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Chemical Constituents (Proximate, Minerals, Bioactive Compounds) of Pea [*Pisum sativum* (L.)] Shells

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ABSTRACT

Background: Peas are preserved by freezing in pea processing industries because of seasonal limitations; there is a vast amount of pea peels as solid waste generated. Now days, the nutritional and techno-functional properties of by-products play an important role in the development of functional and enriched products in the food sector. The current study aim to analyze the nutrients content in pea shells. The result suggests pea shells can be used for value-addition in products and presence of antioxidant in pea shell powder indicates a better health effect if consumed.

Methods: In this laboratory investigation during 2017-2018 peas were collected from market a single lot and analyzed for chemical constituents. In this connection, a fibrous coat of pea shells was separated, dried and prepared powder to perform nutritional analysis.

Result: The study result indicates that pea shells have high nutritive value, *e.g.* protein (17.76%), total dietary fiber (21.04%), calcium (803.33 mg/100 g), iron (10.70 mg/100 g), potassium (1078.75 mg/100 g), magnesium (1029.55 mg/100 g) and bioactive compounds. Fresh pea shells have higher antioxidant activity (91%) compared to powder (86%). The total phenols, vitamin C and β-carotene strongly correlated with antioxidant activity. During the storage study, total phenols and antioxidant activity significantly decreased while on 90 days it was increased.

Key words: Antioxidants, Bioactive, Nutrients, Pea shells, β-carotene.

INTRODUCTION

The production of peas at the world level, India is the second producer (4 million tons/annum) after china, which contributed 22.9% (FAOSTAT 2019). In India pea (*Pisum sativum*) is growing as a vegetable in different states due to suitable climate zone (winter) and fulfilling the aim of human and animal feed consumption (Mmihailvoic *et al*. 2005). The peel of seed is not pea peel waste; the outer covering is considered as a waste. India's yearly generated more than 1 million tons of pea peel is discarded as waste or use an animal feed (Upasana and Vinay, 2018). Due to the seasonal and perishable nature of peas, their accessibility is short, which generates the demand for its preservation (Garg *et al.* 2014). Now a days, the nutritional and techno-functional properties of by-products (fruits and vegetables) play an important role in the development of functional and enriched products in the food sector because they are promising sources of functional and bioactive compounds (Sagar *et al.* 2018) and due to antioxidant and anti-germicide properties, traditionally used as a remedy to prevent various degenerative diseases. An alternative path for consumption of plants components (fiber-rich) are the value addition of food, dietary supplementation and fortification will not boost the nutritional status but provide health benefits to peoples (Kiran, 2017). Plant proteins, primarily originating from industrial by-products, have gained attention in recent researches and also more demand for pulses and cereals having phenols content. Drying is an essential method to preserve of agricultural products, reducing their bulk and ensuring better shelf life. Pea pods have a good amount of moisture, so its storage is difficult (Garg, 2015). Pea shells can be dehydrated without much quality deterioration and can be utilized a nutrient rich mix for product development. Based on experiment we propose that pea by-products hold many biologically active compounds which attain value addition or supplementation of products for nutraceutical use. The present investigation aims to prepare pea shells powder, analyzed nutritional properties and develop value-added products.

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MATERIALS AND METHODS

This study was performed in 2018 in February at the Food and nutrition department, College of Home Science, CCS HAU, Hisar, Haryana.

Procurement of material

Fresh peas were obtained from the vegetable market, Hisar, Haryana, India in single lots.

Preparation of samples (Fig 1)

Fresh pea pods shelled and drenched under tap water to remove dirt and impurities. After that, pods were dipped in hot water (60°C for 10 minutes) and outspread over filter paper sheets to drain excess water. Separated the layer manually, chopped finely (edible layer) and firstly dehydrated in shadow (12 hours) at ambient temperature, after that, oven drying (24 hours, 45°C). The dried shells were ground to make a fine powder (sieve size 420 microns) and stored (22±2°C) in air-tight plastic bags for the next step.

Table 1: Nutrients composition of pea shells.

Parameter	Fresh pea shells	Pea shells powder
	Proximate (%)	
Moisture	88.47±0.74	3.89±0.02
Crude Protein	2.05±0.01	17.76±0.32
Fat	0.05±0.01	0.44±0.03
Ash	0.58±0.01	5.05±0.04
Crude fiber	0.89±0.06	7.76±0.18
Total carbohydrates	7.58±0.38	65.11±0.64
Energy (kcal/100 gm)	38.68±0.12	335.43±1.24
	Dietary fiber (%)	
Total dietary fiber	2.43±0.06	21.04±0.62
Insoluble dietary fiber	1.96±0.02	17.03±0.14
Soluble dietary fiber	0.46±0.04	4.00±0.10
	Protein fractions (%)	
Albumin	2.99±0.07	25.97±0.86
Globulin	1.78±0.04	15.41±0.43
Prolamin	0.54±0.02	4.71±0.14
Glutelin	0.48±0.01	4.13±0.08
	Total minerals (mg/100g)	
Calcium	92.62±0.88	803.33±8.82
Iron	1.27±0.03	10.70±0.31
Zinc	0.38±0.01	3.28±0.12
Magnesium	118.71±0.76	1,029.55±7.59
Potassium	124.38±1.44	1,078.75±14.43
Sodium	5.45±0.13	47.37±1.32
Manganese	0.07±0.02	0.59±0.06

Data represent mean±standard error (S.E) of three variable values (independently).

Methods

Nutritional evaluation of pea shells

Fresh pea shells and powder were analyzed for the nutrients content (samples were performed in triplicates).

Proximate composition (moisture, crude protein, crude fat, ash, crude fiber) examined by the standard methods (AOAC 2000) and total carbohydrate and energy calculated by difference and multiplication method. Protein fractions examined by Naik (1968) modified version of Osborne (1907) method, dietary fiber (Total, insoluble and soluble) determined by Furda (1981) and total Minerals investigated by Lindsey and Norwell (1969), method by atomic absorption spectro photometer 2380, (PERKIN-ELMER, USA) digested (acid) samples. Bioactive compounds (Total phenolic content by Zhishen *et al.* 1999, Total Flavonoids by Singleton and Rossi (1965), Antioxidant activity by Brand-william *et al.* 1995), Vitamin C and β-carotene performed by AOAC (2000) method.

Storage study

Pea shells powder were stored at room temperature (22±3°C) for 90 days and analyzed moisture, total phenols, flavonoids and antioxidant activity.

Statistical analysis

Data analyzed by using standard statistical methods ANOVA (CRD) and interpretation presented through average and standard error. The significant ($p<0.05$) proved by C.D. value (Sheoran and Pannu 1999).

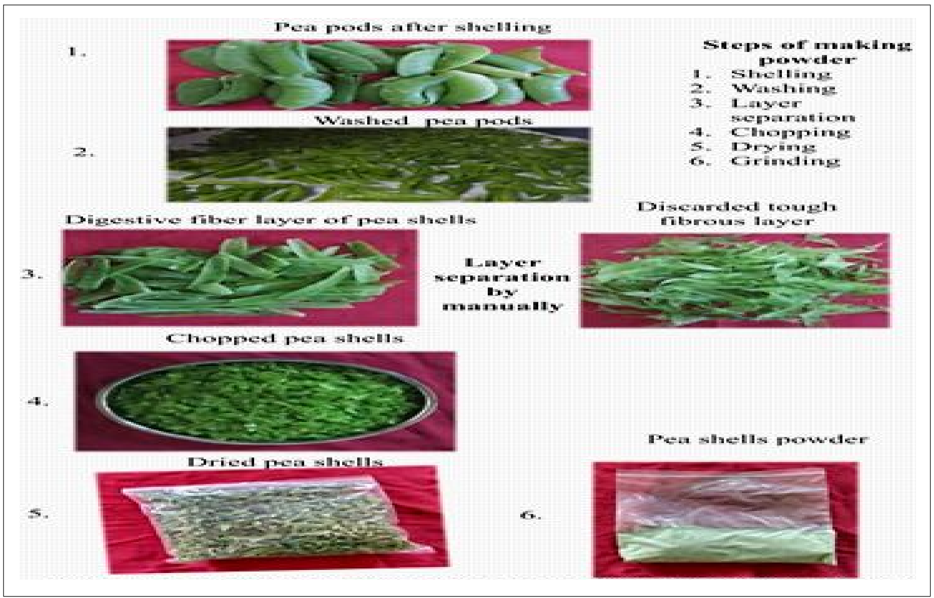

Fig 1: Procedure of preparation of pea shells powder.

RESULTS AND DISCUSSION

Nutritional parameters of pea shells

The pea shells finding of proximate composition conferred in Table 1. Almost similar results regarding moisture content (88.47%) in pea shells were reported by Krimat *et al.* 2021 (87.79%) and Upasana *et al*. (2018) reported lower moisture (83.41%) content. A higher and lesser amount of moisture in pea shells powder reported by Hanan *et al.* (2020) (10%) in green pea pods. Protein content in present study reported 17.76 gm/100 gm, whereas a higher protein (19.79, 18.29 gm/100 gm) content in pea shells powder was recorded by Upasana *et al*. (2018), Rathore *et al.* (2021) in chickpea and lower amount of protein content was noticed by Garg (2015) (14.8%) and Hanan *et al.* (2020) (11.99%) compared to present study. Almost similar results in appreciate to fats (0.43%) content were by Garg *et al.* (2015). A higher fat content (1.34%) noticed in green pea peels by Fendri *et al*. 2016 (0.87%) and 3.88% Hanan *et al.* 2020. Similar results of ash (5.04%) content reported by Garg (2015) (5.0%) and Upasana *et al*. 2018 (5.65%) in pea peel. A higher value noticed by Aparicio *et al*. 2010 (6.6 gm/100 gm) and another study addressed by Hanan *et al.* (2020) reported lower amount of ash content 4.61% compared to present study. Crude fiber content (7.76%) in pea shells powder are close proximity (7.86%) reported by Garg (2015). The lower values for carbohydrates reported by Garg (2015) (61.43%) than present investigation (65.11%) and a higher value reported by Hanan *et al.* 2020 (69.5%). Garg (2015) reported 309.11 kcal/100 gm energy content, whereas 335.43 kcal/100 gm found in pea pod powder present study. On the contrary, Bakshi and Wadhwa (2013) reported a higher concentration of albumin (59.3%) followed by glutelin (17.8%), globulin (15.6%) and prolamin (7.3%) when compared to present results. Lu *et al.* 2020 reported 3-5% (prolamin and glutelin) protein fractions. The dietary fibers with the amount, 21.04%, 17.03% and 4.01% total, insoluble and soluble content, respectively found in present study. Aparicio *et al.* (2010) reported contradicting results with a high amount of dietary fiber content 58.6%, 54.4% and 4.2% respectively. Hanan *et al.* (2020) found that insoluble and soluble content in pea pods powder was 25.04% and 11.08%. Rudra *et al.* (2020) reported that the lesser amount of fiber content in plant sample due to exclusion of the parchment layer with the intention to gain non-disruptive fibrous materials. In the present study, calcium content was found 803.33 mg/100 gm in pea shells powder. Almost similar results reported 0.83 gm/100 gm calcium in pea pods powder by Garg (2015) but a lower amount of calcium (0.77 gm/100 gm) and iron (1.20 mg/100 g) content in pea pods was revealed by Aparicio *et al.* (2010) and Bakshi and Wadhwa, 2013 (0.39%). Inside the present investigation, potassium content discovered 1078.75 mg/100 gm in pea shells powder comparable to 1.03 gm/100 gm potassium content of pea pods reported by Aparicio *et al.* (2010) and Bakshi and Wadhwa 2013 (0.80%). Pea shells powder had 1029.55, 47.37, 10.70, 3.28 and 0.59 mg/100 gm magnesium, sodium, iron, zinc and manganese content respectively. Aparicio *et al*. (2010) reported a contradictory results of minerals *i.e.* magnesium (0.21 gm/100 g), sodium (0.14 gm/ 100 g), iron, zinc and manganese as 1.20, 0.27 and 0.06 mg/100 g, respectively. Bakshi and Wadhwa (2013) reported that the peas by-products containing minerals like magnesium (0.22%), sodium, Iron, zinc and manganese content were 189.0, 9.0, 27.58 and 18.4 (ppm) per 100 gm, respectively. Hanan *et al.* 2020 reported a lower amount (2.66 mg/100 gm) of iron in pea pods powder.

Bioactive compounds in pea shells

From the existing investigation (Table 2) it was found that the quantity of total phenols in fresh and pea shells powder was 36.46 and 304.62 mg GAE/100 g, respectively which was higher compared to the values (62.5 mg/100 gm) noted by by Hadrich *et al.* (2014) in dry pea pods. The concentration of phenols depends upon the kind of seeds variety. The flavonoids content was found to be 7.3 and 24.44 mg RE/100 gm in fresh and pea shells powder in existing experiments. Flavonoids amount in ethyle acetyate and methanol extraction were 22 and 3.5 mg QE/100 gm as reported by Hadrich *et al.* (2014). The antioxidant activity (FRAP) observed in present study was 133.33 and 1000.00 mgTE/100 gm in fresh pea shells and powder, respectively. The antioxidant activity (DPPH) was 2,595.69 and 2468.0 mg TE/100 gm in fresh pea shells and powder in present study. Hadrich *et al.* (2014) reported 650 µg/ml (methanol) and 350 µg/ml (ethyl acetate) in extract of pea pods. The percent of inhibition (DPPH) was 91.05% in present study

Table 2: Bioactive compounds in pea shells.

Bioactive compounds	Fresh pea shells	Pea shells powder
Total phenols (mgGAE/100 gm	36.46±1.35	304.62±3.75
Flavonoids (mgRE/100 gm)	7.30±0.49	24.44±1.32
FRAP (mgTE/100 gm)	133.33±2.98	1000.00±17.52
DPPH (mgTE/100 gm)	2,595.69±60.17	2,468.10±56.61
inhibitions (DPPH)	91.05±0.16	86.40±0.18
Vitamin C (mg/100 gm)	35.9±0.09	6.6±0.74
β-carotene(µg/100 gm)	387.2±1.62	2483.87±2.29

Data represent mean ±standard error (S.E) of three variable values (independently), GAE=Gallic acid equivalents, TE=Trolox equivalents, RE=Rutin equivalents, (FRAP-Ferric reducing antioxidant power, DPPH-Free radical scavenging activity).

Table 3: Bioactive compounds in pea shells powder (0 to 90 days) during storage study.

Days	Bioactive compounds				
	Total phenols (mgGAE/100 gm)	Flavonoids (mgRE/100 gm)	FRAP (mgTE/100 gm)	DPPH (mgTE/100 gm)	Moisture (%)
0 day	303.85±2.0	24.38±0.64	1001.00±17.34	2,468.10±26.61	3.89±0.02
15 days	292.10±1.30	22.57±0.32	980.56±1.17	2,366.22±22.09	4.03±0.03
30 days	280.05±1.41	20.28±0.30	967.14±1.83	2,273.00±17.03	4.37±0.02
45 days	267.40±1.40	19.18±0.36	952.18±1.20	2,216.20±13.74	4.62±0.01
60 days	243.55±1.32	17.08±0.55	948.93±1.16	2,116.45±13.45	4.82±0.02
90 days	252.82±1.80	13.19±0.75	959.28±1.43	2,199.62±15.72	5.02±0.02
C.D.	4.895	1.068	22.359	35.670	0.084

Data represent mean±standard error (S.E) of three variable values (independently) C.D.= Coefficient of dispersion, mg= Milligram, GAE= Gallic acid equivalents, TE= Trolox equivalents, RE= Rutin equivalents.

Table 4: Correlation of bioactive compounds in pea shell powder.

Parameters	FRAP	DPPH
Total phenols	-0.33	0.65
Flavonoids	0.66	-0.32
Vitamin C	-0.35	0.64
β-carotene	0.95	0.75

whereas; Ishaq *et al.* (2015) reported 75% antioxidant activity and Jalilisafaryan *et al.* (2016) found 91.03% antioxidant activity through DPPH in peas. On the contradicted results reported by Krimat *et al.* 2021 total phenolic content in fresh and powder in peas were 4.34 and 4.05 to 13.29 mgGAE/gDW and flavonoids content 2.91 and 2.74 to 5.76 mgQE/gDW respectively. The formation of Maillard reaction products may add antioxidant activity and interfere with the Folin-Ciocalteu, DPPH and FRAP test (Sousa *et al.* 2018). Hanan *et al.* 2020 reported carotenoids content 7.628 mg/100 gm but in present investigation fresh pea shells and powder reported 1.2 and 56.87 µg/100 gm. In the present investigation, vitamin C was found higher in fresh pea shells (35.9 mg/100 g) compared to pea shell powder (6.6 mg/100 g). Similarly, Srivastava and Jain 2019 reported that the ascorbic acid content was decreased in dried ker compared to fresh form. B-carotene in fresh pea shell and powder was recorded 387 and 2483.87 µg/100 gm. El-din *et al.* (2013) reported that different fresh vegetables contain β-carotene (41.40 to 340.51 µg/100 gm) and vitamin C (33.83 to 92.65 mg/100 gm) in different range.

Storage study of bioactive constituents in pea shells powder

The storage study results of bioactive compounds depicted in Table 3 indicated a significant decrease ($p<0.05$) in total phenols in pea shells powder after 15 days to 60 days but significantly increased at 90 days. Similar results reported by Sonawane and Arya (2015) in wood apple and jambhul and Syamaladevi *et al.* (2012) in canned black and blue berries, the total phenols were significantly increased during storage. This change during storage due to chemical reaction or may be external factors (air, light and temperature) or moisture and cell destruction affected the stability of polyphenols. In the present investigation, the total flavonoids amount in pea shells powder was decreased significantly throughout storage periods. Sonawane and Arya 2015 noticed a simliar decreasing pattern of flavonoids content in wood apple and jambhul. Antioxidant capacity measured by FRAP found reduction during the storage period from 1001 to 959.28 mgTE/100 gm but at 90 days increasing pattern was noticed. The degradation of the amount of flavonids and total phenols in pea shells powder reduced the antioxidant capacity measured by FRAP. The antioxidant capacity measured by DPPH method shows a significant reduction but at 90 days it was significantly increased 2,199.62 mgTE/100 gm. Similarly result pattern was reported by Sonawane and Arya (2015) in wood apple and jambhul. The moisture content was consistently increased in pea shells powder during the storage ranging from 3.89 to 5.02%. Breda *et al.* (2012) reported a similar result during storage in guavira pulp powder. Moisture content influences shelf life during storage, excessive water supports the microbial growth increased leading to decreased shelf life. Total phenols, vitamin C and β-carotene strongly correlated with DPPH while poorly (weak) correlated with flavonoids (Table 4). B-carotene (0.95) and flavonoids (0.66) strongly correlated with FRAP while very poor correlated with total phenols (-0.33) and vitamin C (0.35) was noticed. No significant correlation was observed in this experiment.

CONCLUSION

This study reveals peas shell is a superb source of nutrients similar to pea grains. This study highlights the scope that incorporation of pea shells for value addition in traditional recipes can be encouraging and popularizing in terms of boost up the level of nutrients (minerals, antioxidants, dietary fiber and protein). Present effects advocate that pea shells hold many biologically energetic materials that can be applied to reap the high cost and prepared value-added products for nutraceutical uses. The value-added products are developed by incorporating powder (pea shells) at the market or household levels, which solve the environmental problem and are an appropriate choice for fulfillments the nutritional demand of the country. Due to its high nutritional properties, this could be a significant role in alleviating the protein-energy malnutrition of developing countries. Its antioxidants activity shows that it can be used for therapeutic purposes in many diseases.

Conflict of interest: None.

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