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Effect of Pea Shell Powder on Chemical, Sensory and Cooking Quality of Macaroni

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ABSTRACT

Background: This research looks at putting pea shells, a byproduct of pea processing, into macaroni to improve nutrition and sustainability. It aims to emphasize the feasibility and benefits of utilizing pea shells in popular cuisines by investigating their nutritional profile and sensory characteristics. This study addresses waste and nutrient-deficient packaged foods by exploring the synergy of culinary innovation and sustainability. Utilizing phyto-nutrient-rich by-products from fruits and vegetables, it proposes enhancing products like macaroni, noodles, cakes, biscuits and soups for a healthier and more environmentally sustainable future.
Methods: Studied how adding pea shell powder (10-30%) affected the chemical, sensory and cooking quality of four macaroni types, comparing them to a control group without pea shell powder.
Result: Macaroni with pea shell powder excelled in color, appearance and taste. Type I (10%) showed superior sensory attributes, while Type III (30%) lagged, impacting overall acceptability. Furthermore, cooking performance analysis indicated that the inclusion of pea shell powder influenced cooking time (16.45-11.48 minutes), water absorption capacity (106-160 g/100 g) and cooking loss (14.3-4.89 g/100 g). The pea shell powder incorporation enhances the nutritional profile of macaroni, including significantly increased protein (8.57-12.64%), dietary fibers, minerals and decreased fat, carbohydrate and energy (370.4-206.66 kcal/100 g) content. Calcium, magnesium, iron and potassium contents were significantly higher in value-added macaroni than in the control. The quality analysis clearly showed that value addition improves the nutrition and taste of macaroni, which indicates potential premium macaroni products for the food industry and healthy alternatives for consumers.

Key words: Macaroni, Nutritional, Pea shell powder, Sensory, Significance.

INTRODUCTION

Macaroni is a form of pasta. It is an ancient food that is defined as a type of dough extruded or stamped into many shapes for cooking. Due to their long shelf life, low cost and easy cooking recipes, extruded products have become one of the fastest-growing sectors in the world (Oliviero and Fogliano 2016). Extruded products prepared with wheat and by-products are claimed to lack nutrients such as vitamins, dietary fiber, proteins, minerals and antioxidants and are rich in starch, energy and fat. The food industry has made a continuous effort to introduce newer functional pasta products according to consumer preferences (Oliviero *et al*., 2016). Vegetables are an excellent source of nutrients but are often refused by children or adolescents because of their low satiating value, bitterness and texture. Researchers have reported that the incorporation of vegetables, fruit powder, purees and by-products into pasta products affects the sensory attributes, cooking qualities and nutritional content compared to traditional products (Jalgaonkar *et al*., 2018) and reduces the risks of biodegradation and has a positive impact on the health and environment.

India is the second-largest producer of peas (5.73 million tons/annum) in the world, contributing 22.9% after China. In India, pea (*Pisum sativum*) is grown in the winter season as a vegetable in different places due to its suitable climate zone. Yearly, more than 1 million tons of pea peel (outer covering of pea) waste is generated in India and used as animal feed. Fruits and vegetable by-products have nutritional and techno-functional properties that play an important role in the food sector for the development of enriched products (Sagar *et al*., 2018). Pea seed consumption has additional health benefits beyond their nutritional value, such as laxative, astringent, anti-obesity, anti-fungal, anti-cancer, anti-diabetic, anti-bacterial, anti-antioxidant and cardio-protective actions (Zilani *et al.*, 2017).

Plant proteins, which are high in bioactive substances, are becoming more popular. Drying preserves agricultural products, extending their shelf life. Dehydrated pea shells, with minimum quality loss, provide a nutrient-rich combination for product development. We propose augmenting

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products with pea by-products for nutraceutical applications, leveraging their bioactive components. Pea peel powder is a well-known nutritional source (Beniwal *et al.,* 2022, 2022). This study investigates underutilized pea shells for nutrient-rich macaroni compositions, to improve sensory, culinary and nutritional qualities. Investigating the influence of pea shell powder can lead to novel, nutritious macaroni variations.

MATERIALS AND METHODS

This research was carried out in 2018 from January to June at the College of Home Science, CCS HAU, Hisar, Haryana, in the Foods and Nutrition Department.

Procurement of material and preparation of sample

Peas were bought from the vegetable market (Hisar) in a single lot Beniwal *et al*. (2022) previously detailed how to develop pea shell powder. The small store on campus served as the source of all other ingredients.

Preparation macaroni

Macaroni was prepared using a lab-scale pasta machine (20 holes of 2.25 mm diameter) reported by Bouacida *et al.* (2017) with slight modifications of ingredients. The treatments and formulation levels were as follows:

The proportion of refined flour (RF), pea shell powder (PSP) and water.

Control = 100 gm RF + water 25 mL.
Type I = 90 gm RF + water 30 mL + 10 gm PSP.
Type II = 80 gm RF + water 35 mL + 20 gm PSP.
Type III = 70 gm RF + water 40 mL + 30 gm PSP.

Method

The flours were mixed; water was then added to make dough. The dough was processed through a machine (pasta) by setting the speed and length of the macaroni cutter. The macaroni were dried (7-8% moisture) in tray dryer at 45^{238}_{92}C for 24 hours.

Cooked macaroni (plate 1)

The proportion of ingredients used for cooking macaroni

Raw macaroni-100 gm, capsicum-60 gm, onion-50 gm, tomato - 60 gm, salt - ½ tsp, black pepper -A pinch, vinegar-½ tsp, tomato sauce-1 tsp, refined flour- 25 ml.

Method

Set aside boiled macaroni with oil. Onion, sautéed till golden. Tomatoes, chilies and capsicum were added and cooked for 5 minutes. Cooked for 2 minutes after adding tomato sauce, salt and pepper. For 2 minutes, toss in cooked macaroni (Plate 1).

Cooking properties

The cooking properties of the developed macaroni were analyzed for their cooked weight, boiling water requirement, dry weight, swelling index (Mestres *et al.,* 1988), water absorption ratio, water absorption index (Desai *et al*., 2018) with slight modification), cooking loss and cooking times (AACC, 2000).

Organoleptic evaluation of value-added cooked macaroni

Sensory evaluation was conducted by 15 semi-trained panel members from the Department of FN, CCS HAU Hisar by adopting a 9-point hedonic scale (Peryam, 1957) at room temperature.

Nutritional evaluation

The dried macaroni powder was analyzed for the nutrient content (samples were performed in triplicate). Proximate composition *e.g.* moisture, crude protein, crude fat, ash and crude fiber examined by standard methods (AOAC, 2000) and total carbohydrates are calculated by the difference method, whereas energy is estimated by the multiplication factor. The dietary fiber (Furda, 1981) and total minerals (Lindsey and Norwell, 1969) were determined by the standard method.

Statistical analysis

Data obtained from the present investigation were analyzed using standard statistical methods ANOVA (CRD) for data interpretation. The significance ($p<0.05$) was proved by the Critical Difference (C.D.) value (Sheoran *et al*., 1999).

RESULTS AND DISCUSSION

Sensory characteristics of cooked macaroni

Table 1 shows Type I (10% level) macaroni scores higher in color, appearance and taste, indicating enhanced sensory qualities. Type III lags overall, impacting

Table 1: Mean scores of sensory characteristics of cooked macaroni.

Types Macaroni	Sensory characteristics					
	Colour	Appearance	Aroma	Texture	Taste	Overall acceptability
	Mean scores					
Control	7.70±0.34	7.90±0.18	8.10±0.18*	8.10±0.18*	8.00±0.21	7.96±0.19
Type I	8.30±0.21*	8.20±0.20*	8.00±0.26	7.90±0.23	8.20±0.20*	8.14±0.17*
Type II	7.80±0.25	7.90±0.23	7.90±0.18	7.80±0.29	7.90±0.23	7.86±0.22
Type III	7.20±0.29	7.10±0.18	7.40±0.27	7.00±0.33	6.90±0.28	7.14±0.23
C.D.	N/A	0.574	N/A	0.765	0.669	0.587

Values are mean±SE of fifteen independent observations, * highest score, C.D. ($p<0.05$) significant, $p>0.05$ non significant.

acceptability. Type II (20% level) rates 'like very much.' Cooking method and supplementation influence macaroni sensory attributes, with significant differences in appearance, texture, taste and overall acceptability across types, while color and aroma show no significant differences. Our findings support Roland *et al.* (2017) finding that pasta absorbs legume tastes. The incorporation of pulse ingredients is limited by taste, however, it can be concealed to some extent in the food matrix. The organoleptic results are consistent with those reported by Shere *et al.* (2018) for pasta enriched with spinach (40%) or vegetable blends. Bouacida *et al.* (2017) discovered that 10% rocket leaves in pasta had the highest acceptance. Pea pod powder (0-30%) enhances the color, sensory score and texture features of a variety of foods such as soup or bread (Hanan *et al*., 2020, 2021), biscuits (Garg, 2015), crackers (Mousa *et al*., 202), bread or cake (Fendri *et al.,* 2016), sweet and salty biscuits (Kaur *et al.,* 2023). Food containing pea pod powder (PPP) reduced stickiness, adhesion work, extensibility and resistance to extension. Improves structural stability, crumb texture, springiness and cohesiveness. PPP inclusion should range between 7.5% and 15%. Beniwal *et al.* (2022) observe color, taste and texture changes in fresh pea shell incorporated *tikki,* cutlet and dry vegetable; which improve sensory scores and overall product impression. Important for macaroni makers and developers looking to improve sensory quality. A 10% improvement is considered optimal.

Cooking performance of raw macaroni

Table 2 shows the cooking performance of four types of macaroni, including the control group. Cooked weight (206-260 gm/100 gm), boiling water need (600-750 ml/100 gm), cooking time (11.48-16.45 minutes), cooking loss (4.89-14.3 gm/100 gm), swelling index (1.35-1.73 g water/gm dry macaroni), water absorbent ratio (106-160 gm/100 gm) and dry weight are some of the characteristics to consider. Type III distinguishes itself with beneficial features such as higher water absorption (160 gm/100 gm), which results in a quicker cooking time (11.48 minutes) and lower cooking loss (4.89 gm/100 gm), indicating quick texture achievement and better structural retention. Fruit and vegetable by-products affect pasta cooking quality by increasing water absorption, raising the swelling index and changing cooking times (Biernacka *et al.,* 2017; Foschia *et al.,* 2015). Getachew *et al.* (2020), Wang *et al.* (2021), Cervini *et al.* (2021), Shere *et al*. (2018), Nilusha *et al.* (2019) and Messia *et al.* (2021) found that ingredients like carrot powder, moringa leaves and vegetable puree, ridge gourd peel, non conventional ingredients, plant or animal protein influenced cooked weight (240-248 gm/100 gm), swelling index (1.53-1.86 ml/gdry matter), cooking loss (4.3-12.0 g/100 gm), water absorption (73-121%), cooking times (8-14 minutes) and water intake (48-56.3%). Combining wheat flour with other ingredients, as demonstrated by Kuchtová *et al.* (2016) and Bouacida *et al.* (2017), has an effect on cooking qualities. Longer cooking times improve water absorption, which is impacted by resistant starch properties. Pasta cooking quality is affected by the protein-starch matrix, with longer ideal cooking durations and lower cooking loss improving overall quality (Diantom *et al.* 2019).

Nutrients composition of cooked macaroni

The addition of pea shell powder reduced fat (7.49-5.56%), carbohydrate (81.73-75.49%), total starch (72.45-59.78%) and calories (434.85-402.56 kcal/100 gm) while boosting protein (10.13-12.64%), ash (3.56-4.92%) and crude fiber (1.48-3.76%) and moisture (57.60-63.42%) in macaroni (Table 3). Dietary fiber in value-added macaroni was roughly twice (13.77%) as high as in the control (8.25%). Total, soluble and insoluble dietary fiber all increased significantly. Calcium (112-319.33 mg), iron (5.90-8.23 mg), zinc (2.13-2.93 mg), potassium (180.05-443.75 mg), magnesium (204.69-451.95 mg) and sodium (21.83-31.23 mg) mineral content (mg/100 gm) considerably enhanced in value-added macaroni as compared to the control. Table 3 shows the nutrient composition of enriched macaroni, which corresponds to research by Cervini *et al.* (2021), Wang *et al.* (2021), Bchir *et al.* (2022) and Shere *et al.* (2018). Protein (2.9-14%), fat (0.8-1.90%), carbs (52.8-80%), energy (291.61-391 kcal/100 gm), dietary fiber (1.2%-13.77%), moisture (64%), ash (0.44-8.0%) and crude fiber (2.5-10%) are all present in pasta and macaroni made from fruit and vegetable by-products. For protein, energy, moisture, fat and carbohydrate, the results closely resemble those of Bchir *et al.* (2022). Bouacida *et al.* (2017) found enriched pasta to be high in dietary fiber 5.30-9.50 g/100 g) and low in fat (2.13-2.80 g/100 g). The reduction of total starch with pea

Table 2: Cooking performance of raw macaroni.

Cooking properties	Control	Type I	Type II	Type III
Cooked wt. (gm)	206	220	240	260
Boiling water (ml)	600	650	700	750
Water absorbent ratio	1.0	1.2	1.4	1.6
Dry wt. (gm)	87.43	86.24	92.46	95.11
Optimal cooking time (minutes)	16.45	14.33	12.56	11.48
Cooking loss (g/100 gm)	14.3	13.76	7.54	4.89
Swelling index (g water/gm dry macaroni)	1.35	1.55	1.60	1.73
Water absorption index (g/100 gm)	106	120	140	160

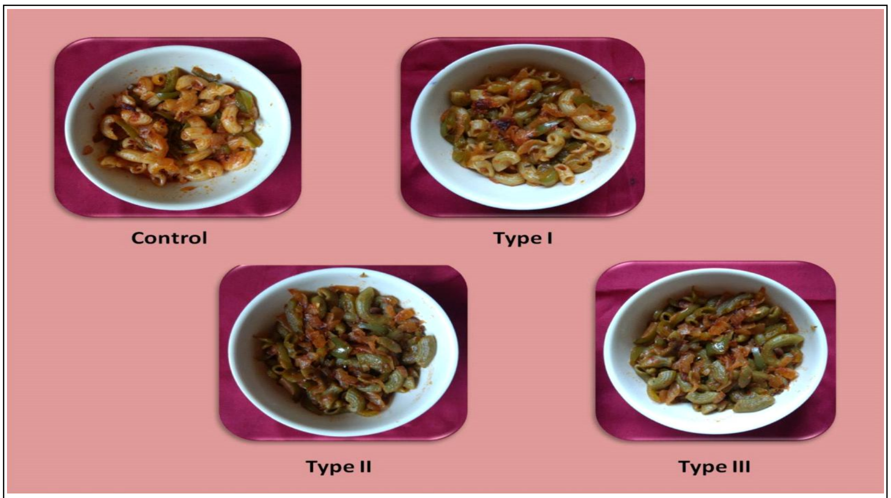
Boiling time= 5-10 minutes, Blanching for pea shells powder incorporated macaroni (1-2 minutes).

shell powder is consistent with Wang *et al.* (2021) that reported (70.35-60.34%). According to Wang *et al.* (2021), increased ash (0.68-1.94%) content is constant. By prior studies, including pea pods (0 to 30% level) in soup (Hanan *et al*., 2020), biscuits (Garg 2015), cakes (Fendri *et al*., 2016); (Beniwal *et al*., 2024) crackers (Mousa *et al*., 2021) and sweet and salty biscuits (Kaur *et al.,* 2023) all resulted in varying degrees of nutrient content augmentation. Pasquale *et al.* (2021) determined that wheat semolina pasta contains around 8.9% moisture, 12.6% protein, 2.0% fat, 79.0% carbs, 0.84% ash and 2.84% crude fiber on a dry matter basis. Energy levels (352.86-370.4 kcal) are consistent with Bchir *et al.* (2022). According to Yadav *et al.* (2014), spinach pasta had more protein (10.7%), but carrot

Table 3: Nutrients composition of cooked macaroni (dry matter basis).

Nutrients	Control	Type I	Type II	Type III	CD
			Proximate composition (%)		
Moisture*	57.60±0.81	60.80±0.90	61.46±0.56	63.42±0.94	2.71
Crude Protein	10.13±0.20	10.80±0.20	11.73±0.25	12.64±0.24	0.74
Fat	7.49±0.11	7.17±0.08	6.39±0.06	5.56±0.12	0.31
Crude Fiber	1.48±0.06	2.26±0.04	3.05±0.03	3.76±0.04	0.15
Ash	3.56±0.04	4.33±0.05	4.49±0.05	4.92±0.04	0.14
Total CHO	81.73±0.53	79.72±0.58	77.41±0.61	75.49±0.55	1.88
Energy	434.85±1.01	426.61±0.71	414.07±1.81	402.56±2.20	5.14
Total starch	72.45±0.69	68.26±0.51	64.12±0.48	59.78±0.61	2.06
			Dietary fiber (%)		
Total dietary fiber	8.25±0.20	10.11±0.10	11.91±0.20	13.77±0.23	0.63
Insoluble	6.13±0.20	7.65±0.18	9.10±0.15	10.62±0.24	0.64
Soluble	2.13±0.03	2.47±0.04	2.81±0.03	3.15±0.04	0.12
			Total minerals (mg/100 g)		
Calcium	112.00±1.73	179.33±1.45	250.00±1.73	319.33±1.45	5.29
Iron	5.90±0.23	6.59±0.18	7.44±0.17	8.23±0.17	0.63
Zinc	2.13±0.06	2.33±0.07	2.62±0.05	2.93±0.05	0.19
Potassium	180.05±5.82	261.67±6.14	346.25±5.77	443.75±5.77	19.47
Magnesium	204.69±2.11	287.79±2.33	366.83±2.54	451.95±2.11	7.55
Sodium	21.83±0.74	25.15±0.97	28.15±0.70	31.23±1.01	2.87
Manganese	0.97±0.01	0.98±0.01	1.00±0.01	1.01±0.01	0.02

Values are mean±SE of three independent determinations, *= on fresh weight basis, Energy= (kcal/100 g), C.D. ($p<0.05$) significant, $p>0.05$ non significant.



Control= 100% Refined flour, Type I- 10% Pea shell powder + 90% Refined Flour, Type II- 20% Pea shell powder + 80% Refined Flour, Type III- 30% Pea shell powder + 70% Refined Flour.

Plate 1: Cooked macaroni.

pasta had more nutritional value due to greater calcium and phosphorus levels. Beniwal *et al.* (2022) demonstrated the importance of pea shell powder in terms of protein (17.76%), dietary fiber (21.04%) and vital minerals and incorporations in *tikki,* cutlet *etc*. Beniwal *et al.* (2022) found pea shell methanolic extracts contain carbohydrates, amino acids, alkaloids, tannins and phytosterols. The research emphasizes the functional properties of pea shell powder for nutrient enrichment and the incorporation of bioactive components into food compositions. Integrating pea shell powder into products is a viable nutritional enrichment strategy that caters to health-conscious consumers.

CONCLUSION

By incorporating pea shell powder into macaroni value-added, environmentally friendly goods are developed. It reduces waste, offers new nutritional ingredients and boosts market attractiveness. Pea shell powder considerably improves the nutritional profile of macaroni by increasing dietary fiber, protein and mineral content. The enriched macaroni stands out in color, appearance and flavor, making it a healthier pasta option. Texture and fragrance variances indicate the need for additional adjustment. Changes in cooking performance include changes in cooking time, water absorption and cooking loss. Incorporating pea shell powder into nutritious macaroni shows promise in appealing to health-conscious consumers. More study is required to improve sensory features and overall acceptability through formulation and processing changes.

Conflict of interest

All authors declared that there is no conflict of interest.

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