استخدام قشور البازلاء والجزر والبطاطس في تحضير الكب كيك الوظيفي

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مدرس بقسم التغذية وعلوم الأطعمة

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المستخلص:

تُنتج صناعة الأغذية الكثير من البقايا الغذائية، والتي غالبًا ما تكون متوفرة بكميات كبيرة ودون تكلفة. وكان الهدف من هذه الدراسة هو تحسين أطعمة محددة من خلال الاستفادة من بقايا الغذاء لإنتاج منتجات مستدامة عالية القيمة الغذائية. تم تحضير خثارة خضراء مجففة من قشور البازلاء (DGCPp) ، والذي يحتوي على نسبة عالية من البروتين بنسبة (١٨٪)، ومسحوق القشر المختلط المصنوع من (قشور البطاطس والجزر) (MPP) ودمجهما في الكب كيك. وعلى عكس عينة الكب كيك الضابطة المصنوعة من (دقيق القمح بنسبة ١٠٠٪)، تم استبدال DGCPp وMPP بدقيق القمح بمستويين مختلفين (١٠٪ و١٥٪) بشكل منفصل. تمت دراسة تأثير DGCPp وMPP على التركيب الكيميائي والخصائص الحسية لعينات الكب كيك. أدى زيادة مستوى هذا الاستبدال إلى تحسين القيمة الغذائية للكب كيك، حيث احتوى الكب كيك DGCPp على أعلى نسبة بروتين (١٥٪)، بالإضافة إلى ذلك، احتوى الكب كيك المحتوي على MPP(١٥٪) على نسبة أعلى من المعادن Fe وCa وZn، كما أظهر التقييم الحسي أن جميع العينات المختبرة مقبولة من الناحية الحسية. أيضا كانت العينة المدعمة الأكثر تفضيلاً هي ١٥٪ مسحوق قشور البطاطس والجزر المختلط، يليه ١٠٪ مسحوق قشور البطاطس والجزر المختلط (MPP) من ناحية أخرى كانت اقل العينات تفضيلا هي DGCPp ١٥٪. تشير هذه النتائج إلى إمكانية استخدام مسحوق قشور البازلاء DGCPp ومسحوق القشر المختلط المصنوع من قشور البطاطس والجزرMPP في العديد من المنتجات الغذائية، مثل الكب كيك، لتعزيز قيمتها الغذائية.

الكلمات المفتاحية: قشر البازلاء – مسحوق القشر المختلط – قشور البطاطس – قشر الجزر – التقييم الحسي.

Utilization of Pea, Carrot and Potato Peels in Formulating Functional Cupcakes

ABSTRACT:

The food industry generates a lot of waste, which is frequently given away for free in large quantities. The goal of this study was to improve specific foods by utilizing food waste to produce high-nutrient, sustainable products. Dried green curd made from pea peels (DGCPp), which has a high protein content of 18%, and mixed peel powder made from potato and carrot peels (MPP) were prepared and incorporated into cupcakes. In contrast to the control cupcake sample made with 100% wheat flour, DGCPp and MPP were substituted for wheat flour at two different levels (10% and 15%) separately. It was investigated how DGCPp and MPP affected the chemical makeup and sensory qualities of cupcake samples.

The nutritional value of cupcakes was improved by increasing the amount of this substitution; DGCPp cupcakes had the highest protein content (15%). Additionally, the cupcake with MPP (15%) had a higher mineral content (Fe, Ca, and Zn). The sensory evaluation revealed that all studied samples were acceptable from a sensory perspective. The most preferred fortified sample was 15% mixed peel powder, followed by 10% mixed peel powder (MPP). On the other hand, the lowest one was 15% DGCPp. These findings suggest that DGCPp and MPP can be used in various food products, such as cupcakes, to enhance their nutritional value.

Keywords: pea peel – Mixed peel powder– potato peels – carrot peel –sensory evaluation.

INTRODUCTION

Food waste is a significant global issue, as approximately one billion people worldwide suffer from malnutrition and hunger, while food intended for human consumption is wasted or lost. Today, the nutritional and functional properties of by-products from fruits and vegetables are increasingly important in the food industry. Functional and bioactive substances like carotenoids, polyphenols, vitamins, and dietary fiber can be found in these by-products in promising amounts **(Sagar *et al.*, 2018)**. Food waste refers to food that remains acceptable for consumption but is ultimately discarded or left unconsumed **(Khalid *et al.,* 2019)**.

Peas (*Pisum sativum* L.), a member of the Fabaceae family, are a common green pod-shaped vegetable widely cultivated during the winter months. When peas are removed from their pods, approximately 35%–40% of solid waste is generated in the form of green pea peels. Despite being considered waste, pea pods offer significant health benefits. They offer a wealth of nutrients, such as dietary fiber, vitamins, and minerals. They are also cholesterol-free, low in calories, and low in fat **(Pathak *et al.*, 2016)**.

Utilizing this waste can not only improve human health through the development of new products, but it can also help address environmental issues, which is a crucial step towards achieving sustainable development goals. The growing demand for pulses and cereals high in phenolic content has drawn attention to proteins made from industrial by-products in recent studies. Drying decreases the volume of agricultural products and increases their shelf life, making it an essential preservation technique. However, due to the high moisture content in pea pods, their storage can be challenging **(Garg, 2015)**.

Pea pods are a nutrient-rich ingredient for product development because they can be dehydrated with little loss of quality. According to our findings, valuable biologically active compounds found in pea by-products can be used to make nutraceuticals. Preparing pea pod powder, evaluating its nutritional qualities, and creating value-added products are the main objectives of this study.

A vital crop in the Apiaceae family, carrots (*Daucus carota* L.) are abundant in antioxidants, vitamins, and minerals, particularly beta-carotene, which gives them their vivid orange hue. Carrots are affordable and nutritious, providing significant amounts of vitamins B1, B2, B6, and B12, along with fiber **(Raees-ul and Prasad, 2015).**

As a root vegetable, carrots are rich in carotenoids, flavonoids, polyacetylenes, vitamins, and minerals, all of which provide numerous nutritional and health benefits. The popularity of orange carrots has surged due to the recognition of their high pro-vitamin A content **(Sule and Abu, 2017)**. Carrots are packed with antioxidants, just like a lot of other vibrant veggies. Carotenoids, which are strong antioxidants that can mitigate the effects of free radicals, are found in orange carrots. They have also been shown to inhibit mutagenesis, which may reduce the chance of getting some types of cancer.

The most widely produced and consumed staple food in the world, potatoes (*Solanum tuberosum* L.) are economically significant. Due to its significant contribution to human consumption, it ranks as the fourth-largest food crop, behind maize, rice, and wheat **(Karamova *et al.,* 2023)**.

The potato industry as a whole is currently undergoing major changes. Previously, the use of fresh potatoes, which served as the foundation for potato consumption, was steadily declining, especially in developing countries. This is because of rising incomes and populations, which have increased demand for processed foods like chips, frozen fries, crisps, canned potatoes, and puree **(Fradinho *et al.,* 2020)**.

In the food manufacturing industry, especially in potato chip production, a considerable volume of potato peel is discarded, with losses ranging from 15% to 40% depending on the peeling method **(Kot *et al.,* 2020)**. A good source of many nutrients is potato peel. Compared to potato pulp, it has a higher concentration of a number of advantageous ingredients. Additionally, bioactive substances like antioxidants, flavonoids, dietary fiber, minerals, and vitamins are abundant in potato peel **(Jimenez-Champi *et al.,* 2023)**.

Gaining an understanding of the physicochemical characteristics of potato peel waste requires an understanding of its chemical and physical properties. This information could help create sustainable ways to use potato peel **(Javed *et al.,* 2019)**.

The commercial viability of newly developed functional foods relies on several factors beyond their health benefits, including standard quality indicators such as taste, affordability, and convenience **(Alongi and Anese, 2021)**. However, the limited application of certain processing technologies has led to challenges in the sensory qualities of cereal foods, such as taste, color, and texture, especially after the addition of natural sources rich in bioactive compounds and dietary fiber **(Saleh *et al.,* 2019)**.

Cakes are among the most popular bakery products, often enjoyed during special occasions **(Zhang *et al.,* 2012)**. A cake is defined as a semi-dry, frothy baked product with trapped air bubbles in the aqueous phase of the batter's starch and protein matrix **(El Tanahy *et al.,* 2021)**. High-quality cakes are characterized by their low density, high volume, spongy texture, and lightweight nature. Carbon dioxide production, protein denaturation, and starch gelatinisation give cakes their fluffy, soft texture **(Agrahar-Murugkar *et al.,* 2018)**. Cakes are generally classified as baked goods with an intermediate moisture content, typically between 22% and 28% **(Cauvain and Young, 2008)**. The current study aims to utilize pea pods, potato peels, and carrot peels for the development of functional cupcakes. By incorporating powder made from these peels, we can enhance the nutritional value of the cupcakes, contributing to a variety of health benefits.

MATERIALS AND METHODS

Materials

Fresh potatoes (*Solanum tuberosum* L.), carrots (*Daucus carota* L.), and peas (*Pisum sativum* L.) weighing roughly 10 kg each Peels were collected in Tanta, Gharbya, Egypt, from a nearby market. The remaining ingredients, which include sugar, shortening, milk powder, baking powder, salt, and wheat flour (72% extraction ratio), fresh egg, and vanilla, were all purchased from a supermarket in Tanta, Gharbya, Egypt.

Methods:

Making dried green curd DGCPp.

The pea peels were cleaned, sorted, and allowed to sit at room temperature for two hours in order to remove any remaining moisture. (2.5 kg) of pea peels were put in a blender to extract the juice and insoluble dietary fiber. The juice was heated to 85–90 °C for five minutes in order to coagulate the protein. Using a Buchner funnel equipped with the proper size filter paper, the coagulum (moist green curd 19.6%) was separated by vacuum filtration. It was then dried in an electric oven (UNOX, XBC605, Italy) at 50 °C for six hours, resulting in a final moisture content of 8.76%.

Subsequently, for future use, after being finely ground in an electric grinder (Model Moulinex type, No Y45, Spain), the dried green curd made from pea peels (DGCPp) was stored in low-density polythene bags in a cool, dry place. **Fig. 1.**

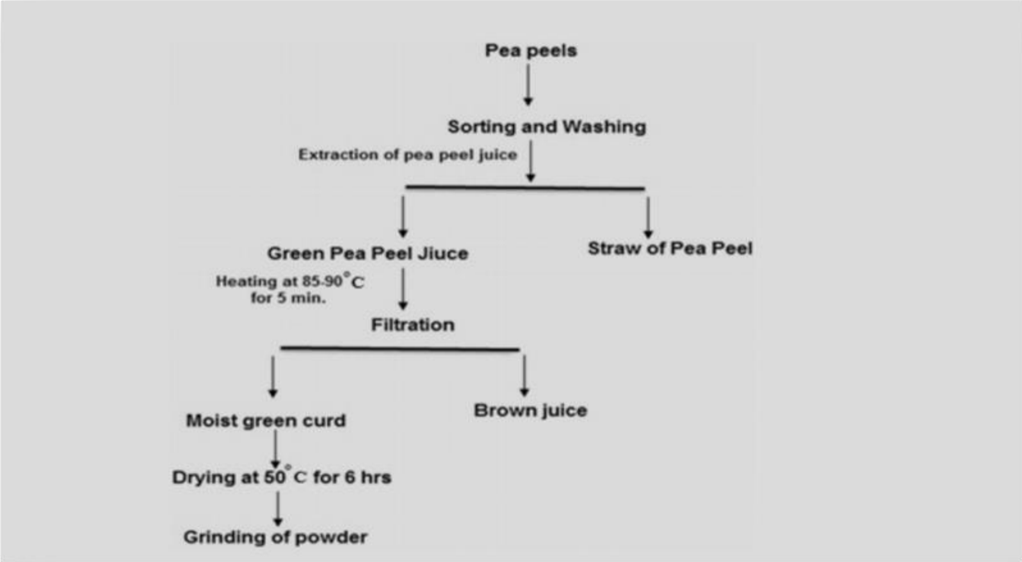

Fig. (1): The processing flow chart for DGCPp

Making a mixture of peel powder (MPP)

To clean and get rid of extra dirt, whole potatoes and carrots were washed with tap water. Clean vegetables were then chopped after being peeled with a peeler. After that, the collected peels were spread out on trays and dried for five days at 50 °C in a cabinet dryer. Separately, dried peels were ground into fine powders in a grinder. Each powder was combined in an equal quantity, sealed in polythene bags, and kept in airtight food-grade plastic containers until it was needed. **Fig. 2.**

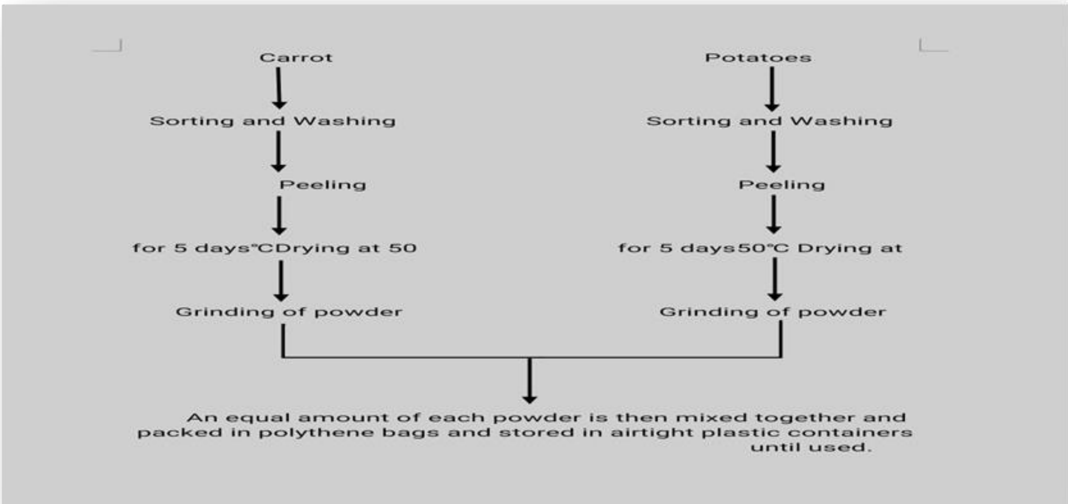

Fig. (2): The processing flow chart for MPP

Preparation of Cupcake samples.

Cupcakes products were prepared from blends containing 10% and 15% DGCPp were used to partially replace the 72% wheat flour. and replaced by 10% and 15% MPP. The cake was prepared following the procedure outlined in **(AACC, 2002)**, and the ingredients used are listed in **Table 1**. After baking, the cake was allowed to cool for an hour and then packaged in plastic bags for subsequent analysis.

Table (1): Recipe formulation of Cupcakes (g).

Ingredients	Control	DGCPp (10)	DGCPp (15)	MPP (10)	MPP (15)
Wheat flour 72% extraction	100	90	85	90	85
DCGPp	—	10	15	—	—
MPP	—	—	—	10	15
Shortening (oil)	50	50	50	50	50
Fresh Egg	85	85	85	85	85
Sugar	60	60	60	60	60
Dry skim milk	3	3	3	3	3
Baking powder	4	4	4	4	4
vanillin Extract	1	1	1	1	1
Table salt	0.5	0.5	0.5	0.5	0.5

Approximate chemical composition:

- The amounts of moisture, protein, ash, fat, and crude fiber were measured using recognized methods **(AOAC, 2016)**.
- The value of total carbohydrates was calculated by deducting the sum of the amounts of ash, moisture, protein, fat, and crude fiber from 100.
- Total carbohydrate was calculated by difference. Total calories were determined as mentioned by **(James, 2013)** according to the equation:

Total calories= 4 (%protein + %carbohydrates) + 9 (% fat).

- Iron (Fe), zinc (Zn), and calcium (Ca) mineral contents were measured using an Agilent Technologies atomic absorption spectrophotometer (model 4210 MP-AES), as stated by the **AOAC (2019)** method**.**

Sensory evaluation:

After baking, before undergoing an organoleptic evaluation, the cupcake samples were left to cool for four hours at room temperature (25°C±2).. The samples were assessed in their fresh state. Fifteen semi-trained panelists, all regular cupcake consumers, evaluated the sensory qualities of the cupcakes. Each panelist was briefed on the evaluation procedure prior to its start. Crust color, crumb porosity, aroma, taste, texture, appearance, and general acceptability (consumer preference) were among the sensory qualities evaluated. The panelists had access to ambient-temperature water to wash their mouths in between assessments. The study employed a nine-point hedonic scale, with nine representing "like extremely" and one representing "dislike extremely" **(Anuradha Mishra *et al.*, 2015)**.

Statistical analysis:

SPSS PC statistical the statistical analysis was conducted using software (version 11.0, SPSS Inc., Chicago, USA), and the results were displayed as mean ± SD. The data was subjected to a one-way analysis of variance (ANOVA). In order to ascertain whether the mean differences were significant at ($p \leq 0.05$), Duncan's test was utilized **(Armitage and Berry, 1987)**.

RESULTS AND DISCUSSION

Chemical composition of Wheat flour, Dried green curd of pea peel (DGCPp), and Mixed peel powder (MPP):

According to the data in **Table 2**, on a dry weight basis, the dried green curd of pea peel (DGCPp) contained noticeably more protein, fat, and ash than the wheat four. These findings concurred with those of other research **Vinay (2018)**, **El-Gohery (2020)** who also found higher protein and mineral contents in the extracted juice from pea peel. DGCPp protein content (18.30±0.36) was higher than those of the pea pod powder (PPP, 11.99±0.31) **Vinay (2018)**, which is attributable to the recently developed, efficient technique for preparing DGCPp, which removed brown juice and insoluble dietary fiber to produce a more protein-rich, moist green curd. However, DGCPp's ash content (5.02±0.11) was greater than PPP's reported amount (4.61±0.28%) **(Vinay, 2018)**. Ca (802.99±7.60 mg/100 g) was the most abundant mineral found, and it was also higher in DGCPp than in wheat flour. Along the same lines, **Abd-Allah *et al.* (2016)** and **El-Sharnouby *et al.* (2012)** discovered that the Ca concentrations in PPP (1037.99 mg/100 g) and wheat four (15.0 mg/100 g) were comparable. DGCPp had substantially higher Fe and Zn contents than wheat flour. DGCPp is a good source of both macro and micro elements and can be used to fortify food due to its high mineral content.

The results of a few chemical indicators are shown in Table 2 for the Mixed peel powder of potatoes and carrots (MPP) contained substantially less fat, protein, and moisture on a dry weight basis than wheat flour. The MPP sample has a lower moisture content than the wheat flour sample (7.73% and 11.25%), according to the studied samples. These findings concur with **Dhingra *et al.* (2012)**, where the potato peel powder's moisture content was 7.85%, and **Kohajdová *et al.* (2011)**, where wheat flour moisture was 13.90%. Comparing the carrot peel moisture values obtained experimentally with those reported in previous studies, it can be seen that they are comparable to those reported 7.6% - in pomace powder, in the range 7.12- 7.65% - in powders from carrot wastes 6.80% in carrot peel powder 6.64% in carrot pomace **(Sahni and Shere, 2017**; **Luca *et al.,* 2022**).

As can be observed, the MPP sample's ash and crude fiber contents were 10.24% and 8.03%, respectively. These findings concur with those of other research. For instance, potato peel powder had an ash content of 9.03% **(Rowayshed *et al.*, 2015)** and 0.46% in wheat flour **(Kohajdová *et al.,* 2011)**, On a dry weight basis, the protein content of potato peel powder was 15.71% **(Jeddou *et al.,* 2017)** and 11.32% in flour made from wheat **(Kohajdová *et al.,* 2011)**. Meanwhile**, Leo *et al.* (2008)** showed that potato peel contained 10.76% protein, 10.56% ash, 4.98% fat, 4.97% fiber, and 68.53% carbohydrates. As well as **Sharoba *et al.* (2013)** found that wheat flour contained 11.98% moisture, 11.85% protein, 1.05% fat, 0.51% ash, 0.54% fiber, and 86.04% carbohydrates, whereas potato peel powder contained 3.57% moisture, 6.91% ash, 2.25% fat, 12.17% protein, and 7.25% fiber.

The high percentage of mineral content in DGCPp and MPP may be the cause of the elevated ash content. These findings are consistent with those reported by **Ebere *et al.* (2015)**.

Increased concentrations of vital mineral elements, which have many health benefits, such as tissue maintenance, bone and tooth formation and health, cofactors and coenzymes to improve various enzyme systems, the regulation and coordination of most bodily functions, and other biochemical and physiological functions, are shown in a high ash content **(Awuchi *et al.,* 2020)**.

Table 2: Proximate chemical composition of wheat flour, DGCPp, and MPP on a dry weight basis.

Components	Wheat flour	DGCPp	MPP
Moisture %	11.25±0.36[a]	3.60±0.34[c]	7.73±0.39[b]
Crude protein %	11.50±0.25[b]	18.30±0.36[a]	10.69±0.48[c]
Fat %	0.94±0.07[a]	1.06±0.07[a]	0.61±0.04[b]
Ash %	0.76±0.05[c]	5.02±0.11[b]	10.24±0.22[a]

Crude fiber %	1.15±0.09[b]	7.59±0.38[a]	8.03±0.18[a]
Carbohydrates %	74.38±0.51[a]	64.42±0.86[b]	62.68±0.69[c]
Ca (mg/100 g)	19.06±0.15[c]	802.99±7.60[a]	251.15±5.39[b]
Fe (mg/100 g)	1.32±0.22[c]	10.63±0.65[a]	2.46±0.35[b]
Zn (mg/100 g)	1.07±0.09[c]	3.12±0.14[a]	2.7±0.24[b]
Energy value(kcal/100 g)	352.02±1.98[a]	340.44±2.61[b]	299.05±1.66[c]

- The mean ± SD is used to express the data. At $p \leq 0.05$, mean values in the same row that have different superscript letters [a (the highest values)—c (the lowest values)] are significantly different. Every group was contrasted with the others.

The chemical composition of cupcakes made with wheat flour, dried green curd of pea peel (DGCPp), and mixed peel powder (MPP):

Wheat flour is a typical ingredient. Changing the type of flour can alter the characteristics of the cake and increase its nutritional content. **(Zhang *et al.,* 2012)**.

The findings in **Table 3** show that the percentages of protein, fat, ash, crude fiber, and carbohydrates were significantly impacted when dried green curd from pea peel (DGCPp) was substituted for wheat flour at 10% and 15%. Likewise, the percentages of ash and crude fiber were significantly impacted when the same amounts of mixed peel powder (MPP) were substituted for wheat flour.

Remarkably, the fortified cupcake samples with the 15% DGCPp replacement had the highest levels of protein, fat, ash, and crude fiber in comparison to the control sample (15.31g/100g dry weight for protein, 21.49g/100g dry weight for fat, 2.11% for ash, and 0.87g/100g dry weight for crude fiber). Furthermore, in comparison to the control sample, the 10% and 15% MPP replacements had the highest ash contents (2.62g/100g dry weight and 2.89g/100g dry weight, respectively) and crude fiber contents (0.70g/100g dry weight and 0.81g/100g dry weight, respectively). These findings could be explained by the high protein, fat, ash, and crude fiber content of dried green curd made from pea peels as well as the higher ash and crude fiber content of a potato and carrot peel powder, both of which improve nutritional profiles when compared to wheat flour.

These results are consistent with those of **Abou El-Ez *et al.* (2017)**, who found that pea peel crackers had higher protein content, and **Abd El-Salam *et al.* (2017)**, who found that crackers' protein content increased when protein-rich algae were added. Considering dietary reference intakes **(DRI, 2005)**, an adult female weighing 55 kg and a male weighing 65 kg consume 46 and 56 g of protein daily, respectively. Each 100 g serving of 10% and 15% DGCPp cupcakes in the current study satisfied 26.26% and 33.28% of the daily protein intake for females and 21.57% and 27.33% for males. Ca, Fe, and Zn concentrations in cupcakes were substantially higher in 10% and 15% DGCPp cupcakes compared to control cupcakes, as shown in Table 3. This agrees with **Garg (2015)**, who stated that because of their high mineral content, biscuits made from PPP are beneficial for those with lifestyle diseases. Additionally, the information in the same table showed that adding powdered potato and carrot peels significantly raises calcium and iron levels. These findings are consistent with the research of **Singh *et al.* (2022)**, who found that adding potato peel powder increased minerals by 21%.

Table (3): Cupcakes' chemical composition based on dry weight.

Cupcakes treatment / Attribute	Control	Amount of DGCPp substitution (%)		Amount of MPP substitution (%)	
		10	15	10	15
Moisture %	19.73±0.61[a]	19.72±1.02[a]	21.50±1.80[a]	21.36±0.72[a]	21.41±1.05[a]
Crude protein%	7.58±0.65[c]	12.08±0.78[b]	15.31±0.93[a]	7.89±0.56[c]	8.33±0.96[c]
Fat %	19.54±0.56[bc]	20.28±0.64[ab]	21.49±1.27[a]	17.85±0.41[c]	18.19±1.52[c]
Ash%	1.49±0.28[c]	1.85±0.07[b]	2.11±0.14[b]	2.62±0.12[a]	2.89±0.21[a]
Crude fiber %	0.28±0.05[c]	0.52±0.10[b]	0.87±0.14[a]	0.70±0.05[a]	0.81±0.08[a]
Carbohydrates %	52.71±1.74[a]	46.27±2.33[b]	38.71±3.47[c]	49.56±0.27[ab]	46.26±0.73[b]
Ca (mg/100 g)	65.33±5.50[c]	311.33±3.21[a]	320.33±1.52[a]	88.67±9.07[b]	92.67±2.28[b]
Fe (mg/100 g)	8.58±1.35[c]	16.88±1.73[a]	18.29±1.36[a]	8.76±0.70[c]	11.80±1.43[b]
Zn (mg/100 g)	1.04±0.15[c]	2.26±0.35[b]	3.00±0.33[a]	1.52±0.31[c]	2.33±0.35[b]
Energy value (kcal/ 100 g)	404.94±9.05[a]	409.34±1.76[a]	409.53±6.41[a]	390.50±4.58[b]	400.92±7.96[ab]

- The mean ± SD is used to express the data. At $p \leq 0.05$, mean values in the same row that have different superscript letters [a (the highest values)—c (the lowest values)] are significantly different. Every group was contrasted with the others.

Sensory evaluation of cupcake:

A crucial component in determining whether a processed product is acceptable is its sensory qualities **(Hesarinejad *et al.,* 2019)**. Crust color, crumb porosity, aroma, taste, texture, appearance, and overall acceptability were thus evaluated in the sensory evaluation of cupcake samples. **Table 4** shows the effects of various replacement levels of 10% and 15% DGCPp and replacement levels of 10% and 15% MPP on the sensory qualities of cupcakes in comparison to the control. According to the findings, every sample was suitable. Sample 10%MPP had the highest crust color value (8.13±1.06), while sample 15% DGCPp had the lowest value (4.80±0.88). Samples 10% and 15% MPP had the highest crumb porosity values (7.86±0.83) and (7.60±1.35), respectively, whereas 15% DGCPp had the lowest crumb porosity value (5.53±1.22). The highest texture values were found in samples 10% and 15% MPP (7.20 ±1.69) and (7.40 ±1.18), respectively, while sample 15% DGCPp had the lowest texture value (5.26±0.90).

The crust color, crumb porosity, aroma, taste, texture, appearance, and general acceptability of the 10% and 15% MPP samples did not differ significantly ($p>0.05$). 15%MPP was the most acceptable sample, followed by 10% MPP, 10% DGCPp, and C. The lowest acceptable sample was 15% DGCPp.

The outcomes align with the conclusions of **Belghith-Fendri *et al.* (2016),** who discovered that using pea pod powder flour in cake recipes decreased the sensory evaluations of the cakes' organoleptic qualities. Similar outcomes were noted by **Sudha *et al.* (2007)** for cakes made with apple pod fiber and by **Ayadi *et al.* (2009)** for cakes that contain cladodes flour. Compared to the control, cakes made with 5% pea pod and broad bean pod flour were less palatable. Overall acceptability was rated poorly at 25% and 30% substitution levels. These results outperform those published by **Ayadi *et al.* (2009)** and **Sudha *et al.* (2007)**, who discovered that the substitution of cladodes and apple pod flours in cake recipes was limited to 10%. Furthermore, **Khalifa *et al.* (2015)** found that using potato peel flour in place of 5% and 10% of wheat flour produced cupcakes that were acceptable and did not differ much from cupcakes made with only wheat flour.

Table 4: Cupcakes' sensory qualities.

Cupcakes treatments / Attribute	Control	Amount of DGCPp substitution (%)		Amount of MPP substitution (%)	
		10	15	10	15
Crust color	8.40±0.50^{a}	5.60±1.29^{b}	4.80±0.88^{b}	8.13±1.06^{a}	7.73±0.88^{a}
Crumb porosity	7.66±1.39^{a}	6.80±1.48^{a}	5.53±1.22^{b}	7.86±0.83^{a}	7.60±1.35^{a}
Aroma	8.20±0.94^{a}	6.00±1.36^{b}	4.73±0.98^{c}	7.73±1.57^{a}	7.60±1.12^{a}
Taste	8.06±1.03^{a}	5.33±1.09^{b}	4.33±0.79^{c}	7.86±0.99^{a}	7.73±1.53^{a}
Texture	8.00±1.06^{a}	5.73±1.06^{b}	5.26±0.90^{b}	7.20±1.69^{a}	7.40±1.18^{a}
Appearance	8.53±0.63^{a}	6.33±1.17^{b}	5.33±1.04^{b}	7.66±1.34^{a}	7.60±1.35^{a}
Overall acceptability	8.33±0.97^{a}	5.60±1.29^{b}	5.80±1.02^{b}	7.60±1.24^{a}	7.93±0.96^{a}

- The mean ± SD is used to express the data. At $p\leq0.05$, mean values in the same row that have different superscript letters [a (the highest values)—c (the lowest values)] are significantly different. Every group was contrasted with the others.

CONCLUSIONS:

The study highlights how vegetable peels, specifically those from peas, potatoes, and carrots, can be transformed into nutritious and cost-effective food ingredients. A new method was developed to extract a protein-rich powder (DGCPp) from pea peels, which significantly enhanced the nutritional value of cupcakes, particularly when used at a 15% inclusion rate. In addition, incorporating potato and carrot peel powder not only improved the taste and color but also increased the nutrient content of baked goods. These peel powders provide sustainable alternatives to wheat flour, helping to reduce food waste while enhancing the quality of food products.

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