

Proximate Analysis of Bengal Gram, Dry Peas, and Fresh Peas and Development of a High-Protein Value-Added Chapati: Effect of Processing on Nutritional Composition

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ABSTRACT: The present study was conducted to evaluate the proximate composition of three pulses namely Bengal gram (*Cicer arietinum* L.), dry peas (*Pisum sativum* L.), and fresh peas in their raw and processed forms, and to develop a nutritionally enhanced value-added product. Standard analytical methods were employed to determine moisture, ash, fat, protein, and crude fibre content. Different processing methods such as germination and cooking were assessed for their influence on nutrient composition. The results revealed significant variations in nutrient content after processing. Germination of Bengal gram showed the most notable improvement in nutritional quality, with crude protein and fibre increasing to 22.75% and 9.43%, respectively, compared to raw samples. In fresh peas, moisture content increased after cooking, while protein, ash, and fibre showed a decreasing trend. Dry peas exhibited appreciable levels of protein, fibre, and minerals, highlighting their nutritional potential. Based on the proximate analysis, a high-protein chapati was developed using composite flour prepared from wheat flour, sprouted Bengal gram flour, dry pea powder, and fresh pea incorporation in different proportions. Sensory evaluation was carried out using a 9-point hedonic scale to determine consumer acceptability. Among the formulations tested, the 50% composite flour formulation showed the highest overall acceptability with improved nutritional characteristics and desirable sensory attributes. The study emphasizes the importance of traditional processing methods such as germination and cooking in enhancing nutritional quality and demonstrates the potential of pulse-based composite flour in the development of functional food products to address protein-energy malnutrition and improve dietary quality.

KEYWORDS: - Bengal gram (*Cicer arietinum* L.), dry peas (*Pisum sativum* L.), fresh peas, proximate composition, germination, cooking process, composite flour, protein-enriched chapati, nutritional quality, sensory acceptability, nutrient changes, plant protein, food processing techniques, functional food products.

I. INTRODUCTION

Legumes have long been recognized as an essential part of the human diet due to their high nutritional value, affordability, and versatility in food applications. Among them, fresh green peas, dry green peas, and Bengal gram whole are widely consumed pulses that contribute significantly to dietary protein, fiber, vitamins, and minerals. These legumes are especially important in developing countries such as India, where plant-based protein sources play a major role in maintaining nutritional security.

Fresh green peas (**Pisum sativum**) are appreciated for their pleasant taste, soft texture, and rich content of vitamins such as vitamin C, vitamin K, and folate. They are commonly consumed as vegetables and are known for their antioxidant properties and health-promoting benefits. In contrast, Dry green peas are the matured and dehydrated form of peas, possessing a longer shelf life and higher concentration of nutrients, particularly protein and dietary fiber. Due to their storage stability and nutritional profile, dry peas are increasingly utilized in food formulations, functional foods, and protein-enriched products.

Bengal gram whole (**Cicer arietinum**), commonly known as whole chickpea or chana, is another highly valued pulse crop. It is rich in protein, complex carbohydrates, iron, calcium, and bioactive compounds that support overall health. Bengal gram is widely used in traditional and modern food preparations because of its nutritional richness and ability to improve satiety and digestive health. The regular consumption of chickpeas has also been associated with reduced risks of cardiovascular diseases, diabetes, and obesity.

In recent years, increasing awareness regarding healthy eating habits and plant-based nutrition has encouraged researchers and food industries to explore legumes as sustainable alternatives to animal-based protein sources. Fresh green peas, dry green peas, and Bengal gram whole not only provide essential nutrients but also support sustainable agriculture due to their nitrogen-fixing ability and lower environmental impact. Their incorporation into value-added food products can help address protein-energy malnutrition while meeting the growing consumer demand for nutritious and functional foods.

Therefore, the present study focuses on the nutritional significance and comparative characteristics of fresh green peas, dry green peas, and Bengal gram whole. Understanding their composition and functional properties may contribute to the development of innovative, nutrient-rich food products and promote their utilization in improving public health and food sustainability.

II. MATERIALS AND METHODS

A. Sample Procurement

Bengal gram, wheat flour, and Fresh peas were procured from the local market. All samples were cleaned and prepared for analysis.

B. Proximate Analysis

Proximate composition was determined using standard methods. Moisture content was analysed by hot air oven drying at 105°C until constant weight. Ash content was determined using a muffle furnace at 550°C. Fat content was estimated using Soxhlet extraction. Protein content was determined by the Kjeldahl method using a conversion factor of 6.25. Crude fibre was analysed using acid and alkali digestion method.

C. Preparation of Composite Flour

Dry pea powder was prepared by drying and grinding fresh peas. Bengal gram was soaked, sprouted, dried, and ground into flour. Composite flour samples were prepared in three ratios:

T1 (80:10:10), T2 (70:15:15), and T3 (50:25:25) of wheat, pea, and sprouted Bengal gram flour respectively.

D. Preparation of Chapati

Composite flour was mixed with salt, roasted cumin seeds, sesame seeds, and kasuri methi. Water was added to form dough, which was rested, rolled, and cooked on a hot tawa to prepare chapatis.

E. Sensory Evaluation

Sensory evaluation was conducted using a 9-point hedonic scale by semi-trained panellists. Parameters evaluated included taste, texture, aroma, colour, appearance, and overall acceptability.

III. RESULTS AND DISCUSSION

A. Proximate Composition of Bengal gram whole

Table 1: Proximate Composition of Bengal gram whole

| Parameters | IFCT Values | Raw | Soaked | Sprouted | Pressure cooked |
|--------------|-------------|--------|--------|----------|-----------------|
| Moisture (%) | 8.56 | 6.66 | 33.33 | 53.33 | 46.66 |
| Ash (%) | 2.78 | 3.5 | 14.5 | 4 | 14 |
| Fat (%) | 5.11 | 7 | 5.5 | 6 | 7 |
| Protein (%) | 18.77 | 18.375 | 20.125 | 22.75 | 20.125 |
| Fiber (%) | 15.15 | 7.488 | 8.85 | 9.43 | 7.328 |

Moisture content increased significantly in all processed samples due to water absorption during soaking, pressure cooking, and germination. This, in turn, affected the levels of other nutrients. Ash content varied considerably, likely because of mineral loss during soaking and cooking, as well as the use of minerals during germination. Fat content showed minor changes, hinting at possible loss of soluble lipid fractions and metabolic use during germination. Protein content rose notably in soaked, germinated, and pressure-cooked samples, with the highest levels found in the germinated sample. This increase may result from the loss of dry matter, concentration effects, and the creation of enzymatic proteins during germination. Crude fibre content grew in soaked and germinated samples, reflecting changes in structural carbohydrates, while a slight reduction after pressure cooking could be due to thermal breakdown and dissolution of fibre components.

Table 2: Proximate composition of Dry Peas

| Parameters | IFCT values | Raw | Soaked | Raw Cooked | Soaked Cooked | Sprouted | Sprouted Cooked |
|--------------|-------------|------|--------|------------|---------------|----------|-----------------|
| Moisture (%) | 9.3 | 6.6 | 20 | 46.6 | 53.3 | 66.6 | 86.6 |
| Ash (%) | 7.4 | 4 | 3.6 | 2.4 | 2.9 | 1.9 | 1.4 |
| Fat (%) | 1.8 | 1.5 | 1 | 4.5 | 2.5 | 2 | 2 |
| Protein (%) | 20.4 | 22.1 | 19.5 | 21.7 | 20.3 | 23.5 | 21.8 |
| Fiber (%) | 17 | 10.1 | 7.4 | 8.5 | 6.6 | 7.1 | 7.3 |

The result showed that dry peas remain highly nutritious even after common household processing methods such as 4soaking, cooking, and sprouting. Dry peas were found to be rich in plant-based protein and dietary fiber while naturally low in fat, making them a healthy food choice. Although processing increased moisture content and caused small changes in nutrients due to water absorption and minor mineral loss, the overall nutritional quality was well maintained. These findings suggest that dry peas can be easily included in everyday diets as an affordable, healthy, and sustainable source of nutrition.

Table 3: Proximate composition of Fresh Peas

| Parameter | IFCT Value | Raw | Cooked |
|--------------|------------|-------|--------|
| Moisture (%) | 73–75 | 73.73 | 80 |
| Ash (%) | 1 | 1 | 0.5 |
| Fat (%) | 0.4 | 0.5 | 0.5 |
| Protein (%) | 5 | 5.4 | 4.05 |
| Fiber (%) | 6.6 | 11.6 | 8.22 |

The results indicate that moisture content increased after cooking due to water absorption. Ash content decreased, suggesting mineral loss through leaching into cooking water. Protein content showed a reduction, likely due to thermal denaturation and loss of soluble components. Crude fibre also decreased as a result of structural breakdown during cooking. Fat content remained relatively constant, confirming that fresh peas are naturally low in fat.

B. Product Development and Nutritional Enhancement

Table 2: Protein and Fibre Content of Chapati Samples

| Sample | Description | Protein (%) | Fibre (%) |
|---------|-------------------|-------------|-----------|
| Control | Wheat chapati | 7.28 | 12.28 |
| S3 | Composite chapati | 9.31 | 13.58 |

The composite flour chapati (S3) showed increased protein and fibre content compared to the control. This improvement is attributed to the inclusion of pea and sprouted Bengal gram flours, which are rich in protein and dietary fibre.

C. Sensory Evaluation

Sensory scores indicated that the 50% composite flour formulation had the highest acceptability, with scores ranging from “like moderately” to “like very much.” The product exhibited desirable texture, flavour, and appearance. Higher substitution levels resulted in denser texture and stronger flavour, reducing overall preference. Panel preference followed the order: 50% formulation > 70% formulation > 80% formulation the results demonstrate that partial substitution improves nutritional value without compromising sensory quality.

IV. CONCLUSION

This study highlights the important role that traditional food processing techniques, particularly germination and controlled cooking, have in improving the nutritional profiles of pulses. Among the legumes evaluated, germinating Bengal gram (*Cicer arietinum* L.) was the most effective method for enhancing nutritional quality, resulting in the highest concentrations of crude protein (22.75%) and crude fibre (9.43%) compared to raw Bengal gram. On the other hand, fresh peas had minor nutrient losses and structural breakdown during cooking due to heat and leaching, while dry peas consistently kept their strong nutritional value across different household processing methods. Using these insights, a nutritionally improved composite chapati (S3) was created by replacing regular wheat flour with a nutrient-rich blend of sprouted Bengal gram flour, fresh and dry pea powder. This change led to a significant rise in both macronutrients and dietary fibre content, with protein reaching 9.31% and crude fibre at 13.58%. Sensory evaluation showed that partially substituting pulses can greatly improve dietary quality while keeping consumer acceptance intact. The 50% composite flour formulation (using a 50:25:25 ratio of wheat, sprouted Bengal gram, and dry pea flour) became the best option, earning the highest overall acceptability scores for its pleasant flavour, good texture, and attractive appearance. However, denser textures and strong flavours at higher substitution levels led to lower preferences among panellists. This research emphasizes the combination of traditional processing methods with composite flour formulation as a practical, affordable, and sustainable food science strategy to improve the overall nutritional quality of traditional products. Using pulse-based composites is a useful way to address protein-energy malnutrition, improve public health, and promote diverse diets.

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