International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 6, 2025
https://theaspd.com/index.php

Evaluation Of Proximate Composition Of Green Pea Peel Flour Of Odisha, India

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Abstract
The green pea is a seasonal vegetable that is consumed after its peels are removed. The pea pods, also known as the peel, make about 55% of the total volume of green peas when they are first harvested. Most of these are thrown away as trash and typically haven't received much care with the intention of being used. Therefore, the study's aim is to use laboratory analysis using AOAC protocols to determine the proximate composition of green pea peels and compare the findings with those of other foods and green pea peels that have already been examined by other researchers. After cleaning and peeling the green peas, the peels were dried and ground into powder for testing. The AOAC method was used to analyse the green pea peel flour's proximate composition. As per the study's results, each 100g sample of green pea peels contained 11.1g protein, 58.1g carbohydrate, 0.63g fat, 5g moisture, 5.08g ash, and 362.83 Kcal of energy. Compared to other cereals, millet, and fruit and vegetable peels, it was discovered that green pea peel flour was high in protein, carbohydrates, energy and low in fat. Thus, it can be concluded that green pea peel flour can be utilized as a source of protein to help address the issue related to protein calorie malnutrition.
Keywords: *Green pea, green pea peel flour, proximate composition, nutritive value, protein calorie malnutrition*

INTRODUCTION

Peas (Leguminosae family) are nutrient-dense, cool-season, and perishable crops. Originating from the Mediterranean, with secondary centres in Ethiopia and the Near East, peas are among the earliest cultivated food crops and rank as the second most important food legume after common beans. India is the second-largest producer of green peas after China, contributing 6.592 million tons to the global production of 21.485 million tons in 2023 [7]. These annual, self-pollinating herbs grow as bushes or climbers and are rich in protein (especially lysine), calcium, phosphorus, and vitamins A and C [4]. Commonly known as sweet pea, field pea, garden pea, sugar pea, and more [17].

Table 1: Scientific Classification of Peas

Kingdom	Plantae
Division	Tracheophyta
Class	Magnoliopsida
Order	Fabales
Family	Fabaceae
Genus	Pisum
Species	P. sativum

Source: Rungruangmaitree and Jiraungkoorskul, 2017 [17]

Peas grow well in all soils except heavy ones, with an ideal pH of 6.0 to 7.5. Organic matter improves soil structure and nutrients. Optimal germination occurs at 18–22°C, though seeds can sprout at 4–5°C. Germination declines above 25°C, and high temperatures can cause pest issues like wilt and stem fly. Peas thrive best in regions with a gradual shift from cool to warm weather. [5]. Green peas are annual climbing herbs with hollow stems up to 2–3 meters long. They have pinnately compound leaves with large stipules. The flowers have five green sepals and white to reddish-purple petals. The fruit is a 2.5–10 cm long pod with two sealed valves and a rough inner membrane. Inside are smooth, round, green seeds [16].

Peas exhibit various phytochemical properties, including antibacterial, anticancer, antidiabetic, antioxidant, anti-inflammatory, antifungal, antilipidemic, anti-*Helicobacter pylori*, and insecticidal effects \[17]. Their health benefits are attributed to nutrients and bioactive compounds such as peptides, proteins, and polyphenolics like flavonoids \[25]. Rich in dietary fiber, peas support gut health and help

manage metabolic syndrome. They are also gluten-free, making them suitable for people with celiac disease. Additionally, peas are a good source of calcium, iron, zinc, folic acid, and carotenoids [25].
The pea pods, also known as the peel, make about 55% of the total volume of green peas when they are first harvested. Most of these are thrown away as trash and typically haven't received much care with the intention of being used. Peapods are agro-industrial byproducts of the food industry that are a rich source of phenolic antioxidants and natural food bioactives. In India, almost one million tons of peapod waste are disposed of each year.
Despite significant growth in agricultural productivity over the past 50 years, India still faces severe hunger, ranking 107th out of 121 countries in the 2022 Global Hunger Index [9]. Food waste is a key contributing factor, with the FAO estimating 1.3 billion food products wasted annually, and 45% of this from fruits and vegetables [10]. Vegetable byproducts like seeds, pulp, pomace, and peels contribute to 24% of global food waste [10]. These byproducts possess antiviral and antioxidant properties and are increasingly studied for their potential as nutritional supplements [6]. Therefore, the present research is designed to evaluate the proximate composition of green pea peel flours of Odisha.

MATERIALS AND METHODS

A. Collection and Preparation of Sample

Green peas were purchased from the nearby local market of Bhubaneswar, Odisha. Large amounts of fresh green peas were selected, and any dirt was removed by washing them with tap water. Green peas were then peeled and the parchment layer or the fibrous coat of the peels were removed manually. The peels were then chopped into moderate-sized pieces with stainless steel knives. The peels were then sundried. The dried peels were then ground and sieved to create fine green pea peel flour. A glass container that was airtight was used to store the prepared flour.

Fresh Green Peas **Green Pea Peels** **Dried Green Pea Peels**

Figure 1: Collection and Preparation of Sample

B. Proximate Analysis of Green Pea Peel Flour

Moisture: The AOAC [1] technique was used to determine the moisture content. Two grams of peel flour was placed on an aluminium plate which was weighed and dried at 130 ± 3°C for 20 minutes. The peel flour was dried in an oven at 130 ± 3°C for an hour, and then it was cooled in a desiccator until it reached a constant weight. The weight loss after cooling was computed as the moisture content and expressed as a percentage.

Per cent moisture = $\frac{W1-W2}{W1-W} \times 100$

Where, W = Weight of empty aluminium dish
W1 = Weight of aluminium dish + sample before drying
W2 = Weight of aluminium dish + sample after drying

Total Ash: In order to determine the overall amount of ash, fresh pea peel flour was used instead of leftover flour from the moisture analysis. A cleaned and dried dish (W1) was weighed. The dish was filled with five grams of the flour sample, covered, and placed in an oven set to 130–133°C for two hours. The time was recorded from the moment the oven reached 130°C after the flour were placed inside. Two hours later, the dish was removed, left in the desiccator to cool, and weighed (W2). The dried substance that remained in the plate was burned with a burner flame. After being transferred to a muffle furnace maintained at 550 ± 25°C, the material was ignited until grey ash was generated. After chilling in a desiccator, it was weighed. The heating, cooling, and weighing procedures were repeated every 30 minutes until the weight difference between two consecutive weigh-ins was less than 1 mg. W2 was the lowest weight recorded.

Total ash on dry basis = $\frac{W2 - W}{W1 - W} \times 100$

Where, W = Mass in g of empty dish

W1 = Mass in g of the dish with the dried material (moisture free) taken for test

W2 = Massin g of the dish with the ash

Protein: The crude protein content was determined using AOAC's [1] Kjeldahl procedure. Two-gram flour sample was digested using ten grams of the digestion combination (potassium sulphate and copper sulphate in a 96:4 ratio) and twenty-five millilitres of concentrated sulfuric acid. The contents were then broken down to generate a clear, light green liquid that contained no carbon. The volume of the digested material was raised to 100 millilitres using distilled water. 10 ml of a 40% sodium hydroxide solution was used to distil a 10 ml aliquot of the digested material for 15 to 20 minutes. The released ammonia was collected using a conical flask that contained 25 millilitres of 4% boric acid and a few drops of a mixed indicator (methyl red and bromocresol green in a 2:1 ratio). After that, the distillate was titrated against 0.1N H2SO4 until it reached the end point, which is represented by a light pink tint. To produce a blank determination, the sample was replaced with sucrose. The nitrogen content of the sample was calculated using the following formula:

Percent Nitrogen = $\frac{\text{(Sample titre volume} - \text{blank titre volume)} \times 0.0014 \times \text{total volume of sample}}{\text{weight of sample} \times \text{aliquot distilled}} \times 100$

Per cent Crude protein = Nitrogen % × Conversion factor (6.25)

Total Fat: Total fat was determined using the SOCS plus method, which was supplied by the AOAC [1]. Two-gram flour was placed inside the thimbles after it had been weighed. The beakers were cleaned and then placed in a hot air oven to dry at 100°C. The beakers' empty weight (W1) was measured after they had cooled in the desiccator for around five minutes. Each beaker was filled with 80 millilitres of petroleum ether (B.P. 40–60°C). The beakers were then attached to the SOCS plus assembly, which had already been heated to 80°C. Petroleum ether was used for 45 to 60 minutes to remove fat from the thimbles that were inside the beakers. An hour later, the recovery temperature of petroleum ether quadrupled from 80°C to 120°C. The sample was rinsed roughly twice to remove any remaining fat that might have been present. Following that, every beaker was taken out of the system and heated in a hot air oven to 100°C for 15 to 20 minutes. They were weighed after cooling in desiccators for about five minutes. This was the last weight, or W2. By comparing the beaker's original and final weights, the fat content was ascertained. A percentage representing the amount of fat eliminated was provided. The following formula was used to determine the crude fat percentage:

Per cent crude fat = $\frac{W2 - W1}{Ws} \times 100$

Where, Ws = Weight of sample

W1 = Weight of empty beaker

W2 = Weight of beaker with fat

Carbohydrate: The following formula was used to determine the total carbohydrate after the percentages of moisture, protein, crude fat, and total ash were determined:

Total carbohydrate = 100 - (A + B + C + D)

Where, A = % of w t. of moisture

B = % of wt. of protein

C = % of wt. of crude fat

D = % of wt. of total ash

Energy: To calculate physiological energy, the Mudambi [12] method was used. The calorific value (Kcal/100g) of the sample was calculated by multiplying the percentage of crude protein, crude fat, and carbohydrate by 4, 9, and 4, respectively.

Energy value (Kcal/100g) = 4 x crude protein (per cent) + 4 x Carbohydrate (per cent) + 9 x crude fat (per cent).

C. Statistical Analysis

The values obtained from the current experimental inquiry were tabulated using the percentage, mean, and standard deviation. Additionally, the experimental values are compared with the nutritional values of cereals and cereal products from IFCT NIN, 2017 [11] and other research findings.

Results and Discussion:

This study evaluated the proximate composition of green pea peels, easily accessible in the local market of Bhubaneswar, Odisha. The results of estimating moisture, total ash, protein, fat, carbohydrate, and energy using a number of AOAC [1] provided standardized analytical procedures are shown below. IFCT NIN 2017 [11] was used to compare the proximate composition of green pea peel flour with that of different cereals and millet, as well as with the flours of other food stuffs.

1) Proximate Composition of Green Pea Peel Flour

Table 2: Proximate Composition of Green Pea Peel Flours

Sl. No.	Parameter	Experimental Value	Other Studies
1	Moisture (g/100 g)	5.0	3.89 ± 0.02 [2]
			6.30 ± 0.13 [14]
			4.28 ± 0.27 [20]
2	Total Ash (g/100 g)	5.08	5.05 ± 0.04 [2]
			5.2 ± 0.1 [14]
			4.47 ± 0.51 [13]
			5.65 ± 0.33 [23]
			5 ± 0.50 [8]
			7.18 ± 0.34 [20]
3	Protein (g/100 g)	31.11	17.76 ± 0.32 [2]
			13.27 ± 0.22 [14]
			4.7 ± 0.28 [13]
			19.80 ± 1.65 [23]
			14.88 ± 0.44 [8]
			13.27 ± 0.51 [20]
4	Carbohydrate (g/100 g)	58.18	65.11 ± 0.64 [2]
			20.54 ± 4.24 [13]
			72.28 [23]
			61.43 ± 0.03 [8]
5	Total Fat (g/100 g)	0.63	0.44 ± 0.03 [2]
			3.46 ± 0.1 [14]
			16.5 ± 0.56 [13]
			0.43 ± 0.03 [8]
			1.34 ± 0.03 [20]
6	Energy (Kcal/100g)	362.83	335.44 [2]
			249.46 [13]
			309.11 [8]

Moisture: Moisture content of food has a significant impact on its shelf life, texture, safety, quality, and processing properties. Table 2 and figure 2 presents the moisture content of the experimental green pea peel flour as well as the moisture content of green pea peels as measured by other researchers. The moisture content of experimental green pea peel flour was found to be 5.0 g/100g. The highest moisture content was reported by Nasir et al, 2023 [14] at 6.30 ± 0.13 and the lowest moisture content was reported by Beniwal et al, 2023 [2] at 3.89 ± 0.02. Thus, it was observed that the moisture content of the experimental peels was within the reported range, suggesting a low water content, which can prolong shelf life and inhibit microbial growth, helping in long term storage applications. The type of green pea peel used or the local climate may be the reason for the differences in moisture content reported by various researchers. For example, Beniwal et al, 2023 [2] used green pea peels from Hisar, Haryana, India for their study, Nasir et al, 2023 [14] from Kichha, Uttarakhand, India and Sharoba et al, 2013 [20] from Kaha city, Kaliobia, Egypt.

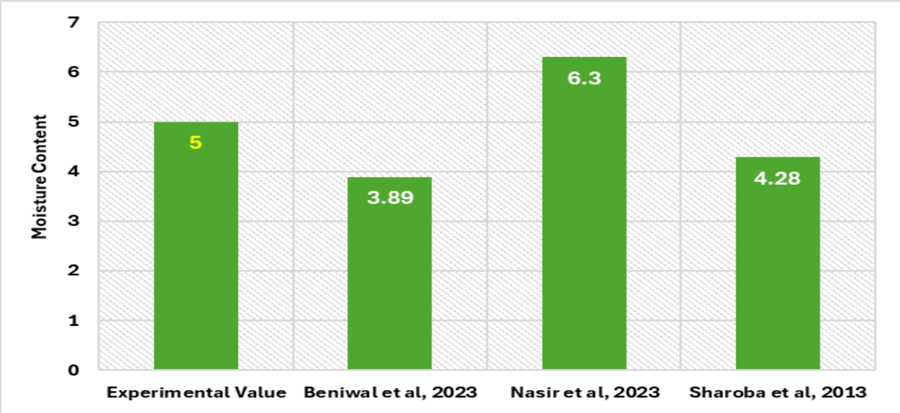

Figure 2: Moisture Content of Green Pea Peel Flour as Compared to other Studies

Total Ash: Total ash content of food indicates its nutritional worth and purity since it represents its total mineral content. Table 2 and figure 3 presents the total ash content of the experimental green pea peel flour as well as the total ash content of green pea peels as measured by other researchers. The total ash content of experimental green pea peel flour was found to be 5.08 g/100g. The highest total ash content was reported by Sharoba et al, 2013 [20] at 7.18 ± 0.34 and the lowest total ash content was reported by Naqvi et al, 2021 [13] at 4.47 ± 0.51. Thus, it was observed that the total ash content of the experimental peels was within the reported range, which indicates its potential as a nutritious ingredient with essential minerals.

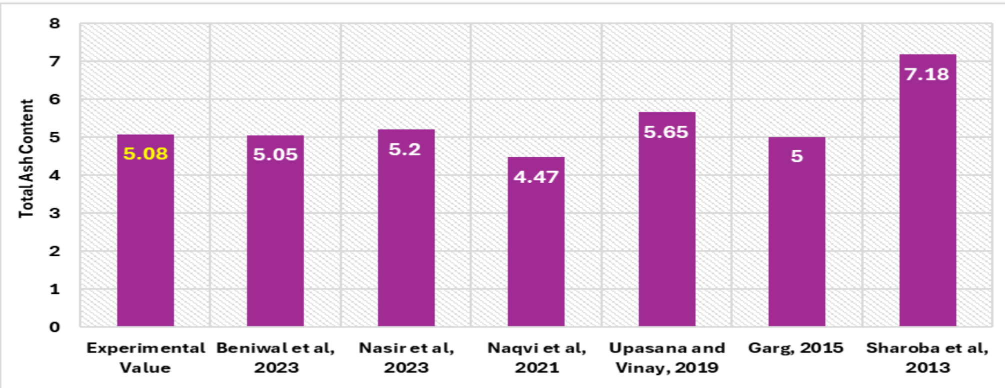

Figure 3: Total Ash Content of Green Pea Peel Flour as Compared to other Studies

Protein: Protein is a necessary component of food because it promotes muscular growth, repair, and other bodily processes. It is essential for hormone regulation, immune system support, and enzyme synthesis. Consuming enough protein promotes satiety, energy levels, and general wellness. Table 2 and figure 4 presents the protein content of the experimental green pea peel flour as well as the protein content of green pea peels as measured by other researchers. The protein content of green pea peels analyzed by other researchers ranged from 4.7 ± 0.28 (Naqvi et al, 2021) [13] to 19.80 ± 1.65 (Upasana and Vinay, 2019) [23]. The protein content of the experimental green pea peel was found to be 31.11 g/100 g, which was higher than the values reported by other researchers, suggesting that it could be a useful source of protein to mitigate protein energy malnutrition.

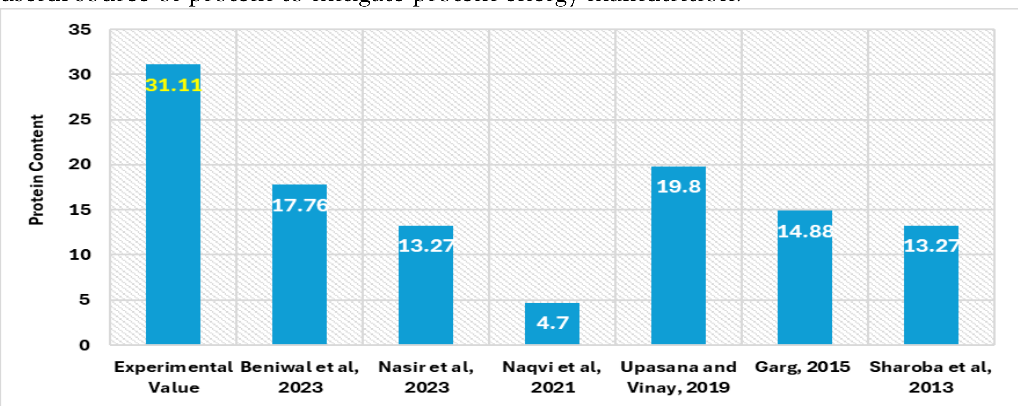

Figure 4: Protein Content of Green Pea Peel Flour as Compared to other Studies

Carbohydrate: The human body uses carbohydrates as its main energy source as they are necessary for metabolism, brain function, and general health. Table 2 and figure 5 presents the carbohydrate content of the experimental green pea peel flour as well as the carbohydrate content of green pea peels as measured by other researchers. The carbohydrate content of experimental green pea peel flour was found to be 58.18 g/100g. The highest carbohydrate content was reported by Upasana and Vinay, 2019 [23] at 72.28 and the lowest carbohydrate content was reported by Naqvi et al, 2021 [13] at 20.54 ± 4.24. Thus, it was observed that the carbohydrate content of the experimental peels was within the reported range, suggesting that the peels are a moderate source of energy, making it useful for meeting dietary energy requirements.

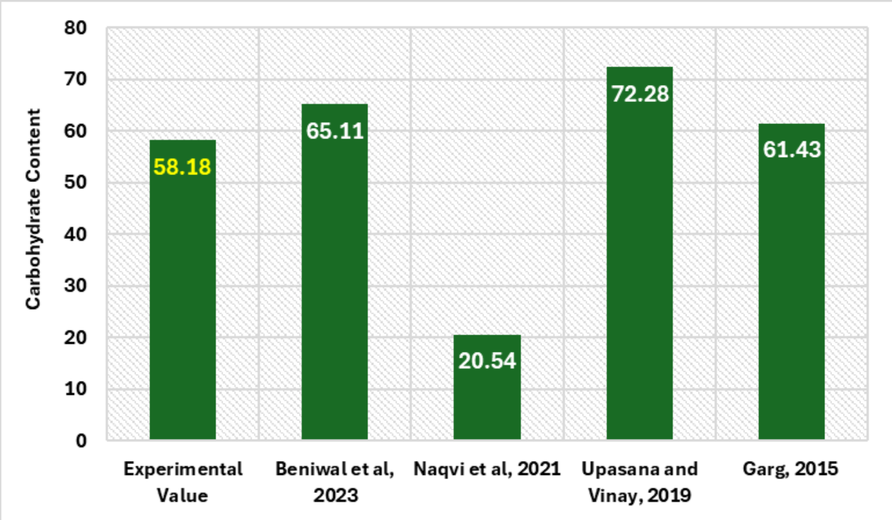

Figure 5: Carbohydrate Content of Green Pea Peel Flour as Compared to other Studies

Total Fat: Food must contain fat in order to promote hormone production, cell function, nutritional absorption, and energy storage. Table 2 and figure 6 presents the total fat content of the experimental green pea peel flour as well as the total fat content of green pea peels as measured by other researchers. The total fat content of experimental green pea peel flour was found to be 0.63 g/100g. The highest total fat content was reported by Naqvi et al, 2021 [13] at 16.5 ± 0.56 whereas the lowest total fat content was reported by Garg, 2015 [8] at 0.43 ± 0.03. Thus, it was observed that the total fat content of the experimental peels was within the reported range, indicating a low-fat composition, which makes the peels a suitable component for low-fat diets. Its low fat level makes it more appropriate for weight-loss and heart-healthy food formulations.

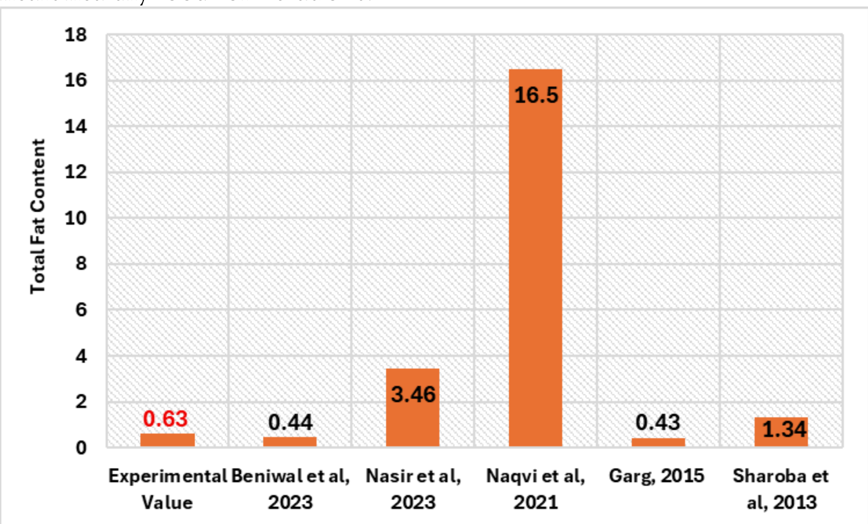

Figure 6: Total Fat Content of Green Pea Peel Flour as Compared to other Studies

Energy: Energy in food is essential for maintaining physical activity, metabolism, and other body processes. It powers vital functions like digestion, respiration, and muscle contraction. A well-balanced energy intake prevents tiredness and fosters wellbeing, supporting general health. Table 2 and figure 7 presents the energy content of the experimental green pea peel flour as well as the energy content of green pea peels as measured by other researchers. The energy content of green pea peels analyzed by other researchers ranged from 249.46 (Naqvi et al, 2021) [13] to 335.44 (Beniwal et al, 2023) [2]. The energy content of the experimental green pea peel was found to be 362.83 Kcal/100 g, which was higher than the values reported by other researchers, suggesting its potential as a nutrient – dense ingredient.

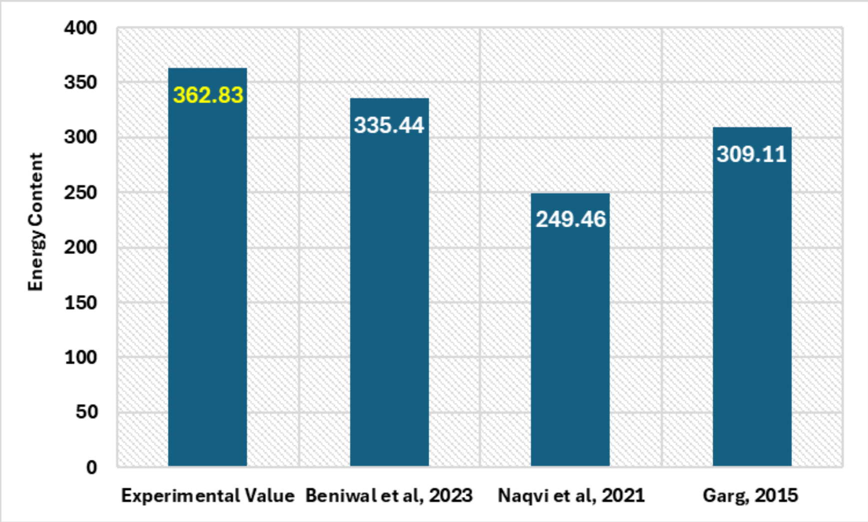

Figure 7: Energy Content of Green Pea Peel Flour as Compared to other Studies

2) Comparison of Proximate Composition of Green Pea Peel Flour with Cereals and Millet

Table 3: Proximate Composition of Green Pea Peel Flour in Comparison with Cereals and Millet

Items	Moisture (g/100g)	Total Ash (g/100g)	Protein (g/100g)	Carbohydrate (g/100g)	Total Fat (g/100g)	Energy (Kcal/100g)
Experimental Green Pea Peel Flour	**5.0**	**5.08**	**31.11**	**58.18**	**0.63**	**362.83**
Wheat flour, Refined*	11.34±0.93	0.51±0.07	10.36±0.29	74.27±0.92	0.76±0.07	351.82±4
Wheat flour, Atta*	11.10±0.35	1.28±0.19	10.57±0.37	64.17±0.32	1.53±0.12	320.27±1.6
Wheat, semolina*	8.94±0.68	0.80±0.17	11.38±0.37	68.43±0.99	0.74±0.10	333.65±4
Rice flakes*	10.36±0.53	0.85±0.13	7.44±0.35	76.75±0.96	1.14±0.11	353.73±3
Ragi*	10.89±0.61	2.04±0.34	7.16±0.63	66.82±0.73	1.92±0.14	320.75±2

Source: *: IFCT NIN 2017 [11]

Table 3 and figure 8 compares the proximate composition of experimental green pea peel flour with other cereal and millet flours. The moisture content of the experimental peels, which was 5.0 g/100g, is significantly lower than that of the cereals and millet, which varied from 8.94 ± 0.68 in semolina to 11.34 ± 0.93 g/100g in refined wheat flour, according to the table. In contrast to the cereals and millet, which had total ash ranging from 0.51 ± 0.07 in refined wheat flour to 2.04 ± 0.34 g/100g in ragi and protein ranging from 7.16 ± 0.63 in ragi to 11.38 ± 0.37 g/100g in semolina, the green pea peels had a higher total ash and protein content (5.08 and 31.11 g/100g, respectively). Green pea peels were found to have a low carbohydrate and total fat content (58.18 and 0.63 g/100g, respectively) when compared to cereals and millet, which ranged in carbohydrate from 64.17 ± 0.32 in atta to 76.75 ± 0.96 g/100g in rice flakes and in total fat from 0.74 ± 0.10 in semolina to 1.92 ± 0.14 g/100g in ragi. Green pea peels had a greater calorie content (362.83 kcal/100g) than cereals and millet, which varied from 320.27 ± 1.6 in atta to 353.73 ± 3 Kcal/100g in rice flakes. This suggests that the flour made from green pea peels is a nutrient-dense alternative that has a greater protein and mineral content, which could be employed as a healthy ingredient in food fortification.

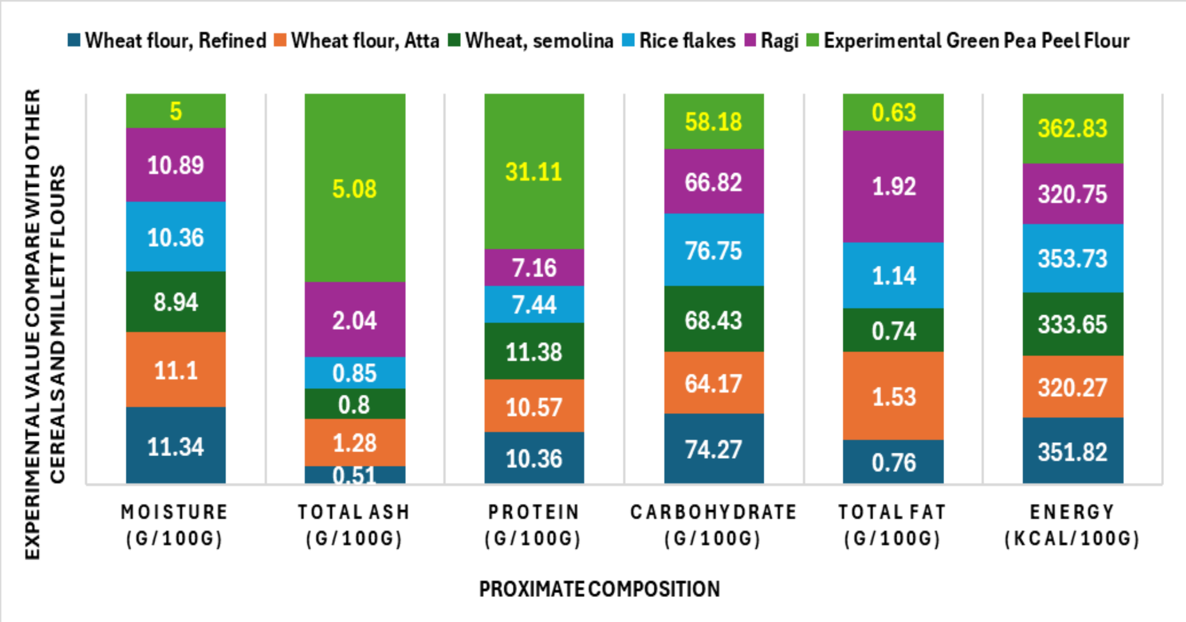

Figure 8: Comparative Statement of Proximate Composition of Green Pea Peel Flour with Cereals and Millet

3) Comparison of Proximate Composition of Green Pea Peel Flours with Other Fruits and Vegetable Peel Flours

Table 4: Proximate Composition of Green Pea Peel Flour in Comparison with Other Fruits and Vegetable Peel Flours

Items	Moisture (g/100g)	Total Ash (g/100g)	Protein (g/100g)	Carbohydrate (g/100g)	Total Fat (g/100g)	Energy (Kcal/100g)
Experimental Green Pea Peel Flour	5.0	5.08	31.11	58.18	0.63	362.83
Potato Peels [3]	5.57±0.89	5.96±0.62	11.42±1.39	64.82±3.81	1.36±0.40	317.2
Beetroot Peels [21]	30.88	10.58	4.10	44.17	3.29	222.69
Pumpkin Peels [22]	7.58±0.32	5.56±0.02	17.99±0.08	61.85±0.05	7.02±0.11	382.54±0.35
Cucumber Peels [15]	92.45±0.03	0.88±0.50	2.39±0.01	0.25±0.04	3.01±0.22	37.65
Banana Peels [19]	8.65	6.79	11.81	72.41	6.7	371.74
Orange Peels [24]	10.43±0.3	3.66±0.2	2.17±0.1	76.56±0.5	4.83±0.1	458.39
Watermelon Peels [18]	8.78±1.25	5.31±0.55	2.88±1.67	70.04±4.05	2.33±0.29	276.56±1.67

Table 4 and figure 9 compares the proximate composition of experimental green pea peel flour with other fruits and vegetable peel powders analyzed by other researchers. The table shows that the moisture content of the experimental peels, i.e. 5.0 g/100g, is much lower than the moisture content of the other peel powders which ranged from 5.57±0.89 in potato peels [3] to 92.45±0.03 in cucumber Peels [15]. The total ash content of green pea peels i.e., 5.08 g/100g was within the range of total ash content of fruit and vegetable peels reported by other researchers i.e., 0.88±0.50 in cucumber Peels [15] to 10.58 in beetroot peels [21]. The protein content of the experimental peels, i.e. 31.11 g/100g, was highest in comparison to the protein content of the other peel powders which ranged from 2.17±0.1 in orange peels [24] to 17.99±0.08 pumpkin peels [22]. The carbohydrate content of green pea peels i.e., 58.18 g/100g was within the range of carbohydrate content of fruit and vegetable peels reported by other researchers i.e., 0.25±0.04 in cucumber peels [15] to 76.56±0.5 in orange peels [24]. The total fat content of the experimental peels, i.e. 0.63 g/100g, was lowest in comparison to the total fat content of the other peel powders which ranged from 1.36±0.40 in potato peels [3] to 7.02±0.11 in pumpkin peels [22]. The energy content of green pea peels i.e., 362.83 Kcal/100g was within the range of energy content of fruit and vegetable peels reported by other researchers i.e., 222.69 in beetroot peels [21] to 458.39 in orange peels [24]. The results imply that among other fruit and vegetable peels, green pea peel flour is a low-fat and high-protein substitute and it has the potential to be used as a sustainable and nutrient-dense food ingredient.

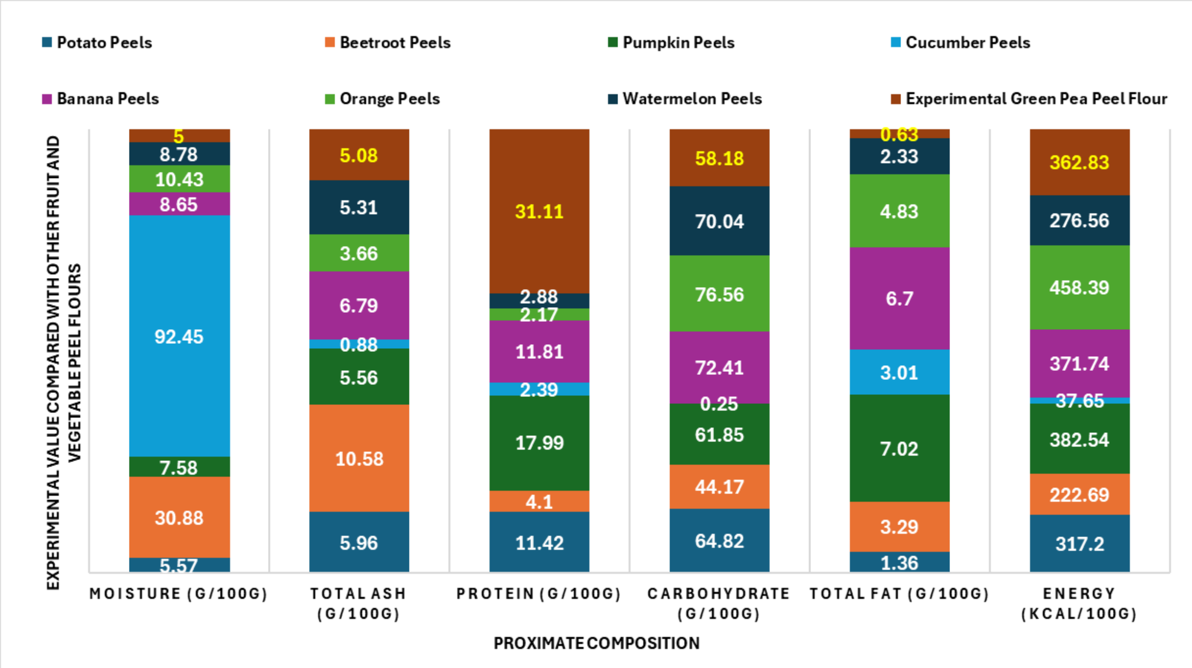

Figure 9: Comparative Statement of Proximate Composition of Green Pea Peel Flour with Other Fruits and Vegetable Peels

CONCLUSION

Pea peels, like pea grains, are an excellent source of nutrients. Pea peels are relatively low in moisture and fat and high in protein, minerals, and calories. In terms of protein and total ash content, their nutritional profile is superior to that of several traditional flours and typical fruit and vegetable peels. Owing to its great nutritional value, it may be able to significantly reduce the protein energy malnutrition that is prevalent in underdeveloped nations and can be a better option to address the sustainable development goals. These findings highlight the need to maximize the use of leftover pea peels and reevaluate their potential as a nutri-dense ingredient. Pea peels can be substituted for other ingredients to create additional-value products that are fit for human consumption. It is a viable approach for waste management that also promotes environmental sustainability. In-depth research should be carried out to find anti-nutrients, toxins and impact of various processing techniques that can be used to process and use green pea peels as a viable ingredient for food value addition. This will act as a weapon to eradicate nutritional insecurities given their potential nutritional value and ability to promote health.

Funding

The authors acknowledge the financial support provided for this work by the Higher Education Department (HED) and Odisha State Higher Education Council (OSHEC), Government of Odisha in Odisha, India, through the Mukhyamantri Research Fellowship (MRF) under the Mukhyamantri Research and Innovation Program (MRIP).

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