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Formulation and nutritional composition of moong dal-based soybean papad as a nutrient-dense snack

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Abstract
The need for functional foods with better glycaemic profiles has increased due to the rising incidence of metabolic diseases, such as diabetes, obesity, and cardiovascular diseases. Through semi-automated processing methods, this study aimed to create and standardise a low-Glycemic-Index (GI) papad made from a blend of moong dal (*Vigna radiata*) and soybeans (*Glycine max*). Because of the bean blend's high nutritional content, specifically in terms of protein, dietary fibre, and minerals that promote metabolic health, it was chosen. To guarantee consistency in thickness and quality, a semi-automatic papad-making equipment was used to make a dough made up of 80 per cent moong dal and 20 per cent soybean flour, papad khar, along with other spices such as red chilli powder, black pepper, jeera powder, and salt. The proximate and mineral components of the produced papad were assessed. 30.13±0.02 g/100g crude protein, 5.85±0.07 g/100g fat, 1.99±0.15 g/100g fibre, 1.85±0.01 g/100g ash, and 49.43±0.46 g/100g carbohydrate were found in the papad, along with 8.31±1.25 mg iron and 151±1.03 mg calcium, according to the results. These results imply that the papad is a potentially glycaemic-friendly, shelf-stable, and nutritionally enriched snack. The study emphasises the possibility of employing semi-automated techniques to incorporate legumes into traditional Indian dishes in order to produce reliable, healthful snack products. Future studies might concentrate on long-term storage stability and the assessment of the *in vivo* glycaemic index.

Keywords: Low glycaemic index, papad, moong dal, soybean, semi-automated processing, functional food, nutritional composition

1. Introduction

As the prevalence of metabolic disorders, including diabetes, obesity, and cardiovascular diseases, has increased, there has been a growing focus on creating functional and health-oriented food products in recent years. The creation of meals with a low Glycaemic Index (GI), which release glucose into the bloodstream gradually and aid in maintaining stable blood sugar levels, is a popular approach. The glycaemic index is now commonly acknowledged as a crucial nutritional metric for assessing the calibre of foods that contain carbohydrates (Foster-Powell *et al*. 2021) [3]. The glycaemic index is a crucial nutritional tool for managing postprandial blood glucose levels, especially in populations prone to metabolic disorders (Muskan *et al.* 2025) [6]. Because of their widespread acceptance, ease of preparation, and extended shelf life, traditional Indian snacks like papad, a thin, crispy disc shaped comprised mostly of pulses and spices, offer a viable vehicle for nutritional enrichment. Moong dal (*Vigna radiata*) and soybean (*Glycine max*) are two legumes that are high in dietary fibre, high-quality protein, vitamins, minerals, and bioactive substances like phenolic acids and isoflavones that have been demonstrated to enhance metabolic health and reduce glycaemic response (Yadav *et al*., 2023; Mishra and Chauhan, 2022) [10, 5]. While the high protein and fat content of soybeans adds to the nutritional profile, moong dal is renowned for being easier to digest and having a lower GI than many other pulses. These legumes can be strategically used in papad formulation to create a low-GI, protein-rich, and nutritionally improved snack substitute that satisfies customer demands for better snack options. A study on the glycaemic index of traditional Indian foods, highlighting the potential of legume-based formulations in lowering postprandial glucose response.

However, methodical process standardisation is necessary to provide uniformity in nutritional value, sensory appeal, and quality. The qualities of the finished product are greatly influenced by important variables such the ratio of legumes to other ingredients, moisture content, seasoning, drying conditions, and processing methods. The adoption of semi-automatic papad-making devices presents a chance for increased accuracy, consistency, and scalability because traditional papad-making is mostly manual and irregular (Patil *et al.* 2022) [8]. Studies explicitly concentrating on the formulation of low-GI papad utilising soybean and moong dal in a semi-mechanised setup are still scarce, despite numerous advancements in papad production. Thus, the objective of this work is to use semi-automated processing methods to create and standardise a low glycaemic index papad utilising a blend of soybean and moong dal. To guarantee consumer acceptability and commercial feasibility, the process involves evaluating the shelf-life, nutritional profile and sensory attributes. This study will add to the expanding field of functional traditional foods by providing a nutritious snack choice for people who are worried about nutritional balance and glycaemic control.

2. Materials and Methods

Soybean (*Glycine max*), moong dal (*Vigna radiata*), papad khar and all other ingredients were purchased from the local market of Udaipur, Rajasthan. Moong dal, soybean, papad khar, jeera powder, black pepper, and salt were used for the development and standardisation of low-glycemic-index papad. The papad was standardised and developed using semi-automatic papad making machine (AP001) in the laboratory of Department of Dairy and Food Technology (CDFT). The developed papad was evaluated for nutritional attributes such as moisture, crude protein, crude fat, crude fibre, total ash, carbohydrate and energy. The proximate analysis and mineral estimation were conducted in the laboratory of the Department of Food Science and Nutrition.

2.1 Development and standardisation of low glycemic index papad

A legume mix of 800 g moong dal (*Vigna radiata*) and 200 g soybean (*Glycine max*) was used to produce and standardise low glycaemic index papad. This blend was selected due to its high protein content, dietary fibre, and potential to reduce postprandial glucose response. To increase hydration and digestibility, both beans were carefully cleaned, rinsed, and then soaked in water for six hours. To create a consistent dough, the soaking grains were drained, dried and then finely grind. Based on the total weight of the flour, 2 per cent papad khar (alkaline salt), 1.2 per cent salt, 1 per cent black pepper, and 1 per cent cumin seeds powder were added to this base. After adding 280 millilitres of water to the mixture, the mixture was moved to the dough feeder. To create a consistent dough, the mixture was thoroughly mixed in the dough feeder. After that, the dough was fed into the rolling machine after being greased with oil. The dough was compacted and distributed into a thin, uniform sheet by the roller, and it was then cut into circular papads with uniform thickness and diameter by the circular cutter. The papad was gathered into the tray with the aid of a conveyor belt. After two hours of shade drying in the tray, the papad was placed in HDPE pouches for additional examination. The nutritional characteristics and sensory acceptability of the papad were assessed.

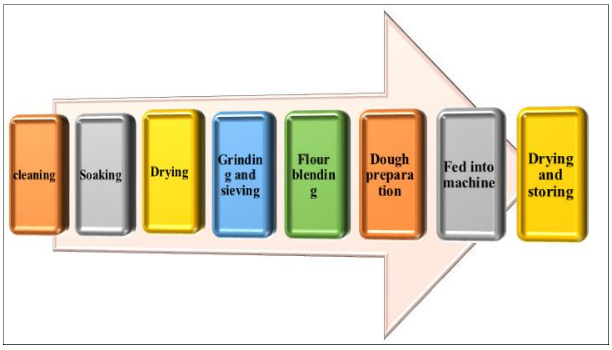

Fig 1: Flow diagram of preparation of papad

Table 1: Raw material used per 100 g

S. No.	Ingredients	Quantity
1.	Moong dal (g)	80
2.	Soybean (g)	20
3.	Papad khar (g)	2.0
4.	Jeera powder (g)	1.0
5.	Black pepper (g)	1.0
6.	Red chilli powder (g)	1.0
7.	Salt (g)	1.2
8.	Water(mL)	28

2.2 Nutritional composition of low glycemic index papad

2.2.1 Moisture: Moisture content of Moong dal-based soybean papad was measured by using loss on drying method (AOAC, 2016) [2].

$$\text{Moisture (g/100g)} = \frac{\text{Initial reading (C)} - \text{final reading (D)}}{\text{Weight of sample taken(B)}} \times 100$$

2.2.2 Crude protein: Estimation of protein content of the papad was done by the Micro-kjeldahl method (AOAC, 2000) [1].

$$\text{Nitrogen per cent} = \frac{(\text{ml HCL in determination} - \text{ml blank}) \times \text{Normalityof HCL}(0.1) \times 14 \times 100 \times 6.25}{\text{Weight of the sample (mg)}}$$

Protein per cent = Total nitrogen per cent × general factor 6.25

2.2.3. Crude fat: Fat content was estimated using an automatic SOCS plus solvent extraction apparatus (NIN 2003) [7].

$$\text{Fat (g/100g)} = \frac{\textit{Weight of flask with extracted fat} - \textit{weight of empty flask}}{\textit{Weight of Sample (g)}} \times 100$$

2.2.4 Crude fibre: The standard method was used to analyse the fibre content (AOAC, 2016)

$$\text{Per cent crude fibre (g/100g)} = \frac{(W2-W1)-(W3-W1)}{\text{Weight of Sample (g)}} \times 100$$

2.2.5 Total ash: The standard method was used to analyse the ash content (AOAC, 2016).

$$\text{Ash (g/100g)} = \frac{\text{Weight of ash(g)}}{\text{Weight of sampl,e taken(g)}} \times 100$$

2.2.6 Carbohydrate: The difference method was used to calculate the dry weight basis of the carbohydrate content (NIN, 2003) [7].

Carbohydrate (g/100g) = 100-(moisture + crude fiber + total ash + crude protein + crude fat)

2.3 Mineral estimation

2.3.1 Calcium estimation: Calcium content was estimated by complexometric titration using EDTA as per AOAC (2000) [1].

mg of calcium (mg/100g) = V×N×20×100/Aliquot volume (mL)

2.3.2 Iron estimation: Iron content was estimated using the dipyridyl reagent method as described by AOAC (2000) [1].

2.4. Statistical analysis: The statistical analysis of the result was done by Microsoft excel in which mean, standard deviation and standard error was calculated for nutrition composition of the developed papad.

3. Results and Discussion

The developed papad was subjected to proximate and mineral analysis. The results are shown in Table 3.1. It was found that the developed papad contains 10.73±0.41 per cent moisture, 30.13±0.02 g of crude protein, 5.85±0.07 of crude fat, 1.99±0.15 g of crude fibre, 1.85±0.01 g of ash and 49.43±0.46 g of carbohydrate per 100g of papad.

Table 2: Proximate composition of the best acceptable papad (100g)

S. No.	Nutrient	Mean ± SD	SE
1.	Moisture (%)	10.73±0.41	0.23
2.	Crude protein (g)	30.13±0.02	0.01
3.	Crude fat (g)	5.85±0.07	0.03
4.	Crude fibre (g)	1.99±0.15	0.08
5.	Ash (g)	1.85±0.01	0.00
6.	Carbohydrate (g)	49.43±0.46	0.26

All values are (Mean ± SD) of three independent observations

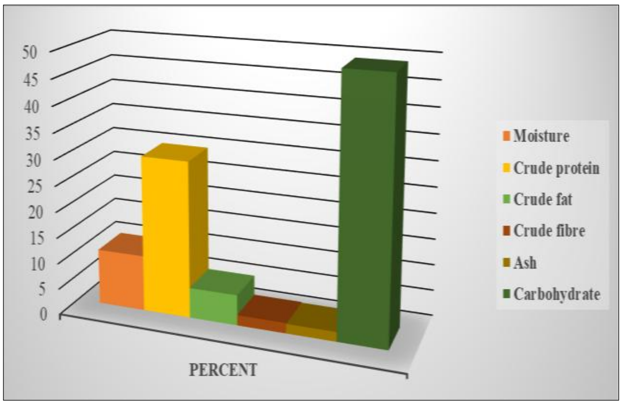

Fig 1: Diagrammatic representation of the proximate composition of papad

Table 3: Mineral content of papad

S. No.	Minerals (Per 100 g)	Mean ± SD
1.	Iron (mg)	8.31±1.25
2.	Calcium (mg)	151±1.03

According to the Table 3 mineral composition, the developed papad has 8.31±1.25 mg of iron and 151±1.03 mg of calcium per 100 gram of papad.

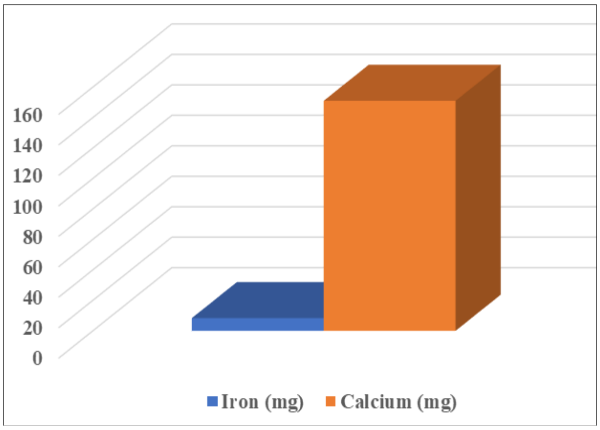

Fig 2: Mineral composition of low glycaemic papad

4. Conclusion

Through semi-automated processing, the current study was able to develop and standardise a low glycaemic index papad utilising a blend of moong dal (Vigna radiata) and soybean (Glycine max). With a high protein content (30.13±0.02 g/100g), moderate fat content (5.85±0.07 g/100g), and significant levels of dietary fibre, iron, and calcium, the papad demonstrated a positive nutritional profile and could be a useful snack for people looking to improve their glycaemic management. The use of semi-automated machine guaranteed consistency in product quality and production scalability, while the combination of moong dal and soybean offered a balance between digestibility and nutritional density. The papad prolonged shelf life and general quality were facilitated by its acceptable moisture and ash levels. In order to meet the increased need for healthier snack options, this study emphasises the potential of improving traditional Indian dishes using contemporary nutritional concepts and processing techniques. Future studies may explore its glycaemic index through *in vivo* analysis and shelf-life stability during extended storage.

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