DR-2149
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RESEARCH ARTICLE Asian Journal of Dairy and Food Research

Development of Nutrient-rich Cake with Supplementation of Pea Shells Powder and Nutritional Evaluation

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10.18805/ajdfr.DR-2149

ABSTRACT

Background: Bakery products like cakes are rich in starch, fat, and energy but deficient in fiber, vitamins, and minerals. The cake is becoming a well-known delicacy during festival periods between all age groups mostly in urban areas. Providing a healthy and nutritious cake remains a main problem on account of extreme sugar or fat content that predisposes the buyers to obesity. Mixing the flours with plant components helps solve problems of low nutritive value of cereals. Pea shells are an excellent source of nutrients and have excellent functional properties, the substitution of flour with pea shells powder is the best way for consuming the nutrients which are likely to contribute substantially to the fight against targeted hunger and to bridge the gap of malnutrition. Keeping the view of the potential of pea shells powder in formulated products the healthy and nutritious cakes were investigated.

Methods: Three cakes were developed with different formulations that include refined flour and pea shells powder in the ratio of 100:0, 90:10, and 80:20 with other basic ingredients of baking. The developed cakes were analyzed for organoleptic and nutritional properties such as proximate, dietary fiber, and minerals.

Result: The sensory mean score was increased by the supplementation of pea shells powder. The result showed that 10% level was the optimum level of incorporation. A significant increase (0>0.05) in the nutrient contents such as protein (10.97 to 12.38%), crude fiber 90.31 to 1.85%), ash, calcium (53.33 to 193.33 mg/100 gm), potassium (162.48 to 335.42 mg/100 gm), magnesium (56.75 to 253.33 mg/100 gm), iron (3.94 to 5.49 mg/100 gm), and potassium (162.48 to 335.42 mg/100 gm) of incorporated cakes and decreased the fat (25.55 to 21.72%), energy (451.83 to 413.76 kcal/100 gm) content compared to control cake. The calcium and magnesium content increased two or four times more than control cakes. From the present study, it can be concluded that cakes containing 20% pea shells powder were nutritionally rich.

Key words: Cake, Formulations, Organoleptic, Pea shells powder, Significant.

INTRODUCTION

Bakery products are widely consumed and are rich in fat, starch and energy but depleted of fiber, protein, minerals and vitamins. Cakes are becoming a major component of the international food market (Kotsianis *et al.,* 2002) and have made their space in Indian kitchens. Cakes are low in cost and associated with customers' minds with appetizing, delicious, spongy products having desired sensory characteristics (Matsakidou *et al.,* 2010). Cakes are classified based on production method and formulation such as 3 types *i.e*. foam, chiffon and batter cake. The quality of cakes depends upon the ingredients used in cake preparations, especially the flour and a high-quality cake is determined by its volume and moist crumb (Cauvain and Young, 2006). The health-conscious public demands high-quality and low-calorie products that are low in fat and sugar. However, altering the amount of ingredients to reduce calorie content may compromise texture, mouthfeel, flavor, and appearance. By mixing of two flours and other ingredients helps solve the problem of the low nutritive value of cereals (Patel and Rao, 1995).

Pea shells are excellent source of vitamins, minerals, bioactive compounds and are low in fat, energy or carbohydrates (Beniwal *et al*., 2022). Peas are grown all over the world, satisfying the purpose of both human use and animal feeding. India is the second producer after China; contributing 22.9% (4 million tones/annum) to the world production (FAO 2019). Peas processing industries generate a large amount of waste approx 1 million tons in India and pea peels are discarded as waste (Garg, 2015; Upsana and Vinay 2018). By-products of fruits and vegetables are promising source of bioactive compounds and have technological or nutritional properties (Aparicio *et al*., 2010) that can be appropriated for enrichment and functional product development (Sagar *et al*., 2018). The value addition, fortification and supplementation of products with plant by-products provide adequate nutrition or health

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How to cite this article: Beniwal, A., Savita, Sangwan, V. and Punia, D. (2024). Development of Nutrient-rich Cake with Supplementation of Pea Shells Powder and Nutritional Evaluation. Asian Journal of Dairy and Food Research. doi: 10.18805/ajdfr.DR-2149.

Submitted: 29-07-2023 **Accepted:** 05-03-2024 **Online:** 09-05-2024

benefits (Rasheed *et al*., 2008) and are effective for people having degenerative diseases (Kiran 2017). In recent research, the plant's protein or fibers gained attention, primarily originating from industrial by-products. Pea shells could be used as functional ingredients to reduce calorie intake, increase micronutrients (Beniwal *et al*., 2022) and improve physiochemical properties such as change in texture, or viscosity in formulated products. The effective management of pea processing industries (by-products) waste has become important environmentally and economically.

The present study presents a novel approach to cake development with the supplementation of pea shells powder and find out the effect on organoleptic and nutritional properties; that can be effective for the baking industry. The proposed method aims to bridge the gap between traditional recipes and modern scientific knowledge, enabling bakers to create cakes that not only meet consumers' preferences but also adhere to scientific standards. Bakery products are consumed by all age groups of peoples. The development of micronutrient-rich products will be needed for the community especially children and adults to alleviate degenerative disorders.

MATERIALS AND METHODS

This study was performed in 2018 in February -May at the Foods and Nutrition Department, College of Home Science, CCS HAU, Hisar, Haryana.

Procurement of material and preparation of sample

Peas were purchased in a single lot from the local market (Hisar). The pea shells powder preparation method was described earlier by Beniwal *et al.* (2022). All other ingredients were purchased from a local shop on campus.

Cake development

Composition of cake flour

Blends of refined flour and pea shells powder were prepared by combinations of; 100:00 (Control), 90:10 (Type I), 80:20 (Type II).

Ingredients used in cake batter preparations

Milkmaid (160gm), baking powder (¾ tsp), baking soda ($^{1}/_{4}^{th}$ tsp), vanilla essence (3-4 drops) used in equal proportions in all types of cakes. The water and refined oil ratio was as Control= 50 (water):100 (refined oil), Type I= 65 (water):105 (refined oil), Type II= 80 (water):110 (refined oil).

Method

First sift refined flour, pea shells powder, baking powder, salt and sodium bicarbonate in a bowl. After that creamed refined oil, sugar (milkmaid), vanilla essence for 1-2 minutes, followed by adding water to the creamed mixture and continued blending for 1-2 minutes with an electric beater. Folded the refined flour and pea shell powder in the above mixture. The prepared mixture was then poured into the greased pan (Plate 2). The cakes were baked at 180°C for 45 minutes (Plate 1). The cakes were left at room temperature for one hour for cooling and then analyzed.

Organoleptic evaluation of cake

A panel of 15 semi-trained (I.C. College of Home Science, HAU) or 30 consumer (different colleges HAU, campus) sensory evaluators participated in the blind testing cake. Each cake variation was rated on a scale (9 Hedonic scale) of 1to 10 for sensory parameters (Peryam and Pilgrim, 1957). The sensory evaluators were physically fit, willing to co-operate gave time for judging the products and were able to discriminate the taste. The respondent characteristics are presented in Table 1.

Nutritional evaluation of value-added cake

All the developed cakes were oven-dried to a constant weight at 45°C. The dried cakes were ground to a fine powder and were analyzed for the nutrients such as proximate composition, dietary fibers and total mineral content. (Samples were done in triplicates). Proximate composition (moisture, crude protein, crude fat, ash, crude fiber) was examined by the standard methods (AOAC 2000) and total carbohydrate and energy were calculated by difference and multiplication method. Dietary fiber (Total, insoluble and

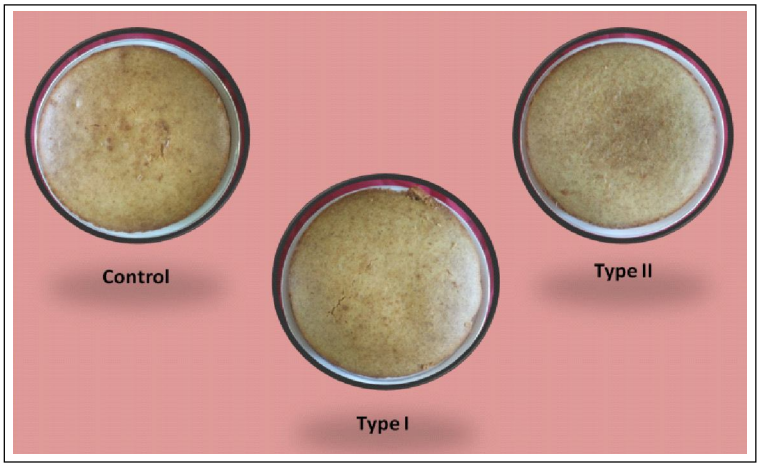

Plate 1: Different type of cakes.

soluble) was determined by Furda (1981) and total mineral were investigated by Lindsey and Norwell (1969), method by atomic absorption spectrophotometer 2380, (PERKIN-ELMER, USA) digested (acid) samples.

Statistical analysis

The data obtained from the present investigation was analyzed using standard statistical method ANOVA for data interpretation and given as mean (±) standard error. Significance accepted at $p \leq 0.05$ by critical difference (C.D.) value (Sheoran *et al.,* 1999).

RESULTS AND DISCUSSION

Weight parameter of developed cake

The raw and cooked weight (Table 2) of the supplemented cake was increased after supplementation of pea shells powder at 10 and 20% levels. Higher weight loss during cooking was noticed in type II cake than in type I and control cake due to low batter viscosity that allowed bubble movements. A large volume of gas was created leaving behind large central holes and increasing the weight loss. In addition, control and type I cake had a higher standing height than type II cake. Those outcomes have been in accordance with Sanz *et al.* (2008); who suggested that the batter viscosity has an important effect on the bubble incorporation and movement which are considered controlling factors in the final cake volume. Water is lost more easily during the baking process so more weight is lost (Jahanbakhshi and Ansari, 2020).

Organoleptic characteristics

The highest scores for all the parameters of the developed cakes were obtained by type I, which fell in the category of "liked very much" by the panelists. The mean organoleptic scores of cake is presented in Table 3 all types of cakes were found to be sensorial acceptable in terms of appearance, colour, texture and taste. The mean score of colour and taste (8.5) improved in supplemented cakes (10% level) than in control (7.9) which fell in the category of "extremely liked". Similar results were reported by Sayed *et al.* (2013) that taste and colour scores increased in cake supplemented with watermelon rind at 7.5% levels. The present study result, supported by Sharoba *et al*. (2013) that cake developed with pea peel flour got a higher score than the control and decreased at 20% supplementation. The studies reported by Singh R. (2016) and Sharam *et al.* (2019) that the organoleptic mean score was higher in supplemented cakes (5-10% level) of apple pomace and wheat grass powder than in control. According to Bourne (1986), the texture of a product is a main factor in the rejection of products; however, in the current study, the

Plate 2: Types of cake batter.

Table 1: Characteristics of respondents.

		Characteristics				
Semi trained panel		n	(%)	Consumer panel	n	(%)
Gender	Female	15	100%	Female	30	100%
Age group (yrs.)	30-40	9	60%	20-23	10	33.3%
	41-50	6	40%	24-27	20	66.7%

n= No. of respondents, %= Percentage.

texture presented a higher score than the control. The present results are supported by Walker *et al.* (2014) and Sudha *et al.* (2015) who found that the replacement of wheat flour in bakery products by different fruits and vegetable by-products never exceeded 20% because it resulted in a reduction in volume, height, texture and an increase in crumb hardness. Other studies reported that the pea pod powder increased the sensory score, especially colour, and made it look appealing in biscuits (Garg, 2015), soup (Hanan *et al.,* 2020) and cake (Fendri *et al.,* 2016). The colour green is due to the presence of natural phytochemicals, which increase sensory qualities in terms of colour, smell and taste (Zhang *et al.,* 2021). Previously, research showed that fruits and vegetable by-products; addition in product development provide contradictory results. Grapes by-products at 30% levels decrease significantly the acceptable scores (Mildner *et al.,* 2016) while no significant differences were reported by Walker *et al.* (2014) at a 10% level of substitution with fruits and vegetable by-products. The sensorial mean scores were decreased or increased in cake development by fruits and vegetable by-products; as reported by Sudha *et al.* (2015), Kaur and Sharma (2018) and Ben *et al.* (2017). The differences may be due to colour, taste (influenced by phenolic compounds), texture and aroma. In all studies, sensory analysis was performed by an insufficient number of panelists (10-15). The present study results also supported that panelist's sex and age influence the sensory mean scores.

Nutritional composition

Proximate

The results presented in Table 4 for the proximate composition of cakes indicated that the nutrient content was increased in moisture (17.30 to 19.84%), crude protein (10.97 to 12.38%), crude fiber (0.31 to 1.85%) and ash (1.39 to 1.98%) content significantly in pea shells incorporated cakes. The nutrients that are fat (25.55 to 21.72%), total carbohydrate (44.46 to 42.19%) and energy (451.83 to 413.76 kcal/100 gm) content decreased significantly after supplementation of 10 to 20 % pea shells powder. A lower amount of moisture (17.30 to 19.845%), ash, and total carbohydrate was found in the present study as compared to the values (27.40. 7.50 and 51.64% moisture, ash and total carbohydrate) reported by Sayed and Ahmed (2013) in cake prepared with 7.5% watermelon rind powder and higher than the values (8.60% protein, 6.82% fat, 55.59% carbohydrate and 308 Kcal/ 100 g energy) reported by Kiran and Neetu (2017) for muffin prepared with 25% cauliflower stem and 25% potato peel powder. Crude fiber content was 0.31 to 1.85% in the cake which was significantly lower than the range (12.74 to 13.16 g/100 g) reported by Singh (2016) for fiber-rich pineapple pulp waste powder incorporated cakes. The difference might be due to the higher fiber content of the pineapple pulp waste. The result in our findings is almost similar to the reports of Olatunde *et al.* (2019), cake prepared with sweet potato (10 to 25%)

Table 2: Weight measurement of cake at different level of supplementation.

Types of cake	Observation (per 100 gm)			
	Paste wt.	Cooked wt.	weight loss	Dry wt.
Control	485 gm	224 gm	53.80%	185.24 gm
Type I	512 gm	238 gm	53.50%	193.02 gm
Type II	542 gm	249 gm	54.10%	199.60 gm

g= gm, wt.= Weight control= (RF: 100%), Type I= (RF: PSP: 90:10), Type II= (RF: PSP: 80:20), RF= Refined four, PSP= Pea shells powder, *= On fresh weight basis.

Table 3: Mean scores of organoleptic evaluation of cake.

Sensory characteristics	Types of cake					
	Control	Type I	Type II	Control	Type I	Type II
	Semi trained			Consumers		
Colour	8.00±0.00	8.10± 0.20*	7.80±0.29	7.90±0.40	8.11±0.72**	7.60±0.81
Appearance	7.90±0.10	8.30±0.21*	7.70±0.21	7.76±0.43	8.33±0.65**	7.56±0.62
Aroma	8.00±0.00	8.00±0.15*	7.90±0.18	7.9±0.30**	7.76±0.63	7.69±0.63
Texture	7.90±0.10	8.20±0.13*	7.80±0.20	7.83±0.37	8.12±0.33**	7.60±0.68
Taste	7.90±0.10	8.50±0.17*	7.70±0.21	8.00±0.52	8.45±0.48**	7.50±0.57
Overall Acceptability	7.94±0.04	8.22±0.13*	7.78±0.19	7.88±0.19	8 .15±0.36**	7.60±0.51

Values are mean±SE of 15 independent observations, *show the higher score in semi trained panel, **show the higher score in consumer panel, Control= (RF: 100%), Type I= (RF: PSP: 90:10), Type II= (RF: PSP: 80:20), RF= Refined flour, PSP= Pea shells Powder, *= on fresh weight basis.

and pigeon pea (20%) flour that is moisture (18.2 to 20.69%), carbohydrate (40.21 to 42.93%), fiber (0.69 to 1.19%) increased and fat content decreased from 232.71 to 27.98%. Sharma *et al.* (2019) reported an almost similar amount of ash (from 1.34 to 2.00%) content in cupcakes prepared with beetroot and wheat grass powder at a 10% level of supplementation. An increase in moisture content in cake has been associated with an increase in fiber content (Elleuch *et al.*, 2011). The previous studies reported by researchers showed increased nutrient contents and decreased fat contents in developed cakes with by-products of fruits and vegetables such as mango and apple by-products (Aziah *et al.,* 2011; Sudha *et al.,* 2015), grapes by-products (Walker *et al*., 2014), berry pomace (Mildner *et al.,* 2016).

Dietary fiber

The results presented in Table 4 indicated that the incorporation of pea shells powder into cake brought about a significant improvement in their total (from 2.82 to 6.42%), insoluble (from 2.18 to 5.13) and soluble (from 0.64 to 1.29%) dietary fiber content. The total dietary fiber content of Type I cake (4.62%) was almost double and Type II (6.42%) cake was almost three times that of the control (2.82%) value of the cake. Kiran and Neetu (2017) reported a higher amount of dietary fiber (12.5%) in muffins (prepared with 25% cauliflower stem and 25% potato peel powder) than the amount reported in the present study. Bender *et al.* (2017) reported total dietary fiber content increased from 4.47 to 7.20% insoluble dietary fiber ranged from 1.49 to 3.17% and soluble dietary fiber from 2.98 to 5.83% when grapes pomace (by-product) was incorporated into muffins**.** Sharma *et al.* (2019) reported 2.12% total dietary fiber in control (refined flour) cupcakes prepared with beetroot and wheat grass powder. The addition of fresh pea shells increased the dietary fiber content in products such as dry vegetables (Beniwal *et al.,* 2022), *tikki* (Beniwal *et al.,* 2022) and cutlets (Beniwal *et al.,* 2022).

Total minerals

A significantly drastic increasing trend was observed (Table 4) in minerals content of value-added cake like calcium (53.33 to 193.33 mg/100 gm), iron (3.94 to 5.49 mg/100 gm), zinc (0.77 to 1.02 mg/100 gm), magnesium (56.75 to 253.33 mg/100 gm), potassium (162.48 to 335.42 mg/100 gm), sodium (17.22 to 23.65 mg/100 gm) and incorporation of pea shells powder to cake did not affect the manganese content, values were almost similar to control (0.65 mg/100 g) cake. The calcium, magnesium and potassium content increased four times and two times in supplemented cakes than in control cake due to pea shells powder being a good source of micronutrients (Beniwal *et al.,* 2022). The results of the present study are consistent with previous studies by Mousa *et al*. (2021) and Garg (2015), who reported that pea pods are an excellent source of nutrients and increase the level of minerals in products developed the pea pods powder. The mineral contents recorded present study differs from those previously reported by Sharoba *et al.* (2013). The addition of fresh pea shells led to a noteworthy rise in the micronutrient profile of

Table 4: Nutrients content of value added cake (% dry weight basis).

Parameter	Control	Type I	Type II	CD (P≤0.05)
Proximate (%)				
moisture	17.30±0.44	18.90 ±0.29	19.84 ±0.26	1.19
Crude protein	10.97±0.14	11.78±0.19	12.38 ±0.17	0.60
Fat	25.57±0.30	23.55±0.31	21.72 ±0.70	1.67
Ash	1.39±0.04	1.74±0.04	1.98±0.03	0.13
Crude fiber	0.31±0.06	1.07±0.04	1.85±0.04	0.17
Total carbohydrates	44.46±0.18	42.96±0.23	42.19±0.22	0.75
Energy (kcal/100 gm)	451.83±2.72	430.91±3.24	413.76±5.79	14.60
Dietary fiber (%)				
Total	2.82±0.04	4.62±0.05	6.42±0.06	0.18
Insoluble	2.18±0.04	3.66±0.11	5.13±0.06	0.27
Soluble	0.64±0.02	0.96±0.02	1.29±0.03	0.08
Total minerals (mg/100 g)				
Calcium	53.33±1.45	101.33±1.	193.33±1.45	5.52
Iron	3.94±0.08	4.68±0.10	5.49±0.21	0.50
Zinc	0.77±0.02	1.02±0.02	1.23±0.02	0.07
Magnesium	56.75±2.03	154.03±1.99	253.33±2.03	7.11
Potassium	162.48±5.15	240.42±6.51	335.42±6.51	21.48
Sodium	17.72±0.72	20.23±1.01	23.65±1.04	3.30
Manganese	0.65±0.01	0.67±0.01	0.68±0.01	0.02

Values are mean±SE of three independent determinations, Control= (RF: 100%), Type I= (RF: PSP: 90:10), Type II= (RF: PSP: 80:20), RF= Refined flour, PSP= Pea shells powder, * = on fresh weight basis.

products such as dry vegetables (Beniwal *et al.,* 2022), *tikki* (Beniwal *et al.,* 2022) and cutlet (Beniwal *et al.,* 2022). Another study reported by Robinson *et al.* (2019), pea and their pods contain many health-promoting bioactive compounds is beneficial for people who suffer from lifestyle diseases if they consume plant products.

CONCLUSION

It is evident from the present study that the cakes can be prepared with the substitution of refined flour without affecting sensorial qualities, up to 20% level but 10% level is the optimal level. The supplemented cakes with pea shells powder had higher nutrients than the control cake. The analytical study shows that the amount of all the nutrients (total minerals, dietary fiber, proximate) content was found to be significantly higher in the Type I and Type II cake as compared to the control cake. Our results suggest that pea shells contain biologically active constituents that can be utilized to obtain high-value-added products for nutraceutical use and the incorporation of pea shells is a viable and effective strategy for fortifying bakery products without sacrificing their organoleptic qualities. Hence development and utilization of such functional ingredients will improve the overall health of the population as well as prevent the onset of degenerative diseases and help in the management of metabolic disorders like diabetes and obesity with today's changing lifestyles and environment thus improving the overall health of the population.

Conflict of interest

All authors declare that they have no conflict of interest.

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