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CONTENTS

Nutrient-enriched wheat *chapatti* with fresh pea shells (*Pisum sativum l.): A* comprehensive quality assessment

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ABSTRACT: This study examines the possibility of improving the nutritional profile of conventional wheat *chapatti* by adding fresh pea shell paste. By incorporating 50% fresh pea shells into *chapatti* preparation, the nutritional value is enhanced as well as waste is minimized, thereby fostering sustainability. The fibrous coat of pea pods was removed, and the digestive layer was incorporated into *chapatti* recipes at levels ranging from 10% to 50%. The study findings revealed that the sensory attributes of the value-added *chapatti* received significantly higher mean scores from panelists, indicating strong preference. The nutritional profile of *chapatti* was improved with the incorporation of fresh pea shell paste. Comparative analysis revealed notable increases in protein content (from 11.74 to 12.25 gm/100gm), crude fiber (from 1.91 to 2.43 gm/100gm), and dietary fiber (from 4.76 to 6.22 gm/100gm) compared to control wheat *chapatti.* Moreover, significant enhancements were observed in magnesium and calcium levels, rising from 137.81 to 218.11 milligrams and 58.00 to 125.10 milligrams, respectively per 100gm. Conversely, the value-added *chapatti* exhibited a marked decrease in fat, energy, and carbohydrate concentrations. This study shows that value-added *chapatti* offers significantly higher nutrients compared to regular wheat *chapatti*, thereby presenting an innovative way to the enhance nutritional profile and diversify staple food options.

Key words: *Chapatti,* fresh pea shells, incorporation, nutrients, sensory, significantly

The wheat produced in India is mainly consumed in the form of *chapatti* and bakery products. *Chapatti* is among the oldest and most consumed wheat products in the world which contributes to a widespread quantity of dietary fiber consumption. *Chapatti* is prepared by kneading wheat flour with water to make dough with the addition of other ingredients such as salt and sugar as per taste requirement. Half of the world's population consumes wheat flour as a staple meal, nevertheless isn't a complete diet that lacks of micronutrients. Plant foods or by-products are wealthy sources of micronutrients that assist in reducing micronutrient deficiency in the population and those are inexpensive or locally available for growing nations. Dietary supplementation, value addition, and food fortification can be alternative routes to intake of minor plant components that can have fitness blessings (Carle *et al.,* 2001; Kiran and Neetu, 2017). Pea (*Pisum sativum*) is the vital essential vegetation of the temperate climatic region and is mainly used for animal feeding or human consumption (Mmihailvoic *et al.,* 2005). In India, approx 1 million tons of pea peel waste is generated every year, based on the total production of peas, which huge range is discarded as waste (Upasana and Vinay, 2018). The waste generated from fruits and vegetables or their by-products are excellent sources of bioactive compounds like dietary fibers, vitamins, polyphenols, and minerals which can be applied to broaden functional and supplemented foods (Sagar *et al.* 2018).

Today the concept of healthy and holistic eating is addressed by consumers. Cereal-based diets often exhibit limited micronutrient bioavailability, contributing to widespread multiple micronutrient deficiencies. (Gupta and Prakash, 2011). Food-based interventions, such as fortification, value addition, and supplementation, play a crucial role in enhancing the micronutrient status of populations. (Allen *et al.,* 2006). The traditional *chapatti* whilst organized with the aid of incorporating green leafy veggies could serve as means of enhancing the nutritive value of food. Previous studies have discovered that the pea peel is an abundant source of nutrients (Beniwal *et al.*, 2022 c,d) and that discarded pea pods can be used as a source of nutrients in biscuits, rusks, cake, breads, and instant soup preparation in powder form. Therefore, modification of conventional recipes into nutritionally wealthy recipes could help in preventing lifestyle disorders. However, the utilization of fresh pea peels in product improvement has not been investigated yet. The nutritional quality of the fresh pea shells was also evaluated to exploit their potential for application in food industries. The current study focused on incorporating fresh pea shells into *chapatti* formulation, investigating their impact on sensory evaluation and nutritional profiles, including both macro and micronutrients.

MATERIALS AND METHODS

Procurement of material and preparation of sample (Figure 1)

Fresh peas were procured from the local vegetable market of Hisar, Haryana in single lots. Pea pods were shelled, washed and dipped in sodium meta bisulphite 0.2% solution, and then dipped in hot water (60^0C) for 10 minutes. The pea shells were then outspread over filter paper to drain excess water. The inner fibrous layer was separated manually and the edible portion was chopped finely to make a paste which was then blended with wheat flour in different formulations to develop value-added *chapatti.*

Preparation of *chapatti* (Plate 1)

Wheat flour, salt, were sieved and pea shell paste was combined and thoroughly mixed. The dough was prepared by adding a small quantity of water slowly to the flour mixture. The resting period of dough was 60 minutes to optimize the dough handling and *chapatti* quality. Then dough was divided into equal portions; small balls were made and rolled out with the help of a rolling pin. *Chapatti*s were roasted on a hot griddle from both sides until golden brown. Treatments and formulation levels were as follows;

The proportion of wheat flour, fresh pea shell paste and water

Control = 100gm wheat flour + water 75ml

Type I = 80gm wheat flour + water 35ml + 20gm fresh pea shells paste

Type II = 70gm wheat flour + water 25ml + 30gm fresh pea shells paste

Type III = 60gm wheat flour + water 15ml + 40gm fresh pea shells paste

Type IV = 50gm wheat flour + water 0ml + 50gm fresh pea shells paste

Weight

The weight of a raw, cooked, or dried *chapatti* and dough was examined by a weighing balance (Table Top ASWS-10 Single Pan Balance). Weight was calculated by the difference method formula.

Weight of food (*chapatti* and dough) = Initial weight (gm)–Final weight (gm)

Sensory evaluation

Sensory evaluation was conducted by 15 semi-trained panel members from the department of Food and Nutrition, I.C. College of Home Science, CCS HAU Hisar by adopting a 9-point hedonic scale (Peryam, 1975) at room temperature (28^0C).

Nutritional evaluation

Moisture content was determined by standard method (AOAC, 2000); subjecting samples to drying in a hot air oven at 100°C for 6 hours. 5-gram portions were placed in pre-weighed petri dishes and placed in the oven. The reduction in moisture content after drying was then calculated.

$$\text{Moisture (\%)} = \frac{W2 - W3}{W2 - W1} \times 100$$

Where W_1 is the weight (gm) of the empty petri dish, W_2 is the weight of the petri dish+weight of the sample before drying (gm) and W_3 is the weight of the petri dish+weight of the dried sample (gm).

The crude protein content was assessed via the Micro Kjeldahl method (AOAC, 2000) employing the Automatic KEL PLUS CLASSIC–DX apparatus. In this procedure, a 0.2g sample was digested with 10ml of sulfuric acid and a 1g catalyst mixture until the solution reached a colorless state. Subsequently, the digested samples underwent distillation in a distillation unit containing 40% NaOH, 4% boric acid, and a mixed indicator (a few drops). The distilled sample was then titrated with 0.1N HCl until a slight pinkish color change was observed.

$$\text{(Nitrogen \%)} = \frac{\text{(sample titrate} - \text{blank titrate)} \times \text{normality of HCl x 14}}{\text{Sample weight (gm)} \times 1000} \times 100$$

Crude protein= 6.25 (conversion factor) × Nitrogen %

Crude fat content was analyzed according to the AOAC (2000) standard method, utilizing an automated extraction apparatus (Automatic SOCS plus) and a solvent (petroleum ether). Two grams of the sample were placed in thimbles and extracted for 1 hour and 30 minutes with petroleum ether in the apparatus, yielding extracts collected in pre-weighed beakers. The beakers were then removed, dried overnight at 100°C in a hot air oven, and subsequently cooled in a desiccator until a constant weight was achieved. The difference between the initial and final weights determined the amount of ether extract in the sample.

$$\text{Fat (\%)} = \frac{W2 - W1}{W} \times 100$$

Where W is the weight (gm) of sample weight, W_1 is the weight (gm) of empty beaker, and W_2 is the weight (gm) of beaker with fat.

The ash content was determined using the standard AOAC (2000) method, which involved ashing in an electric muffle furnace at a temperature range of 550-650°C for 6 hours until a constant weight is achieved. A two-gram sample is placed in a pre-weighed crucible for charring and then subjected to the muffle furnace. After ashing, the crucible is removed, cooled in a desiccator, and weighed to determine the ash content.

$$\text{Ash (\%)} = \frac{W2 - W3}{W2 - W1} \times 100$$

W_1 is the weight of empty silica crucible (gm), W_2 is the weight of sample+weight of crucible before ashing (gm), and W_3 is the weight of sample+weight of crucible after ashing (gm).

The crude fiber content was determined following the AOAC (2000) method. Initially, a defatted sample (using petroleum ether) was digested with 1.25% H_2SO_4 followed by 1.25% NaOH under bulb condensers, boiling for 30 minutes. The sample underwent washing steps with distilled water (2 times), alcohol (2 times), and acetone (3 times). Subsequently, the sample was dried at 100°C and ashed for 1 hour at 550°C in a muffle furnace. The fiber content was then calculated based on the weight remaining after ignition and expressed relative to the initial sample weight.

$$\text{Calculation: (\%)Crude Fiber} = \frac{W2 - W3}{W1} \times 100$$

W_1 is the weight of sample (gm), W_2 weight of the insoluble matter (crucible weight+insoluble matter–crucible weight) (gm), and W_3 is the weight of ash (crucible+ash–wt. of crucible) (gm).

The total carbohydrate content (%) was determined using the difference method as outlined by Das *et al.* (2015). Calculation: Total carbohydrate (%) = 100 – [(%) moisture + (%) crude protein + (%) crude fat + (%) crude fiber + (%) total ash]

The energy (caloric value) was estimated following the calculation method proposed by James (1990), which involves summing the products of protein, carbohydrate, and fat percentages multiplied by specific factors. Calculation: Energy (kcal/g) = Protein (%) × 4 + Carbohydrate (%) × 4 + Fat (%) × 9

Dietary fiber content (total, insoluble, and soluble) in the samples was assessed according to the method outlined by Furda (1981). The procedure involved digesting the defatted sample in 0.005N HCl, boiling for 20 minutes, adding EDTA, and calibrating the pH to a range of 5.0 to 6.5. The sample was then extracted at 60°C for 40 minutes (maintaining pH between 6.0 to 6.5), followed by cooling the suspension to 20 to 30°C and adding 10 mg of enzymes (bacterial protease and alpha-amylase). The suspension was filtered through a coarse tared gooch crucible and washed with distilled water, alcohol, and acetone before drying at 70°C for 24 hours. The soluble residue was acidified with HCl to achieve pH 2-3, followed by the addition of ethanol (4 volumes) and allowing the suspension to stand for 1 hour. Subsequently, the washing steps were repeated for the insoluble residue. The calculation for total dietary fiber (TDF), insoluble dietary fiber (IDF), and soluble dietary fiber (SDF) was performed as follows: TDF = IDF + SDF.

Total minerals were determined following the method described by Lindsey and Norwell (1969) utilizing an atomic absorption spectrophotometer

2380 (PERKIN-ELMER, USA). The samples were digested with a di-acid mixture of $HClO_4$:HNO_3 in a 1:5 (v/v) ratio and left overnight. Subsequently, the samples were heated on a hot plate until clear, with visible white precipitates on the surface of a conical flask. Crystal filtration was carried out using Whatman filter paper (42) and distilled water, and the volume was adjusted to 50 ml with double-distilled water for the estimation of total mineral content in the samples. Readings were then taken using the spectrophotometer, flame photometer, and titration method. The calculation for mineral content (mg/100g) was performed as follows:

Calculation=

$$\text{Minerals (mg/100g)} = \frac{\text{Reading (concentration } \mu g/ml) \times \text{volume made}}{\text{sample weight (gm)} \times 1000} \times 100$$

Statistical analysis

The obtained data was subjected to analysis of variance (ANOVA) following the statistical method described by Sheoran and Pannu (1999) to determine the significance ($p < 0.05$) of the test, the standard error of the mean, and the critical differences between treatments. Three replicates were used for each experiment, employing a completely randomized design to assess various sensorial and nutritional attributes. Hypothesis: Null Hypothesis (H0): ¼ = ¼0, In this scenario, it is assumed that the sensory and nutritional attributes of the *chapatti* will remain the same when fresh pea shell paste replaces wheat flour in the formulation. Alternative Hypothesis (Ha): For a one-tailed test: ¼ < ¼0 or ¼ > ¼0, this suggests that the sensory and nutritional attributes of the *chapatti* will either be greater or smaller than those of the control when fresh pea shell paste is used instead of wheat flour. For a two-tailed test: ¼ "" ¼0, this implies that the sensory and nutritional attributes of the *chapatti* will differ from those of the control when fresh pea shell paste is substituted for wheat flour.

RESULTS AND DISCUSSION

Observations

The trials were conducted with different levels of incorporation (fresh pea shells) for *chapatti* preparation. The total weight (Table 1) of dough, cooked and dry *chapatti* was decreased as the fresh pea shells paste increased in *chapatti*, which may be due to the high moisture content of fresh pea shells. The water requirement, no. of *chapatti,* and cost were also decreased in supplemented *chapattis.* These findings indicated that the economics and production characteristics of *chapatti* were significantly influenced by the type of flour used. Even though Type IV flour was the least expensive, it produced dough with lower moisture content, thereby lowering the cooked weight and producing fewer *chapattis*. On the other side, type I flour has a better yield but a higher price. Based on certain criteria including price, desired *chapatti* features, and manufacturing effectiveness, the choice of flour was made.

Sensory evaluations

The sensory characteristics (Table 2) evaluated by the panel of judges revealed that the appearance, taste, colour score improved with the incremental addition of fresh pea shell paste in *chapatti*. All types of *chapatti* were found to be organoleptically acceptable being in "like very much" range from 7.62 to 7.94 and supplemented *chapatti* got the higher mean scores than control. Type II *chapatti* got the highest score for colour (8.00) or texture (8.00) while the lowest score was attained by type IV for aroma (7.60) or taste (7.30). The appearance (8.00) and aroma (8.00) mean scores were highest in type I *chapatti* compared to control and other treatments. The sensory score overall increased in the order of Type IV>control>Type III>Type I>Type II. A typical wheaty aroma was desirable for *chapatti* which was found in control wheat *chapatti,* but at the highest level (50%) of incorporation of fresh pea shells, it became bland. Current study results are in agreement with studies reported by Pandey *et al.* (2017), Tongbram *et al.* (2020), Laminu *et al.* (2020), and Kadam *et al.* (2012) who developed *chapatti* with multi-grains, composite flour, bengal gram, and other ingredients revealed that the scores of various sensory attributes increased. The pea pod powder incorporated in biscuits soup, and cake improved the sensory quality (Garg, 2015, Hanan *et al.,* 2020, Beniwal *et al.*, 2024, Fendri *et al.*, 2016). The fresh

Table 1: Cooking observation of *chapatti*

Observation	Control	Type I	Type II	Type IIII	Type IV
Total wt. of dough	169g	139g	126g	113g	96g
Water req.	75ml	35ml	25ml	15ml	-
Wt. of one dough	42g	35g	42g	38g	47g
No. of *chapattis*	4	4	3	3	2
Total cooked weight	154.8g	126g	110.78g	96g	78g
Cooked wt. of one *chapatti*	43g	42g	41g	40g	39g
Loss of wt. after making *chapatti*	14.2g	13g	15.3g	17g	18g
Cost of wheat flour(rupees)	3 .00	2.50	2.00	1.80	1.50
Dry weight	113.26g	89.85g	77.03g	63.76g	50.18g

Control = wheat flour (100%), Type I = (80% wheat flour +20% fresh pea shell paste), Type II = (70% wheat flour + 30% fresh pea shell paste), Type III = (60% wheat flour + 40% fresh pea shell paste), Type IV = (50% wheat flour + 50% fresh pea shell paste), wt. – weight

Table 2: Mean scores of sensory characteristics of *Chapatti*

	Sensory characteristics					
Product	Colour	Appearance	Aroma	Texture	Taste	Overall Acceptability
Chapatti						
	Scores					
Control	7.60±0.16	7.90±0.10	7.90±0.10	7.90±0.10	7.90±0.10	7.86±0.07
Type I	7.60±0.16	8.00±0.00*	8.00±0.00*	7.90±0.10	8.00±0.00*	7.90±0.05
Type II	8.00±0.00*	7.90±0.10	7.90±0.10	8.00±0.00*	7.90±0.10	7.94±0.06*
Type III	7.90±0.18	7.80±0.13	7.90±0.18	7.90±0.18	7.90±0.18	7.88±0.17
Type IV	7.70±0.15	7.80±0.13	7.60±0.22	7.70±0.15	7.30±0.26	7.62±0.14

Values are mean ± SE of 15 independent observations, Control = wheat flour (100%), Type I = (80% wheat flour 20%fresh pea shells paste), Type II = (70% wheat flour + 30% fresh pea shells paste), Type III = (60% wheat flour + 40% fresh pea shells paste), Type IV = (50% wheat flour + 50% fresh pea shells paste)

Table 3: Proximate compositions of *Chapatti* (% dry weight basis)

Product	Proximate composition						
Chapatti	Moisture*	Crude protein	Fat	Crude fiber	Ash	Total CHO	Energy(kcal/100g)
Control	26.83±0.23	11.74±0.05	3.19±0.01	1.91±0.04	2.97±0.02	72.92±0.19	367.36±2.37
Type I	28.60±0.36	11.88±0.05	3.13±0.02	2.05±0.03	3.03±0.02	71.76±0.19	362.73±2.31
Type II	30.47±0.34	11.91±0.05	3.11±0.02	2.15±0.03	3.05±0.02	70.14±0.25	356.14±2.89
Type III	33.58±0.39	12.06±0.04	3.03±0.03	2.28±0.04	3.11±0.02	68.41±0.26	347.72±1.91
Type IV	35.65±0.73	12.25±0.03	2.95±0.02	2.43±0.02	3.16±0.02	66.41±0.24	341.17±2.32
CD ($P \leq 0.05$)	1.69	0.14	0.06	0.10	0.06	0.73	7.58

Values are mean±SE of three independent determinations, Control = wheat flour (100%), Type I = (80% wheat flour +20% fresh pea shell paste), Type II = (70% wheat flour + 30% fresh pea shell paste), Type III = (60% wheat flour + 40% fresh pea shell paste), Type IV = (50% wheat flour + 50% fresh pea shell paste)

pea peels used in the preparation of *tikki,* cutlet, dry vegetables, cakes (Beniwal *et al.*, 2022 e, b, a, Beniwal *et al.* 2024) increased the sensory and colour score due to the presence of natural phytochemicals (Zang *et al.*, 2021). The findings of this study revealed that fresh pea shells impact the sensory attributes of the chapattis, enhancing their taste. This stimulation of taste buds triggers the secretion of digestive juices, creating a pleasurable eating experience and indicating a heightened enjoyment of the food.

Nutritional Composition

Proximate Composition

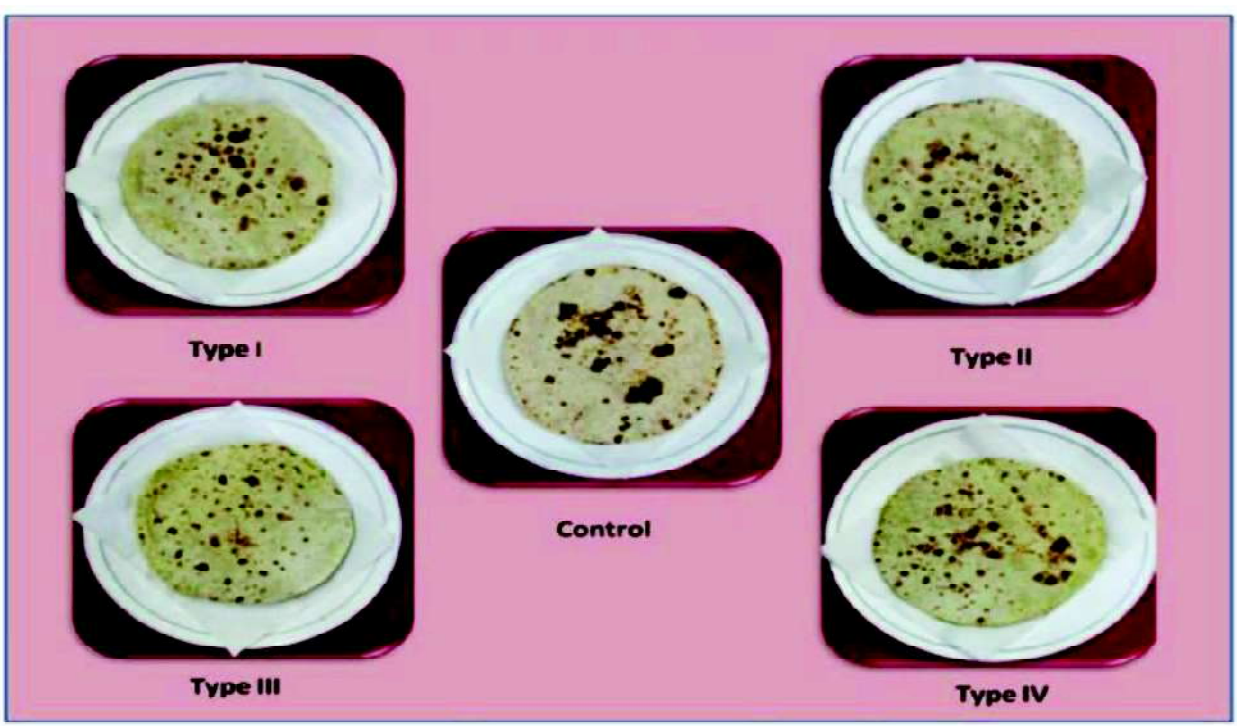
The nutritional analysis revealed that there was significant ($p<0.05$) difference in the value of moisture (26.83 to 35.65%), crude protein (11.74 to 12.25%), fat (3.19 to 2.95%), crude fiber (1.91 to

Table 4: Dietary fiber content of *Chapatti* (% dry weight basis)

Product	Dietary fiber		
Chapatti	Total dietary fiber	Insoluble dietary fiber	Soluble dietary fiber
Control	4.76±0.05	3.86±0.05	0.90±0.03
Type I	5.17±0.07	4.19±0.09	0.98±0.02
Type II	5.41±0.09	4.39±0.08	1.02±0.02
Type III	5.73±0.12	4.65±0.08	1.09±0.02
Type IV	6.22±0.10	5.04±0.08	1.18±0.01
CD (P≤0.05)	0.28	0.24	0.07

Values are mean ± SE of three independent determinations, Control = wheat flour (100%), Type I = (80% wheat flour +20% fresh pea shell paste), Type II = (70% wheat flour + 30% fresh pea shell paste), Type III = (60% wheat flour + 40% fresh pea shell paste), Type IV = (50% wheat flour + 50% fresh pea shell paste)

2.95%), ash 2.97 to 3.16%), energy (367.36 to 341.17 kcal/100gm) and carbohydrate (72.92 to 66.41%) content in all developed *chapatti* (Table 3). A significant decrease in fat, carbohydrate, or energy content and a significant increase in crude protein, crude fiber, and ash content in order of control>Type I>Type II>Type>III>Type IV can be attributed to the gradual replacement of wheat flour by fresh pea shells paste. A non-significant difference in protein and fat content was noticed in type I and type II *chapatti.* Within the *chapatti* for their energy content, a non-significant difference was observed in control and type I or type I and type II. The results of the current study are consistent with the previous finding of Pandey *et al.* (2017), Laminu *et al.* (2020), Kadam *et al.* (2012), Waseem *et al.* (2021), Seleem and Omran (2014) who developed *chapatti* with multi-grains, composite flour, bengal gram, spinach powder, bean flour, and other ingredients revealed that the moisture (8.41 to 8.8%), protein (9.88 to 15.98%), ash (1.43 to 2.05%), fiber (0.43 to 4.05%) content increased and fat (3.95 to 1.5%), energy (347.36 to 357.22), carbohydrate (78.35 to 65.99%) content decreased. The findings align with other studies indicating that incorporating pea pod powder or fresh pea shells significantly enhances nutrient content in crackers and biscuits soup, cake, *tikki*, cutlet, dry vegetables, cakes (Mousa *et. al.,* 2021, Hanan *et al.*, 2020, Beniwal *et al.*, 2022 a, b, e, and Beniwal *et al.,* 2024) The incorporation of non-wheat flours from different cereals improved the nutritional quality of the flour (Koletta *et al.*, 2014).



Chapatti

Table 5: Total mineral content of *Chapatti (*mg/100g, dry weight basis)

Product	Total minerals						
Chapatti	Calcium	Iron	Zinc	Magnesium	Potassium	Sodium	Manganese
Control	58.00±1.53	4.34±0.05	2.73±0.04	137.81±2.03	303.33±4.41	22.17±0.48	2.24±0.03
Type I	77.30±1.16	4.50±0.02	2.74±0.02	160.10±1.73	322.72±4.04	22.80±0.40	2.20±0.05
Type II	87.80±1.15	4.59±0.02	2.75±0.03	173.49±2.89	334.00±4.04	23.00±0.48	2.17±0.05
Type III	102.70±1.16	4.72±0.04	2.76±0.02	191.34±2.89	349.50±4.62	23.50±0.50	2.14±0.08
Type IV	125.10±1.73	4.91±0.04	2.78±0.01	218.11±2.89	372.75±4.91	24.30±0.51	2.09±0.06
CD ($P \leq 0.05$)	4.36	0.12	NS	8.09	14.10	1.54	NS

Values are mean±SE of three independent determinations, Control = wheat flour (100%), Type I = (80% wheat flour +20% fresh pea shell paste), Type II = (70% wheat flour + 30% fresh pea shell paste), Type III = (60% wheat flour + 40% fresh pea shell paste), Type IV = (50% wheat flour + 50% fresh pea shell paste)

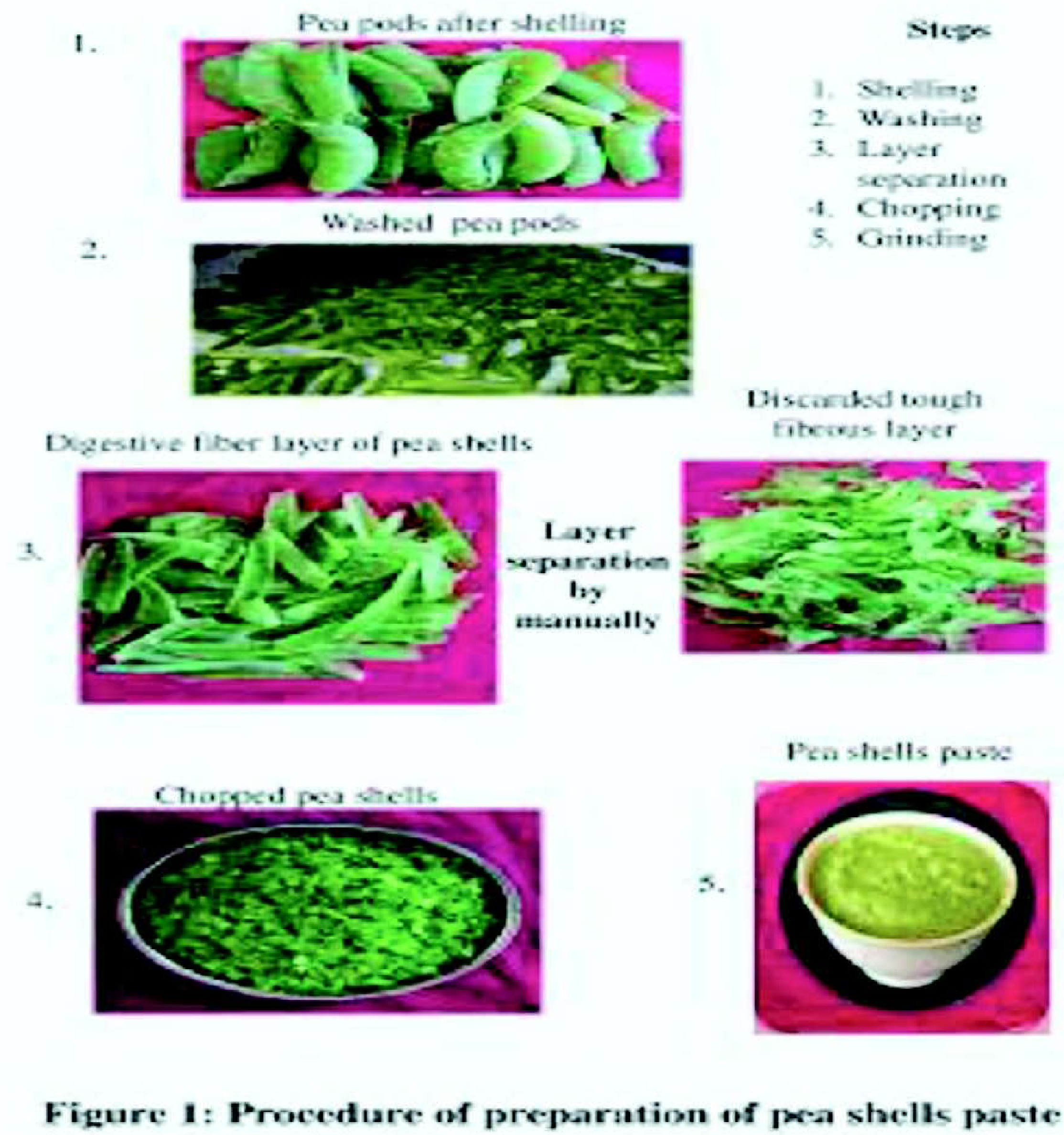


Figure 1: Procedure of preparation of pea shells paste

Dietary fiber

The finding of the study showed (Table 4) that the addition of fresh pea shells brought about a significant increase in total (4.77 to 6.22%), insoluble (3.86 to 5.04%), and soluble (0.90 to 1.18%) dietary fiber content in *chapatti* compared to control. A non-significant difference was observed between type I and type II *chapatti*. Fresh pea shells are a good source of dietary fiber as the soluble and insoluble forms contains 23.81 gm of dietary fiber (Beniwal *et al.*, 2022 c). Incorporating fresh pea shells into *tikkis*, cutlets, and dry vegetables has been shown to increase dietary fiber content, consistent with findings reported by Beniwal *et al.* (2022 e, b, a) . The plants are precise resources of dietary fiber and pea fiber has 3 times more binding water capacity (Ramulu and Udayasekhararao, 1997; Slavin, 2013).

Total minerals

The mineral analysis elucidates (Table 5) that *chapatti* supplemented with fresh pea shell paste improved the quality of *chapatti* and significantly increased all minerals e.g. calcium (58 to 125.1mg/100g), iron (4.34 to 4.91mg/100g), potassium (303.33 to 372.27mg/100g), magnesium (137.81 to 218.11mg/100g) and sodium (22.17 to 24.30mg/100g) content when compared to their control. A non-significant difference existed in zinc and manganese content in all *chapattis* while type I and type II *chapatti* also showed a non-significant difference in iron and potassium content. The calcium content increased two times in supplemented *chapatti.* The previous literature supported the present result reported by Pandey *et al.* (2017), Tongbram *et al.* (2020), Kadam *et al.* (2012), Waseem *et al.* (2021), and Khan *et al.* (2005) who stated that incorporation of other ingredients for value addition in *chapatti* increase the mineral content. The results conform with the other studies that pea pod powder or fresh pea shell incorporation increases the minerals significantly in biscuits, soup, *tikki,* cutlet· dry vegetables, cakes (Garg, 2015; Hana *et al.*, 2020; Beniwal *et al.*, 2022 e, b, a and Beniwal *et al.,* 2024)). The literature indicates that peas and their peels are rich sources of nutrients, including vitamins and minerals (Robinson *et al.*, 2019). Additionally, they are naturally low in phytic acid (Warkentin, 2020), making them suitable for biofortification. This makes them a potential hidden solution for addressing nutrient deficiencies and benefiting individuals with lifestyle-related diseases.

CONCLUSION

The results of this study conclusively show that the addition of fresh pea shells to *chapatti* formulation results in a significant improvement in sensory qualities and nutritional composition. This addition offers a practical and healthy substitute for wheat *chapatti* that is typically made, and it confers a wide range of health benefits. Increased levels of vital nutrients including protein, fiber, calcium, and magnesium are present in the enhanced *chapatti* type, while the amount of carbohydrates, lipids, and overall energy content is decreased. The obvious presence of these essential elements in pea shells highlights their potential to have a favorable effect on human health when eaten. This study emphasizes the critical contribution that traditional recipes with added value can play in reducing protein-energy malnutrition, especially in underdeveloped areas. Promoting and encouraging these value-added methods has the potential to improve public health outcomes by enhancing the nutritional profile of everyday meals.

Limitation of study

The research offers helpful information on using fresh pea shells in making *chapattis*, but there are some important aspects to keep in mind. The sensory evaluations can be subjective and vary based on personal preferences, which could affect how widely the results can be applied. The findings of the study might be affected by the specific types of wheat and pea shells used, making it harder to generalize the results to other varieties or regions.

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