was the highest (342.32 kcal/100 g) and the energy value of T₁ was the lowest (324.16 kcal/100 g). The increasing trend was mainly attributed to the higher carbohydrate contribution from finger millet flour. Therefore, the incorporation of finger millet flour not only enhanced the carbohydrate content of the

3.2.8 Energy value (kcal/100 g)

Energy values of the developed value-added green chickpea-based burfi products were calculated by using formula:

bohydrate. Finger millet is mainly a carbohydrate, especially starch and its use can enhance the energy contribution of cereal based food products (Saleh *et al.*, 2013; Devi *et al.*, 2014) [17, 12]. The lower energy value of T₁ (324.16 kcal/100 g) might be related to its relatively lower carbohydrate content and higher green chickpea paste content. Chickpea is a source of protein, fibre and other nutrients, but the carbohydrate content was lower than in the finger millet treatments in this formulation (Jukanti *et al.*, 2012) [6]. The same has been observed in the studies on millet-based products, which found that the higher the amount of millet incorporated into the foods, the higher the energy value of the products calculated (Saleh *et al.*, 2013) [17]. The energy value was also affected by the contribution of fat and protein, which is approximately 9 kcal/g and 4 kcal/g respectively. The energy increase in the present study, however, seemed to be correlated with the increased carbohydrate content, since the fat content only slightly decreased from 11.49 % in T₁ to 11.35 % in T₉.

The calculated energy value was thus also similar to the carbohydrate content. The differences among the treatments were statistically significant with the CD at 5% of 1.63. The S.E.m. $\pm$ was 0.55 and the C.V. was 0.29 %, which meant that there was low variation among the experimental observations. The findings revealed that as the amount of finger millet flour was increased, the amount of energy value of the prepared burfi also increased significantly. In general, the results showed that the energy value of T₉ was the highest (342.32 kcal/100 g) and the energy value of T₁ was the lowest (324.16 kcal/100 g). The increasing trend was mainly attributed to the higher carbohydrate contribution from finger millet flour. Therefore, the incorporation of finger millet flour not only enhanced the carbohydrate content of the

produced value-added green chickpea-based burfi but also its energy density.

Conclusion

On the basis of overall studied properties like physical properties and nutritional properties, it was observed that the treatment T₉, was found best among all the treatments followed by T₁ and T₂.

Table 1. Different blending proportion of ingredients for burfi product

Sr. No.	Sample code	Blending Proportion of different cereals
1.	T ₁	50 % Khoa + 30 % Sugar + 20 % Green Chickpea paste + 0 % Finger millet flour
2.	T ₂	50 % Khoa + 30 % Sugar + 19 % Green Chickpea paste + 1 % Finger millet flour
3.	T ₃	50 % Khoa + 30 % Sugar + 18 % Green Chickpea paste + 2 % Finger millet flour
4.	T ₄	50 % Khoa + 30 % Sugar + 17 % Green Chickpea paste + 3 % Finger millet flour
5.	T ₅	50 % Khoa + 30 % Sugar + 16 % Green Chickpea paste + 4 % Finger millet flour
6.	T ₆	50 % Khoa + 30 % Sugar + 15 % Green Chickpea paste + 5 % Finger millet flour
7.	T ₇	50 % Khoa + 30 % Sugar + 14 % Green Chickpea paste + 6 % Finger millet flour
8.	T ₈	50 % Khoa + 30 % Sugar + 13 % Green Chickpea paste + 7 % Finger millet flour
9.	T ₉	50 % Khoa + 30 % Sugar + 12 % Green Chickpea paste + 8 % Finger millet flour

Table 2. Variation in length, width and thickness of different burfi products

Sr. No.	Treatments	Length (mm)	Width (mm)	Thickness (mm)
1.	T ₁	37.38 ± 1.06	35.18 ± 0.13	13.37 ± 0.30
2.	T ₂	39.61 ± 0.16	31.74 ± 0.15	9.22 ± 0.99
3.	T ₃	34.99 ± 0.50	33.76 ± 0.15	12.42 ± 0.22
4.	T ₄	32.71 ± 0.26	36.64 ± 0.32	10.24 ± 0.19
5.	T ₅	39.09 ± 0.34	31.94 ± 0.54	12.31 ± 0.48
6.	T ₆	36.69 ± 0.82	29.55 ± 0.93	12.29 ± 0.23
7.	T ₇	38.16 ± 0.14	32.59 ± 0.55	10.13 ± 0.07
8.	T ₈	38.21 ± 0.05	33.86 ± 0.04	9.33 ± 0.28
9.	T ₉	33.35 ± 0.21	28.70 ± 0.52	11.18 ± 0.05

Table 3. Variation in weight, Volume and True density of different burfi products

Sr. No.	Treatments	Weight (g)	Volume (cm ³)	True Density (g/cm ³)
1.	T ₁	17.15 ± 0.17	17.59 ± 0.04	0.98 ± 0.04
2.	T ₂	13.29 ± 0.56	11.60 ± 0.02	1.16 ± 0.17
3.	T ₃	13.76 ± 0.24	14.67 ± 0.01	0.94 ± 0.02
4.	T ₄	13.24 ± 0.07	12.27 ± 0.02	1.08 ± 0.01
5.	T ₅	12.48 ± 0.21	15.36 ± 0.09	0.81 ± 0.04

(continued on next page)

Sr. No.	Treatments	Weight (g)	Volume (cm ³)	True Density (g/cm ³)
6.	T ₆	12.62 ± 0.28	13.33 ± 0.18	0.95 ± 0.07
7.	T ₇	11.80 ± 0.10	12.59 ± 0.05	0.94 ± 0.02
8.	T ₈	12.76 ± 0.15	12.07 ± 0.01	1.06 ± 0.03
9.	T ₉	13.79 ± 0.28	10.70 ± 0.01	1.29 ± 0.03

Table 4. Variation in Moisture, Protein, Crude fibre and Carbohydrate content of different burfi products

Sr. No.	Treatments	Moisture Content %	Protein Content %	Crude Fibre Content %	Carbohydrate Content %
1	T ₁	30.32	9.97	0.86	45.23
2	T ₂	29.75	9.98	0.85	45.78
3	T ₃	29.18	10.01	0.85	46.32
4	T ₄	28.72	10.04	0.84	46.74
5	T ₅	28.12	10.07	0.83	47.32
6	T ₆	27.52	10.09	0.82	47.89
7	T ₇	26.90	10.12	0.81	48.47
8	T ₈	26.08	10.14	0.80	49.28
9	T ₉	25.46	10.16	0.79	49.88
Mean		28.01	10.06	0.83	47.43
C.D. at 5%		0.3776	0.113	0.0517	0.3636
S. Em. ±		0.1271	0.0380	0.0174	0.1224
C.V. (%)		0.786	0.6546	3.6439	0.4469

Table 5. Variation in fat content, ash content, reducing sugar content and energy value of different burfi products

Sr. No.	Treatments	Fat Content %	Ash Content %	Reducing Sugar Content %	Energy Value (kcal/100 g)
1	T ₁	11.49	3.00	41.04	324.16
2	T ₂	11.47	3.02	40.99	326.29
3	T ₃	11.46	3.04	40.98	328.46
4	T ₄	11.45	3.05	40.96	330.17
5	T ₅	11.42	3.07	40.95	332.34
6	T ₆	11.41	3.09	40.94	334.61
7	T ₇	11.4	3.11	40.92	336.96
8	T ₈	11.38	3.13	40.91	340.05
9	T ₉₀	11.35	3.14	40.89	342.32
Mean		11.42	3.07	40.95	332.82
CD at 5%		0.0975 NS	0.0341	0.0251	1.63
S. Em±		0.0328	0.0115	0.0085	0.55
C.V. (%)		0.4977	0.6481	0.0358	0.29

Figures





References

1. Singh A, Verma A, Kumar P. Functional foods and nutraceuticals: Emerging trends and future prospects. *Journal of Food Science and Technology*. 2020;57(10):3621–3632.
2. West CE, Pepping F, Scholte JG. *Food Composition and Nutrition Tables for Use in Developing Countries*. Wageningen Agricultural University, Wageningen, The Netherlands; 1999.
3. Aneja RP, Mathur BN, Chandan RC, Banerjee AK. *Technology of Indian Milk Products*. Dairy India Yearbook, New Delhi, India; 2002.
4. Bodyfelt FW, Tobias J, Trout GM. *The Sensory Evaluation of Dairy Products*. Aspen Publishers Inc., Gaithersburg, Maryland, USA; 1999.
5. De S. *Outlines of Dairy Technology*. Oxford University Press, New Delhi, India; 2006.
6. Jukanti AK, Gaur PM, Gowda CLL, Chibbar RN. Nutritional quality and health benefits of chickpea (*Cicer arietinum* L.): A review. *British Journal of Nutrition*. 2012;108(S1):S11–S26.
7. Kumar N, Sharma P, Singh R, co-authors. Comprehensive review of chickpea (*Cicer arietinum*): Nutritional significance, health benefits, techno-functionalities and food applications. *Comprehensive Reviews in Food Science and Food Safety*. 2025.
8. Hirdyani H. Development and Evaluation of Value-Added Products from Fresh Green Chickpea (*Cicer arietinum* L.). M.Sc. Thesis, Punjab Agricultural University, Ludhiana, India; 2014.
9. Parmar MM, Patel JM, Patel AA. Development of value-added products from green chickpea. *International Journal of Agriculture Sciences*. 2016;8(53):2678–2682.
10. Chethan S, Malleshi NG. Finger millet polyphenols: Characterization and their nutraceutical potential. *American Journal of Food Technology*. 2007;2(7):582–592.
11. Malleshi NG, co-authors. Finger millet: Functional properties and novel food product formulations. *Critical Reviews in Food Science and Nutrition*. 2026.
12. Devi PB, Vijayabharathi R, Sathyabama S, Malleshi NG, Priyadarisini VB. Health benefits of finger millet (*Eleusine coracana* L.): A review. *Journal of Food Science and Technology*. 2014;51(6):1021–1040.
13. Sharma R, Sharma S, Singh B. Nutritional and functional properties of finger millet-based food products: A review. *Journal of Food Science and Technology*. 2021;58(8):2876–2888.
14. Kamble KB, Kamble DK. Storage related changes in green chickpea (*Cicer arietinum* L.) burfi. *International Journal of Current Microbiology and Applied Sciences*. 2025;14(8):234–242.
15. Kamble KB, Patil GR, Shinde PD. Development and quality evaluation of green chickpea burfi. *International Journal of Chemical Studies*. 2019;7(5):2454–2458.
16. AOAC. *Official Methods of Analysis*. 21st Edition. Association of Official Analytical Chemists, Gaithersburg, Maryland, USA; 2019.
17. Saleh ASM, Zhang Q, Chen J, Shen Q. Millet grains: Nutritional quality, processing, and potential health benefits. *Comprehensive Reviews in Food Science and Food Safety*. 2013;12:281–295.
18. Bourne MC. *Food Texture and Viscosity: Concept and Measurement*. 2nd Edition. Academic Press, New York, USA; 2002.
19. Pathare PB, Opara UL, Al-Said FAJ. Colour measurement and analysis in fresh and processed foods: A review. *Food and Bioprocess Technology*. 2013;6(1):36–60.
20. Singh U, Kumar J, Saxena MC. Chickpea (*Cicer arietinum* L.). In: *Encyclopedia of Food Sciences and Nutrition*. Academic Press, London, UK; 1999.
21. Stone H, Sidel JL. *Sensory Evaluation Practices*. 3rd Edition. Academic Press, San Diego, California, USA; 2004.
22. Wood JA, Grusak MA. Nutritional value of chickpea. In: Yadav SS, Redden R, Chen W, Sharma B, editors. *Chickpea Breeding and Management*. CAB International, Wallingford, UK; 2007. p. 101–142.

How to cite this article: Patel P, Singh S, Patel A, Burbade R. Studies on physical properties and nutritional composition of green chickpea based value added burfi product. *International Journal of Advanced Biochemistry Research*. 2026;SP-10(10):374-384. doi: <https://www.doi.org/10.33545/26174693.2026.v10.i10Se.10307>