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Development, optimization and comprehensive quality evaluation of Spirulina (*Arthrospira platensis*) enriched peanut chikki

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ABSTRACT

The present study was undertaken to develop, optimize and evaluate spirulina (*Arthrospira platensis*)-enriched peanut chikki as a protein and nutrient-enriched functional food. Spirulina powder contained $67.00 \pm 0.28\%$ protein, $3.80 \pm 0.05\%$ fat, $3.60 \pm 0.04\%$ ash and $3.90 \pm 0.06\%$ crude fibre, whereas peanut contained $26.29 \pm 0.14\%$ protein and $46.24 \pm 0.18\%$ fat. Five chikki formulations (T_0 – T_4) were prepared by incorporating 0, 2, 4, 6 and 8 g spirulina powder per 100 g peanut. The formulations were evaluated for sensory characteristics using a nine-point hedonic scale, and the selected formulation was further assessed for proximate composition, mineral profile, color and texture characteristics. Among the formulations, T_3 containing 6 g spirulina powder per 100 g peanut showed the highest overall acceptability score (8.4/9), with desirable appearance and color (8.5), flavor (8.3), taste (8.3) and texture (8.5). The selected T_3 formulation contained $18.23 \pm 0.21\%$ protein, $23.80 \pm 0.24\%$ fat, $2.46 \pm 0.06\%$ ash and $3.16 \pm 0.08\%$ crude fibre. Compared with the control, T_3 showed increased mineral contents, including calcium, phosphorus, potassium, magnesium, iron, sodium and zinc. Spirulina incorporation also altered the instrumental color characteristics, with changes in L^* , a^* , chroma and hue angle. Texture Profile Analysis indicated lower hardness and fracturability and higher springiness, cohesiveness and chewiness in T_3 compared with the control. The findings demonstrate that incorporation of spirulina at 6 g per 100 g peanut can enhance the nutritional and functional characteristics of peanut chikki while maintaining desirable sensory and textural properties. The developed product therefore shows potential as a value-added functional snack.

Keywords: Spirulina (*Arthrospira platensis*), Peanut chikki, Functional food, Protein enrichment, Amino acids, Texture profile, Nutritional enhancement

1. Introduction

The increasing demand for nutritious, convenient and value-added foods has stimulated growing interest in the development of functional foods that provide essential nutrients along with biologically active compounds. Modern food research is increasingly focused on utilizing natural, nutrient-dense and sustainable ingredients to improve the nutritional quality of conventional foods. In this context, microalgae and cyanobacteria have emerged as promising food resources because of their high nutritional density, functional components and potential applications in food formulation. Among them, *Arthrospira platensis*, commonly known as spirulina, has attracted considerable attention as a promising ingredient for functional food development due to its protein, essential amino acids, minerals, pigments and other bioactive constituents (Lafarga, 2020). Spirulina is a filamentous cyanobacterium recognized for its high protein content and nutritional value. Its biomass contains substantial quantities of protein together with essential amino acids, minerals and bioactive compounds. The composition of spirulina can vary depending on species or strain, cultivation conditions, nutrient availability, harvesting and processing conditions. Nevertheless, its high protein density makes it particularly attractive for protein enrichment and the development of alternative and functional food products. The increasing interest in spirulina as a food ingredient has also been associated with the growing demand for sustainable sources of nutrients and alternative proteins (Lafarga, 2020).

In addition to protein, spirulina contains several biologically important pigments and phytochemicals. C-phycocyanin is one of its characteristic pigments and has received considerable attention because of its functional properties and potential application as a natural food colorant. Phycocyanin is widely investigated for its extraction, stability, bioactive properties and food applications. Recent studies have highlighted its potential use in functional foods, nutraceuticals and as an alternative to synthetic food colors, although its stability can be influenced by temperature, pH and light (Mao *et al.*, 2024; Chhirang *et al.*, 2024) [2, 1]. Spirulina also contains chlorophyll, carotenoids and β -carotene, which contribute to its characteristic color and antioxidant

potential. The presence of phenolic and flavonoid compounds further increases the functional significance of spirulina as a food ingredient. The application of spirulina in food products has expanded considerably in recent years. It has been incorporated into several food matrices, including pasta, bakery products, dairy products and other functional foods. Such applications have demonstrated the potential of spirulina to improve nutritional characteristics, particularly protein, mineral, phenolic and antioxidant contents. For example, incorporation of spirulina into pasta resulted in substantial increases in protein, phenolic compounds, flavonoids, iron and calcium while maintaining acceptable textural and sensory characteristics at appropriate incorporation levels (Kumar *et al.*, 2022). These findings indicate that spirulina can be successfully incorporated into conventional food matrices when the level of addition is optimized.

The incorporation of spirulina into foods also presents technological and sensory challenges. Spirulina possesses a characteristic blue-green color and distinctive flavor, and increasing its concentration may influence the appearance, taste, flavor and overall acceptability of food products. Studies on spirulina-fortified food products have demonstrated that lower or moderate incorporation levels are generally more acceptable than excessive levels because higher concentrations may intensify the characteristic color and flavor of spirulina (Kefalas *et al.*, 2021). Therefore, optimization of the incorporation level is essential to obtain an appropriate balance between nutritional enrichment and sensory acceptability.

Peanut (*Arachis hypogaea* L.) is an important oilseed-legume and a widely consumed food ingredient. It provides considerable amounts of protein, fat and energy and is also valued for its characteristic flavor and crunchy texture. The nutritional and sensory characteristics of peanut make it suitable for the preparation of a variety of traditional snacks and confectionery products. In India, peanut is commonly utilized in traditional products such as chikki, which is widely consumed as a convenient and energy-dense snack.

Peanut chikki is a traditional Indian confectionery generally prepared from roasted peanuts and jaggery. Roasting develops the characteristic flavor and crunchy texture of peanuts, while jaggery acts as a sweetening and binding ingredient. The simple formulation and familiar sensory characteristics of chikki make it a suitable food matrix for the incorporation of nutrient-dense functional ingredients. Enrichment of peanut chikki with spirulina may therefore provide an opportunity to combine the protein and energy contribution of peanut with the high protein, mineral, pigment and bioactive potential of spirulina.

The development of spirulina-enriched chikki is particularly relevant because traditional foods can serve as effective vehicles for nutritional enrichment without requiring major changes in consumption habits. Incorporating functional ingredients into familiar food products may improve their nutritional value while retaining consumer familiarity. However, successful product development requires simultaneous consideration of nutritional quality, sensory acceptability, physicochemical properties, texture and production cost.

Sensory evaluation is an essential component of food product development because nutritional improvement alone does not ensure consumer acceptance. Changes in spirulina concentration may affect appearance, color, flavor, taste and texture. The nine-point hedonic scale is a widely established method for evaluating food acceptability and consumer preference (Amerine *et al.*, 1965) [3]. Therefore, sensory evaluation can be effectively used to identify the optimum level of spirulina incorporation that provides nutritional enrichment while maintaining desirable sensory characteristics.

Instrumental color analysis is also important in spirulina-enriched products because the characteristic pigments of spirulina can produce noticeable changes in product appearance. Parameters such as L^* , a^* , b^* , chroma and hue angle provide objective measurements of lightness, redness-greenness, yellowness, color intensity and hue.

Similarly, instrumental Texture Profile Analysis (TPA) provides quantitative information regarding hardness, fracturability, adhesiveness, springiness, cohesiveness, gumminess, chewiness and resilience. These characteristics are particularly important for chikki because its consumer acceptance is closely associated with its characteristic hardness, brittleness and chewiness. Instrumental texture analysis has therefore become an important tool for evaluating changes in food structure resulting from ingredient incorporation.

Previous research has demonstrated that spirulina enrichment can improve the nutritional and functional characteristics of food products while maintaining acceptable sensory and textural quality when an appropriate concentration is used. For instance, spirulina-enriched pasta showed increased protein, phenolic compounds, flavonoids, calcium and iron, together with acceptable sensory and textural properties (Kumar *et al.*, 2022). Similarly, research on spirulina incorporation into dairy products has indicated that moderate levels can improve nutritional characteristics while excessive addition may negatively influence characteristic flavor and sensory acceptance (Kefalas *et al.*, 2021). These findings support the importance of optimizing spirulina concentration according to the characteristics of the specific food matrix.

Despite increasing research on spirulina as a functional food ingredient, comparatively limited information is available regarding its application in traditional Indian confectionery products, particularly peanut chikki. limited studies have simultaneously examined the proximate composition, mineral profile, phytopigments, phytochemicals, antioxidant activity, essential amino acids, sensory characteristics, instrumental color, texture profile and economic feasibility of spirulina-enriched chikki. An integrated evaluation of these parameters is important for determining the nutritional, technological and commercial potential of such a product.

The present investigation was undertaken to develop and comprehensively evaluate spirulina-enriched peanut chikki using *Arthrospira platensis* powder as a functional ingredient. Different levels of spirulina powder were incorporated into peanut chikki and the formulations were evaluated for sensory quality to identify the optimum incorporation level. The selected formulation was further evaluated for proximate composition, mineral composition, phytopigments, phytochemicals, antioxidant activity, essential amino acid profile, instrumental color, physical characteristics, texture profile and production cost. The study aimed to determine the potential of spirulina incorporation to enhance the nutritional and functional quality of traditional peanut chikki while maintaining desirable sensory, physicochemical, textural and economic characteristics.

2. Materials and methods

2.1 Materials

The investigation was conducted during the academic year 2025–2026 at the College of Food Technology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India. Spirulina powder identified as *Arthrospira platensis* was procured from the local market of Parbhani. Peanuts, jaggery, liquid glucose and cardamom were obtained from local sources. Analytical-grade chemicals and reagents were used for chemical and instrumental analyses.

2.2 Formulation of spirulina-enriched peanut chikki

Five formulations were prepared using spirulina powder at 0, 2, 4, 6 and 8 g per 100 g peanut. The formulations were designated T_0 , T_1 , T_2 , T_3 and T_4 , respectively. The optimized formulation selected on the basis of sensory evaluation was T_3 , containing 6 g spirulina powder per 100 g peanut. For T_3 , 164 g jaggery, 10 g liquid glucose, 6 g spirulina powder and 0.5 g cardamom were used with 100 g roasted peanut.



Figure 1. Raw materials for preparation of spirulina peanut chikki

Table 1. Formulation for preparation of peanut chikki by using spirulina powder

Ingredients (g)	T ₀ (Control)	T ₁	T ₂	T ₃	T ₄
Peanut	100	100	100	100	100
Jaggery	170	168	166	164	162
Liquid Glucose	10	10	10	10	10
Spirulina powder	-	2	4	6	8
Cardamom	0.5	0.5	0.5	0.5	0.5

• **T₀ (Control):** Peanut 100 g + jaggery 170 g + liquid glucose 10 g + cardamom 0.5 g.

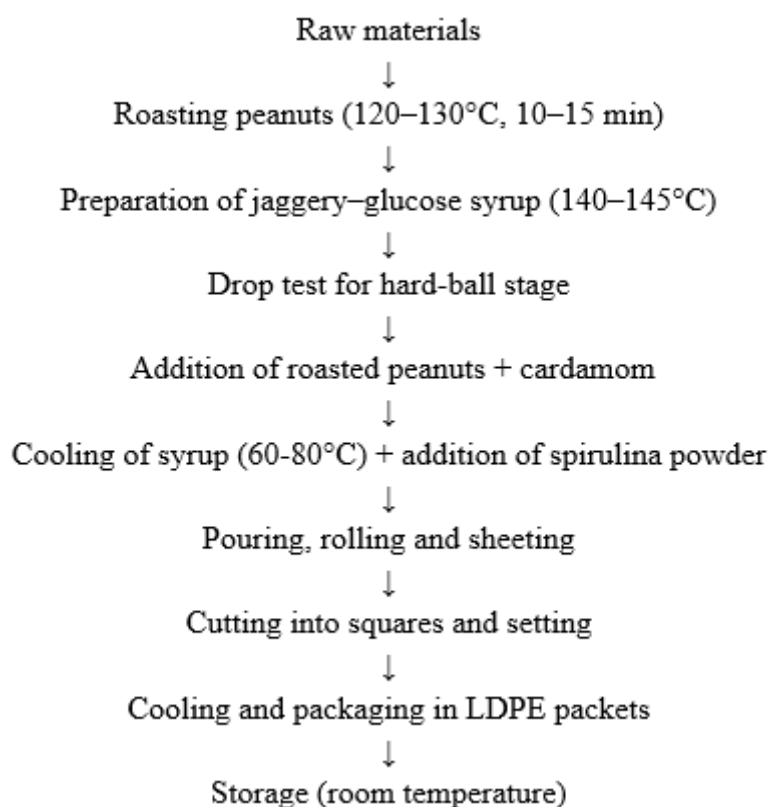
• **T₁:** Peanut 100 g + jaggery 168 g + liquid glucose 10 g + Spirulina 2 g + cardamom 0.5 g.

• **T₂:** Peanut 100 g + jaggery 166 g + liquid glucose 10 g + Spirulina 4 g + cardamom 0.5 g.

• **T₃:** Peanut 100 g + jaggery 164 g + liquid glucose 10 g + Spirulina 6 g + cardamom 0.5 g.

• **T₄:** Peanut 100 g + jaggery 162 g + liquid glucose 10 g + Spirulina 8 g + cardamom 0.5 g.

2.3 Methodology for preparation of spirulina peanut chikki



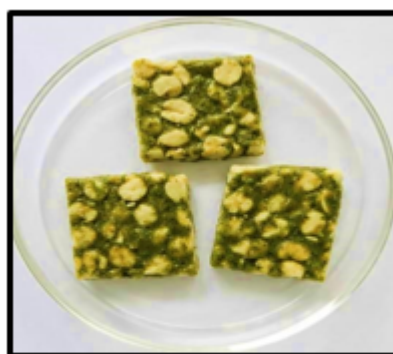
Flow sheet 1: Preparation of spirulina peanut chikki

Peanuts were roasted at approximately 120–130 °C for 10–15 min and cooled. Jaggery and liquid glucose were heated to approximately 140–145 °C until the required hard-ball stage was achieved. Roasted peanuts and cardamom were incorporated into the syrup. The mixture was subsequently cooled to approximately 60–80 °C, after which

spirulina powder was incorporated into the selected formulation. The mass was immediately transferred onto a greased surface, rolled and sheeted to uniform thickness, cut into pieces and allowed to cool. The prepared chikki was packed in suitable packaging material and stored at room temperature.



T₀



T₁

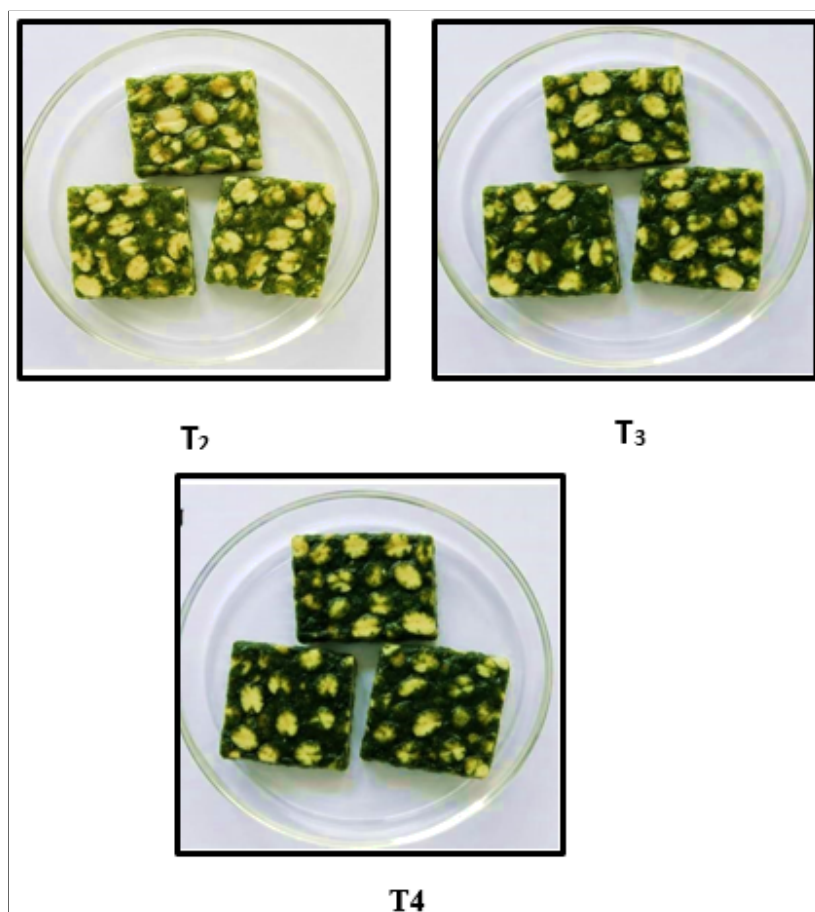


Figure 2. Formulation of spirulina peanut chikki

2.4 Sensory evaluation

The sensory quality of the developed spirulina peanut chikki was assessed using a nine-point hedonic scale. A panel of ten semi trained judges evaluated the samples for appearance and color, flavor, taste, texture and overall acceptability. Samples were coded and presented to the panellists under uniform conditions to minimize possible bias. The sensory responses were recorded on a scale ranging from 9 (like extremely) to 1 (dislike extremely), as described by Amerine *et al.* (1965) [3]. Mean sensory scores were calculated for each attribute, and the formulation obtaining the highest overall acceptability score was selected for subsequent quality evaluation.

2.5 Proximate composition

Moisture, ash, protein, fat and crude fibre contents were determined using standard analytical procedures described by the Association of Official Analytical Chemists (AOAC). Protein content was determined by the Kjeldahl method using the appropriate nitrogen-to-protein conversion factor, while carbohydrate content was calculated by difference. All analyses were performed in triplicate and the results were expressed as percentages of the sample (AOAC, 2019) [4].

2.6 Mineral analysis

The mineral composition of the control and selected spirulina peanut chikki was analysed for calcium, phosphorus, potassium, magnesium, iron, sodium and zinc using the analytical procedure adopted in the laboratory. The mineral contents were determined and expressed as mg/100 g of sample. The results were used to assess the contribution of spirulina incorporation to the mineral profile of the developed product.

2.7 Phytochemical and phytopigment analysis

The phytochemical constituents of spirulina powder were evaluated in terms of total phenolic, total flavonoid and tannin contents. Total phenolic content was estimated using the Folin-Ciocalteu method and expressed as mg gallic acid equivalents (GAE)/g. Total flavonoid con-

tent was determined by the aluminium chloride colorimetric method and expressed as mg quercetin equivalents (QE)/g. Tannin content was estimated using the Folin-Denis method and expressed as mg tannic acid equivalents (TAE)/g (Singleton and Rossi, 1965).

The major phytopigments, namely chlorophyll, phycocyanin, total carotenoids and β -carotene, were quantified using the respective spectrophotometric and chromatographic procedures adopted in the laboratory. Chlorophyll was estimated spectrophotometrically following extraction with acetone, while phycocyanin, total carotenoids and β -carotene were determined using their respective analytical procedures.

2.8 Essential amino acid analysis

The essential amino acid profile of Spirulina powder was determined by HPLC following hydrolysis, derivatization and chromatographic separation. Tryptophan was analysed separately where required. Results were expressed as g/100 g sample.

2.9 Color analysis

Color characteristics were determined using a Hunter color difference meter. L^* , a^* , b^* , chroma (C^*) and hue angle (h°) were recorded. L^* represents lightness, positive a^* represents redness and negative a^* represents greenness, whereas positive b^* represents yellowness.

2.10 Physical properties

Length, width, thickness, individual weight and bulk density of control and selected chikki were determined using standard laboratory procedures.

2.11 Texture profile analysis

Texture profile analysis (TPA) was performed for the control and selected spirulina peanut chikki using an instrumental texture analyser. The samples were evaluated for hardness, fracturability, adhesiveness, springiness, cohesiveness, gumminess, chewiness and resilience. The textural characteristics were determined under standardized test conditions, and the mean values were recorded for comparison between

the formulations. Texture profile parameters were evaluated based on the instrumental TPA approach described by Bourne (1978) [5].

2.12 Economic analysis

The cost of raw materials was calculated from the quantity of ingredients used and their prevailing purchase price. Processing cost was estimated as 20% of raw material cost. Production cost was calculated per batch, per 100 g, per kg and per 10 kg of product.

2.14 Statistical analysis

All analytical determinations were performed in triplicate and the results were expressed as mean $\pm$ standard deviation. Sensory evaluation was conducted using ten semi-trained panellists, and the mean scores for each sensory attribute were calculated for each treatment. The experimental data were analysed using analysis of variance (ANOVA) under a Completely Randomized Design (CRD). Differences among treatment means were considered statistically significant at the 5% probability level ($p < 0.05$). Standard error and critical difference were calculated wherever applicable following the procedures described by (Panse & Sukhatme 1967).

3. Results and discussion

3.1 Nutritional composition of raw materials

The proximate composition of the raw materials demonstrated substantial differences among spirulina, peanut and jaggery. Spirulina powder contained $67.00 \pm 0.28\%$ protein, indicating its potential as a concentrated protein ingredient. Peanut contained $26.29 \pm 0.14\%$ protein and $46.24 \pm 0.18\%$ fat, confirming its role as both a protein and energy source. Jaggery contained $89.60 \pm 0.25\%$ carbohydrate, reflecting its primary technological function as a sweetening and binding ingredient. The complementary composition of these three ingredients provides a nutritional and technological rationale for the development of Spirulina-enriched peanut chikki. The high protein content of spirulina can contribute to protein enrichment, while peanut provides lipid, protein and desirable sensory characteristics and jaggery provides sweetness and binding. The observed protein concentration of Spirulina is consistent with the broad range reported in recent literature for spirulina biomass

Table 2. Proximate composition of raw materials

Parameters (%)	Spirulina powder	Peanut	Jaggery
Color	Blue green to green	Light Brown	Dark Brown
Shape	--	Oblong	--
1000 kernel wt (g)	--	365.40	--
Moisture	5.7 ± 0.08	4.56 ± 0.08	4.1 ± 0.06
Fat	3.8 ± 0.05	46.24 ± 0.18	1.2 ± 0.03
Carbohydrate	16 ± 0.12	17.4 ± 0.12	89.6 ± 0.25
Protein	67 ± 0.28	26.29 ± 0.14	2.4 ± 0.04
Ash	3.6 ± 0.04	2.64 ± 0.05	2.6 ± 0.05
Crude Fibre	3.9 ± 0.06	2.82 ± 0.04	0.12 ± 0.01

Values are mean $\pm$ SD based on the available replicate determinations.

3.2 Sensory evaluation of spirulina peanut chikki

Table 3. Sensory evaluation of prepared food product spirulina added peanut chikki

Treatments	Parameters				
	Appearance and color	Flavour	Taste	Texture	Overall Acceptability
T ₀	7.8	8	8	8.2	8
T ₁	7.5	7.8	7.5	7.8	7.7
T ₂	7.2	7.5	7.2	7.5	7.4
T ₃	8.5	8.3	8.3	8.5	8.4
T ₄	7	7.2	7	7.5	7.2
SE ($\pm$)	0.090	0.085	0.089	0.087	0.088
CD at 5 %	0.262	0.247	0.259	0.253	0.256

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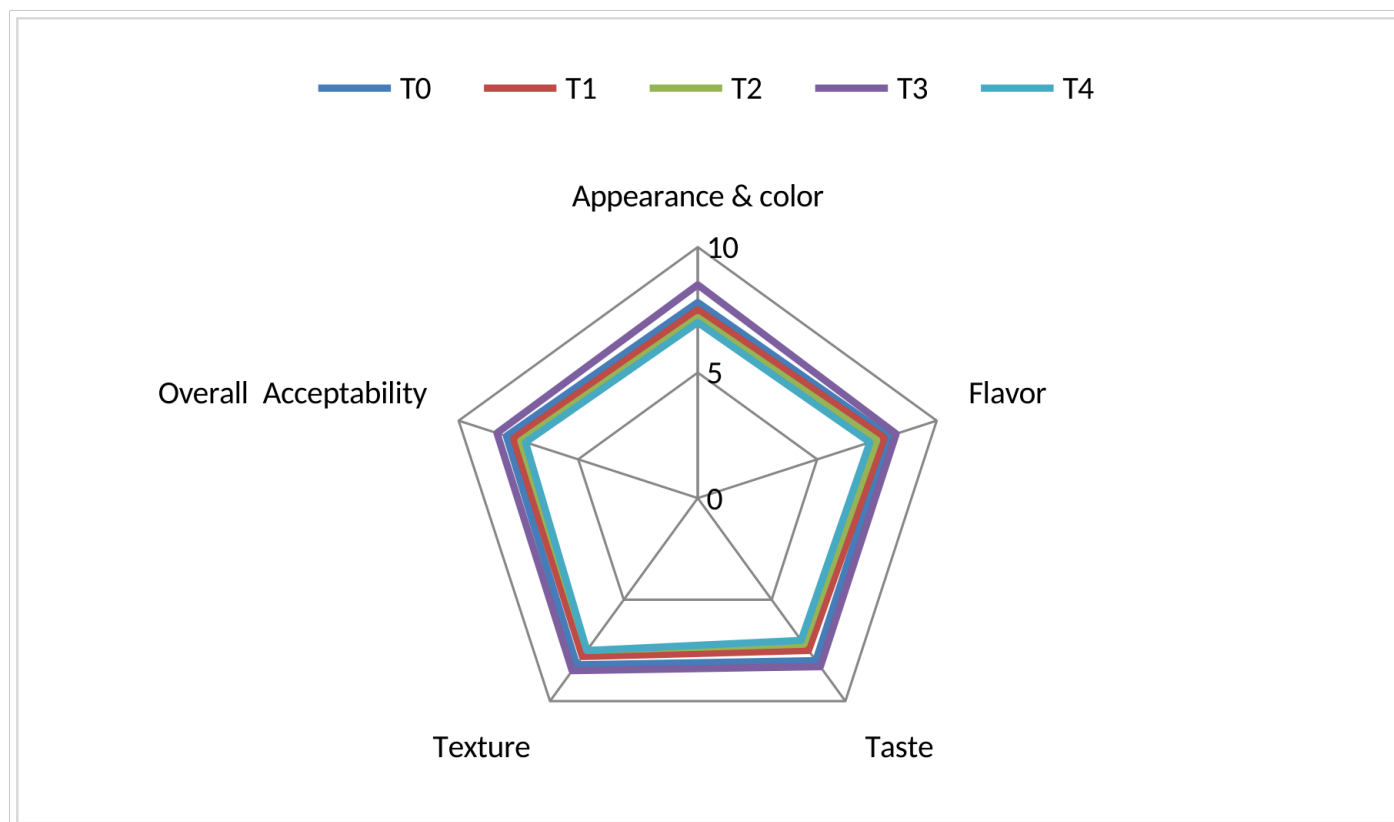


Figure 3. Sensory evaluation of spirulina peanut chikki

Sensory acceptability of the developed spirulina peanut chikki was assessed using a nine-point hedonic scale following the method described by Amerine *et al.* (1965) [3]. A panel of ten semi-trained judges evaluated the formulations for appearance and color, flavor, taste, texture and overall acceptability. The hedonic scores ranged from 9, indicating “like extremely”, to 1, indicating “dislike extremely”. All samples were assessed under similar conditions, and the mean scores for individual sensory attributes were considered for statistical evaluation.

Among the five formulations, T₃ containing 6 g spirulina powder per 100 g peanut showed the highest sensory scores for appearance and color (8.5), flavor (8.3), taste (8.3), texture (8.5) and overall acceptability (8.4). The control (T₀) also exhibited good sensory acceptance, with an overall acceptability score of 8.0. Formulations T₁ and T₂, containing 2 and 4 g Spirulina, respectively, showed comparatively lower sensory scores. In contrast, T₄ containing 8 g Spirulina recorded the lowest scores, particularly for appearance and color (7.0) and taste (7.0). The reduction in sensory scores at the higher level of spirulina incorporation suggests that excessive addition may adversely influence the sensory attributes of chikki. Based on the overall sensory performance, T₃ was identified as the most acceptable formulation and was selected for further quality evaluation.

3.3 Mineral composition of control and spirulina-enriched chikki

The mineral composition of spirulina powder, control, and the selected T₃ formulation is presented in Table 4. Spirulina powder contained appreciable amounts of potassium (1460 ± 1.35 mg/100 g), phosphorus (750 ± 0.92 mg/100 g), sodium (640 ± 0.95 mg/100 g), magnesium (280 ± 0.68 mg/100 g), calcium (140 ± 0.45 mg/100 g), iron (54.6 ± 0.18 mg/100 g), and zinc (3.2 ± 0.03 mg/100 g). Incorporation of Spirulina resulted in an increase in the mineral content of the selected T₃ formulation compared with the control. Calcium increased from 38.20 ± 0.24 to 44.60 ± 0.29 mg/100 g, phosphorus from 328 ± 0.57 to 340 ± 0.62 mg/100 g, potassium from 705 ± 0.21 to 755 ± 0.25 mg/100 g, and magnesium from 178.50 ± 0.11 to 191.60 ± 0.18 mg/100 g. Iron showed a marked increase from 2.10 ± 0.02 to 3.50 ± 0.03 mg/100 g, while sodium increased from 38.00 ± 0.15 to 42.00 ± 0.18 mg/100 g and zinc from 2.80 ± 0.02 to 3.20 ± 0.04 mg/100 g. The observed improvement in mineral content may be attributed to the contribution of spirulina biomass, which is a source of both macro and trace minerals. However, the mineral composition of spirulina may vary depending on cultivation and processing conditions.

Table 4. Mineral composition of spirulina powder, control and selected spirulina enriched chikki

Mineral	Spirulina(mg/100g)	Control	Selected (T ₃)
Calcium (Ca)	140 ± 0.45	38.2 ± 0.24	44.60 ± 0.29
Phosphorus (P)	750 ± 0.92	328 ± 0.57	340 ± 0.62
Potassium (K)	1460 ± 1.35	705 ± 0.21	755 ± 0.25
Magnesium (Mg)	280 ± 0.68	178.5 ± 0.11	191.60 ± 0.18
Iron (Fe)	54.6 ± 0.18	2.10 ± 0.02	3.50 ± 0.03
Sodium (Na)	640 ± 0.95	38 ± 0.15	42 ± 0.18
Zinc (Zn)	3.2 ± 0.03	2.80 ± 0.02	3.20 ± 0.04

Values are mean ± SD based on the available replicate determinations.

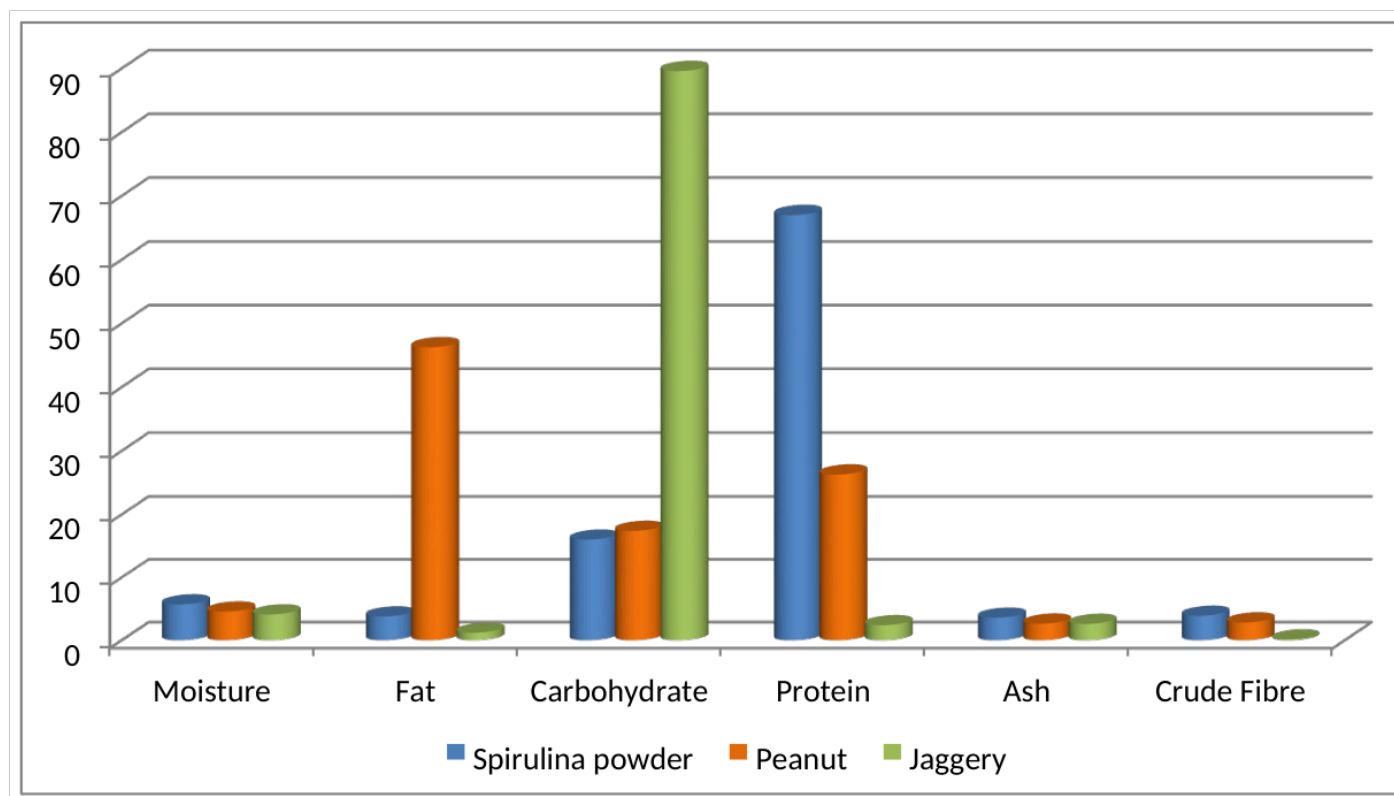


Figure 4. Chemical composition of raw materials

3.4 Color composition of spirulina chikki

Table 5. Color composition of spirulina chikki

Parameters	Spirulina powder	Control (T ₀)	Selected(T ₃)
<i>L</i> [*]	20.71 ± 0.18	42.24 ± 0.18	50.93 ± 0.20
<i>a</i> [*]	-6.51 ± 0.12	12.71 ± 0.12	3.67 ± 0.10
<i>b</i> [*]	3.04 ± 0.10	25.25 ± 0.15	24.94 ± 0.16
<i>C</i> [*]	7.20 ± 0.14	28.30 ± 0.16	25.2 ± 0.19
hue [*]	155.19 ± 0.28	63.22 ± 0.22	81.60 ± 0.28

The color characteristics of spirulina powder, control (T₀), and selected formulation (T₃) are presented in Table 5. Spirulina powder exhibited a low *L*^{*} value (20.71 ± 0.18) and a negative *a*^{*} value (-6.51 ± 0.12), indicating a darker and greenish color. Incorporation of spirulina increased the *L*^{*} value from 42.24 ± 0.18 in the control to 50.93 ± 0.20 in T₃, while the *a*^{*} value decreased from 12.71 ± 0.12 to 3.67 ± 0.10, indicating reduced redness and a shift towards greenish color.

3.5 Texture profile analysis (TPA) of spirulina peanut chikki

The texture profile characteristics of the control and selected T₃ spirulina peanut chikki are presented in Table 6. The selected T₃ formulation exhibited lower hardness (20.45 kg) and fracturability (0.875 kg) than the control (23.10 and 0.960 kg, respectively), indicating a comparatively softer and less brittle product. A slight increase in springiness (0.684), cohesiveness (0.667), gumminess (0.986 kg), chewiness (0.675) and resilience (0.520) was observed in T₃ compared with the control. Adhesiveness showed a small change from -0.061 to -0.069 kg-s. The incorporation of spirulina produced moderate changes in the textural characteristics of chikki, with a reduction in hardness and fracturability and an improvement in springiness, cohesiveness and chewiness.

The *b*^{*} values of the control and T₃ were comparable (25.25 ± 0.15 and 24.94 ± 0.16, respectively). Chroma decreased from 28.30 ± 0.16 in T₀ to 25.20 ± 0.19 in T₃, whereas the hue angle increased from 63.22 ± 0.22° to 81.60 ± 0.28°. Spirulina incorporation produced measurable changes in the color characteristics of the developed chikki, particularly in lightness, redness and hue.

Table 6. Texture profile analysis (TPA) of spirulina peanut chikki

Parameter	Control	Selected (T ₃)
Hardness (kg)	23.10	20.45
Fracturability (kg)	0.960	0.875
Adhesiveness (kg-s)	-0.061	-0.069
Springiness	0.615	0.684
Cohesiveness	0.610	0.667
Gumminess	0.936	0.986
Chewiness	0.575	0.675
Resilience	0.510	0.520

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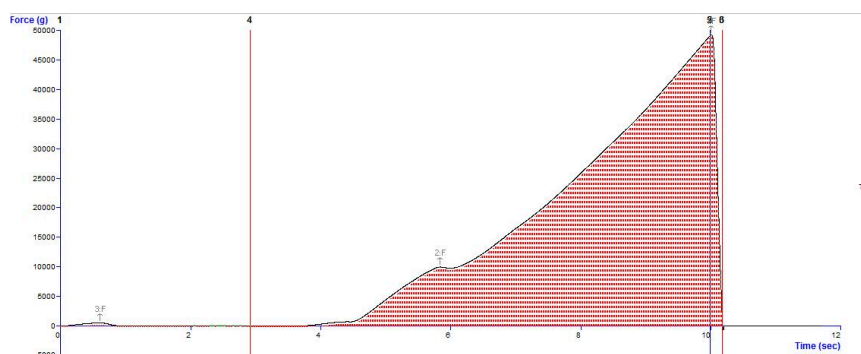


Figure 5. TPA graph of control sample (T_0)

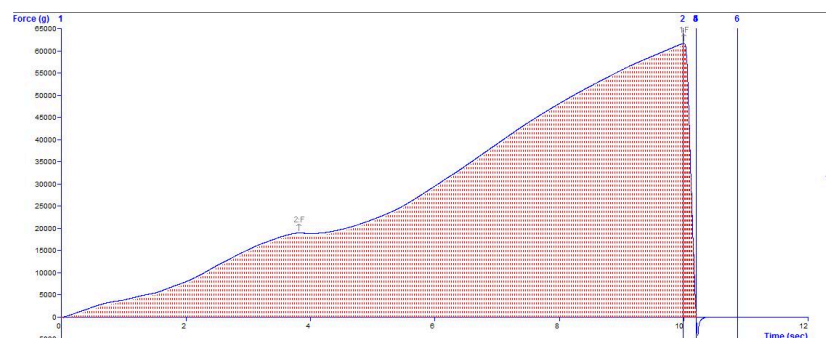


Figure 6. TPA graph of sample selected (T_3)

4. Conclusion

The present study demonstrated the potential of *Arthrospira platensis* (Spirulina) powder as a functional ingredient for nutritional enrichment of traditional peanut chikki. Spirulina powder showed a high protein content along with appreciable levels of minerals, phytopigments, phytochemicals and essential amino acids. Among the developed formulations, T_3 containing 6 g spirulina powder per 100 g peanut showed the highest sensory acceptability and was therefore selected for further evaluation. Compared with the control, the selected formulation exhibited improved mineral content, particularly calcium, phosphorus, potassium, magnesium, iron, sodium and zinc. Spirulina incorporation also influenced the color characteristics of the product and resulted in lower hardness and fracturability with improved springiness, cohesiveness and chewiness. The selected formulation had an estimated production cost of Rs. 18.36 per 100 g, indicating its economic feasibility. The findings suggest that incorporation of Spirulina at an optimum level can enhance the nutritional value of peanut chikki while maintaining acceptable sensory, physical and textural characteristics. Thus, spirulina-enriched peanut chikki may serve as a promising value-added functional food product with potential for further development and commercialization.

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