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Quality evaluation of functional pie crust enriched with banana peel flour

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Abstract

Pie crust is a popular bakery product that is consumed all around the world. It could be used as a beneficial supplementation source for improving nutritional profile and acceptability in large population from all over the world. Banana peels, which are commonly discarded after eating banana pulp, are causing wastage issues. These are considered as a rich source of dietary fiber and some other valuable nutrients, which can offer a significant role in enhancing the nutritional profile and shelf life of product. Keeping in these applications, this research was planned to study the different levels of banana peel powder on rheological, chemical, physical and sensory properties of pie crusts. For quality evaluation parameters like water holding capacity, farinograph assay, moisture, crude proteins, crude fat, ash, crude fiber and dietary fiber nitrogen free extract was analyzed. Physical properties such as width, thickness, spread factor and sensory parameters was also part study. Data was analyzed by using analysis of variance (ANOVA).

Keywords: Pie crust, banana peel powder, quality evaluation, dietary fiber

Introduction

Pie crust is a bakery product that is made up of wheat flour, fat, and water which affect its overall features after baking. It has low moisture content and a high-fat level. These fats provide tenderness, crispiness, and shortness. The strength of gluten in baking products is determined by the protein content of its flour. The structure of baked pie crust remains weak and easy to crumble if its flour contains low protein content. On the other hand, the structure of baked pie crust remains compact and dry if its flour contains high protein contents (Atmaja *et al*., 2022).

Pie crust could be used as a beneficial supplementation source for improving nutritional profile and acceptability in human beings from all over the world. During preparation, nutrients containing fruit and vegetable peels may be incorporated into the pie crust to make it a functional food product (Kandemir *et al*., 2022). As the world population is increasing day by day, the problems with their food are also increasing and the utilization of wasted parts of different fruits is one of the ways to overcome this problem. If we properly manage and use these wastes, we can attain dual benefits from this as it reduces food problems by providing us with a nutritional food product, and in this way, our waste can also be minimized (Ganesh *et al*. 2022).

The banana is a popular tropical fruit belonging to the Musaceae family. The banana industry is a significant part of worldwide industrial agriculture. Bananas are a well-known fruit, with 113 thousand tons produced in 2017 reported by FAOSTAT, (2019). Bananas were produced 115.74 metric tons globally in 2018, Southern Asia and Thailand produced 32.14 metric tons and 1.05 metric tons, respectively reported by FAO, 2020.

Functional Foods (FF): It is observed that there is an increase in food related diseases which are occurring in humans all over the world and especially in developing countries due to the lack of essential nutrients such as protein, iodine, dietary fiber, calcium and some other essential nutrients (Jirukkakul 2021). In contrast to traditional diets, functional foods (FFs) have been found to have physiological benefits and can reduce the risk of chronic illness beyond basic nutritional tasks like gut health maintenance. As a consequence, functional food provides the vitamins, lipids, proteins, carbohydrates, and other nutrients that the body needed to be healthy (Cenic and Walter 2010). Because of their good health effects, functional foods have become a popular modern therapeutic technique in recent years. It's a new name for foods that affect basic nutrition and are fortified with natural ingredients that have a physiological preventive effect that supports certain health outcomes (Vukasovi 2017) [19]. Following that, the focus shifted to meals supplemented with micronutrients like omega-3 fatty acids, phytosterol, and soluble fiber to promote good health and prevent illnesses like cancer (Arshad *et al*., 2021) [5]. Functional foods have mostly been developed in dairy, confectionery, soft drinks, bakery, and baby-food sectors, among others (Nevara *et al*., 2022).

Usage of banana peel powder: The pulp of banana is mostly consumed raw, but their peel is discarded as trash that causes solid waste management issues (Kema *et al*., 2021). The role of banana peel powder in the food industry is accepted and encouraged by analysts due to its important compounds such as dietary fiber and nutrients. Simultaneously, the attention towards utilization of these sources of nutritional compounds from fruit peel powder is growing to make functional food products (Zaini *et al*., 2019) [21]. Banana peel powder have higher protein, fat, and fiber contents than wheat flour. The water holding capacity (WHC) of banana peel powder is higher than wheat flour. The moisture content of the banana peel powder is also lower than the wheat flour (Eshak, 2016) [13].

The use of banana peel powder as a source of fat, carbohydrates, minerals & dietary fiber is very beneficial from nutritional perspective. Banana peel powder can be used for different medical purposes because of its dietary status. We can use it for the treatment of heart infection, the intestinal sore, diarrhea, ulcerative colitis, looseness of the bowels, nephritis, gout, hypertension and diabetes. Higher fiber content in banana peel powder is also helpful for the treatment of constipation and

improve general health and wellbeing (Rebello *et al*., 2014). The advised dietary fiber intake for youngsters must be 20-30 g per day but according to a reported data, in teenagers, the daily mean eating of dietary fiber is still lesser than the suggested daily consumption of dietary fiber with an average of 12g/day dietary fiber (Ng *et al*., 2016). This lack of dietary fiber occurred when a lot of population moved from villages to big cities and this movement changed the consumer's preferences. Due to this migration, the breakfast pattern of people is changed and they start consuming high-fat foods, fast food and other unbalanced diets (Nemnunhoi & Sonika, 2016).

Implementation and Aptness of Banana Peel Powder in Food Items

Flour, which may be used in a variety of bakery items, is the most frequent way to incorporate bio-waste into FF. The mixed-method approach with the exploratory and explanatory design was used to investigate the use of BPP in the production of nutraceutical meals (Bakar *et al*., 2018) [8]. The food industry's literature has opened the path for investigating how BPP is employed by food scientists. The novelty of this phenomenon leads to an examination of several non-academic pieces, such as those written by experts on their blogs or published by newspapers and magazines that have explored the use of BPP in the valorization of functional foods.

After a series of studies to determine the maximum degree of whole meal flour (WMF) substitution with BPP in bread, comparison research was conducted on a control bread sample and another sample with 7% substitution with BPP. The sample with 7 % BPP had a greater total DF content than the control sample. This increased antioxidant activity did not appear to be enough to extend the sample's microbiological shelf life. It also had a much greater total phenolic content, about twice that of the control sample (Nasution *et al*., 2012). Chapatti dough produced with BPP (5, 10, 15, and 20%) was evaluated for dough viscosity, sturdiness, kneading, and reliability. Chapatti produced with dough containing BPP (5, 10, 15, or 20 %) has a lower tear force than regular bread. Enhanced BPP levels resulted in higher dough stickiness as well as increased dough strength (Kurhade 2016). Five samples of biscuits were made by replacing WF with 0, 5, 10, 20, and 30 % BPP in regular biscuits. The ash concentration in the control sample was 1.5 percent, whereas it ranged from 1.80 percent to 2.0 percent in the BPP substitution samples. Biscuits prepared with BPP (10 %) had a larger spreading than biscuits made up of different elements (Khatun *et al*., 2021). Biscuits were made with varying quantities of Unripe BPP (0 % to 40 %). Biscuits using UBPP as a partial substitute had a higher total DF level. The partial substitution of Berangan BPP significantly reduced the rate of starch digestion in biscuits (Bakar *et al*., 2020) [7].

Green banana peel powder (GBPP) (5, 10, 15, and 20 %) is used to make a gluten-free nutrition cake, and the physical features of green BPP replacement cakes are investigated. Sensory investigations showed that all GBPP replacement levels were reliable as determined by the hedonic scale, resulting in correct physical characteristics (Turker *et al*., 2016). The water content of the test product is 17.52 percent, the ash content is 1.14 percent, the protein content is 17.23 percent, and the carbohydrate content is 18.52 percent. Wheat flour and BPP formulations preferred by panelists were almost 75% and 25% respectively (Mutia *et al*., 2018). Mineral analysis revealed that cookies made with BPP included greater levels of calcium, potassium, magnesium, iron, manganese, potassium, and sodium than cookies made with wheat flour. BPP was substituted at 11 percent, 13 percent, and 15 percent in wheat flour before being used to make cookies (Oguntoyinbo *et al*., 2021).

With the addition of BPP, the lightness value, and aroma of the muffin crust and crumb all dropped. The springiness was improved by the use of BPP. Singh *et al*., (2022) [16] produced a functional snack bar for starved persons using various mixtures of amaranth grain, oat, and BPP. Protein, mineral, b-glucan, DF, essential amino acid, phenolic, and antioxidant properties of the healthy snack bar were increased by the addition of oat and BPP. Fresh egg noodles exhibited lighter color and harder texture than dried egg noodles, but greater phenolic compounds. To compare wheat flour egg noodles to egg noodles fortified with BPP at two levels (40 and 60 %). As a result, BF egg noodles have a greater chance of being employed to increase the commercial-grade of egg noodles (Jirukkakul 2021). A physical study of yellow noodles found that replacement levels of 20 and 30 % resulted in worse physical qualities. BPP was substituted for wheat flour in the creation of healthy yellow noodle formulations (10, 20, and 30%). The pH, color, strength, and elasticity of BPP yellow noodles were all tested (Zanariah *et al*., 2019) [22]. Castelo-Branco *et al*., (2017) created tagliatelle pasta using varying percentages of green banana mixed pulp and PP (GBPP) instead of wheat flour. The GBPP was utilized to substitute wheat flour in the pasta compositions in two concentrations (15 and 30 %). The pasta formulations, with 15% BPP added had the highest ash content as well as the highest sensory acceptability. The addition of BPP to low-fat mayonnaise resulted in a considerable difference in pH, moisture, and constant sensory rating. The addition of BPP can improve the emulsion's stability and acceptability, and mayonnaise made with 1% BPP was of high quality (Evanuarini and Susilo 2020). Ripe and ripe BPPs are now being used to improve nutritional and physicochemical features in a variety of food items (e.g., bread, noodle, jelly, or meat products, among others). Increased physiochemical and antioxidant efficacy will almost surely come from a larger content of BPP in a food recipe.

Results and Discussions

The latest results of the study are presented in the following chapter.

Analysis of ingredient flours: The industrial application of peel extracts as ingredients depends upon various desirable characteristics which are known as functional properties. These are the physiochemical characteristics that influence the behavior of banana peel flour in different food formulations. Functional properties of extract flours are evaluated to assess their suitability for industrial application.

Rheological Properties of Included Flours

Table 4.1 depicts the rheological properties of both varieties of banana peel powder along with wheat flour. The value of water holding capacity (WHC) in table 4.1 indicates that BPP (variety 1) has the capacity to absorb more water than its weight. This high WHC of BPP might be attributed to the elimination of non-protein components during the extraction process ensuing better swelling, dissociation and unfolding to expose additional binding sites.

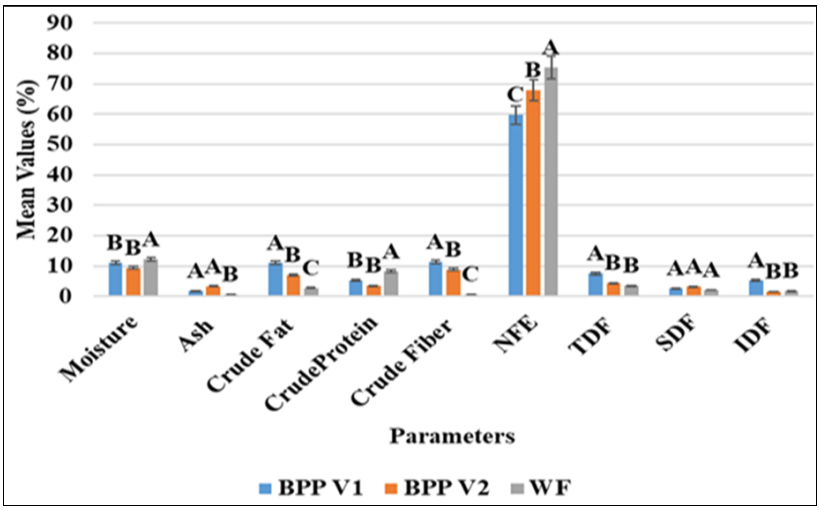
Oil holding capacity (OHC) is a decisive attribute in BPP functionality because of its influence on emulsifying capacity which is an advantageous feature in the food formulation systems. High oil holding capacity of BPP variety 2 (0.9) indicated by table 4.1 make it a promising ingredient for bridging the water and fat, especially in bakery products. The BPP variety 1 has low OHC than BPP variety 2.

Table 1: Rheological Properties of Included Flours

Parameters	WF	BPP V1	BPP V2
Water Holding Capacity	3.59	5.89	4.02
Oil Holding Capacity	0.97	1.56p	1.74

Proximate Composition of the Included Flours

The proximate analysis of our included flours indicates that the BPP (variety 1) and BPP (variety 2) have less moisture and more ash content in them. The fiber and fat content of wheat flour is also less than both varieties of BPP but wheat flour has more carbohydrate than BPP(s).



Chemical analysis of pie crust

Chemical analysis is an essential criterion to evaluate the nut total quality as well as suitability of any ingredient for food applications. The results of chemical analysis on the pie crust with BPP (variety 1) and whole wheat samples are presented in table 4.4. The chemical analysis of BPP in general depicts the percentages as; Moisture % (11.650), Ash % (84.61), Fat % (19.63), and Fiber % (14.125). The results showed that BPP treated pie crust contained significantly better chemical composition in formulated pie crust compared to control crust.

The table 4.4 indicate the average values of chemical analysis after triplicating the treatments. T_0 depicts the control pie crust with 0 % BPP, whereas variety 1 refers to the Pakistani variety of banana and variety 2 refers to the Indian variety of banana. The significance of treatments and contents is statistically evaluated by using one-way ANOVA. All the significant values are highlighted in table 4.4.

Table 4.4 summarizes that with the increase in percentage of banana peel powders the chemical properties of pie crust are evaluated to be better. The arrangement of improved samples according to the treatments is $T_5 > T_4 > T_3 > T_2 > T_1 > T_0$. It indicates that including BPP has improved the chemical properties of pie crust. It is clearly depicted that moisture content is decreased and ash content is increased with the addition of BPP percentage respectively. Crude fiber and dietary fibers (TDF, SDF, and IDF) are also increased with the increase in quantity of BPPs with the constant quantity of wheat flour. Carbohydrate and nitrogen free extract also have increased values with the increased percentage of BPPs. While protein content of the pie crust is decreased with the increase in banana peel powder because BPP contains low protein content as compared to wheat flour, the chemical composition of the pie crust was considerably altered by both kinds of BPP ($p < 0.05$). The moisture level of pie crust derived from the addition of BPP varieties 1 and 2 has the lowest values, but the ash content has increased significantly ($p < 0.05$). These levels were within the allowed range (20.0%) for achieving a stable shelf life. Protein is essential for the human body's growth, healing, and maintenance, as well as the maintenance of fluids, and protein functions as enzymes, hormones, and other substances. The protein content of the BPP-treated pie crust was also significantly higher ($p < 0.05$) than that of the wheat flour-treated pie crust. With an increase in BPP concentration, all treatments had significantly increased protein content.

The carbohydrate content of the pie crusts differed considerably ($p < 0.05$). Furthermore, the carbohydrate content of BPP-incorporated pie crusts varied between 79.3±0.25 and 89.3±0.26. The fat content result ranged from 4.5±0.00 to 7.14±0.01, with a substantial difference between. The fat level of all samples was similar due to the same amount of flour used.

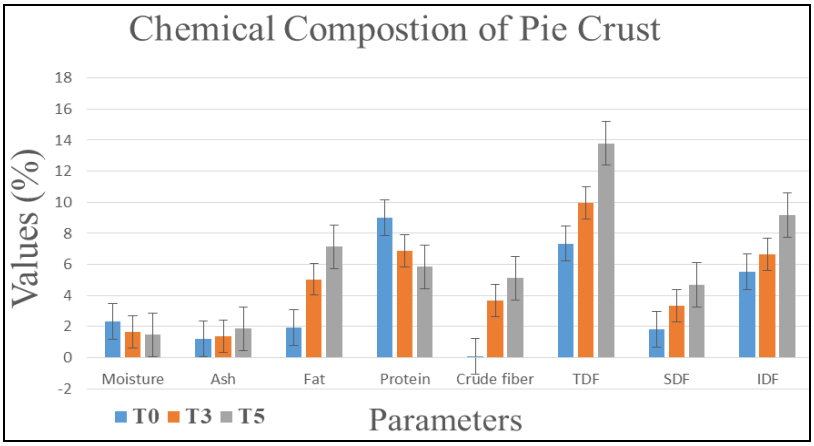


Fig 1: Graphical results shown the Chemical composition of pie crust with both varieties of BPP

Table 4.5 represents the chemical composition of treatments using wheat flour and BPP (variety 1) for the preparation of pie crust. The pie crust formulated with the more concentration of BPP (variety 1) show significant and better characteristics in terms of chemical properties. The average values for T_6 to T_{10} after three experiments are depicted in the table 4.5. These treatments include 3 %, 6 %, 9 %, 12 %, and 15% of BPP (variety 1) respectively and it shows that the highest the concentration of BPP is the better is the composition of pie crust.

The mean moisture content of developed pie crusts (T_6 to T_{10}) is lower than the control pie crust. Developed pie crust had higher fat contents than control pie crust. As compared to control crust with original and the developed recipe showed no significant difference ($p > 0.05$) in the fiber content (Table 4.5). However, there are significant differences ($p < 0.05$) in the moisture, fat, ash, NFE, and carbohydrate contents of the samples (Table 4.5). The inorganic minerals that make up the sample are represented by the ash content. When comparing wheat flour pie crust to BPP integrated pie crust, the BPP created samples exhibit a greater ash content. Overall, there was a reduced mineral content. Furthermore, the ash concentration of BPP-incorporated pie crusts varied between 1.29±0.05 and 2.81±0.06.

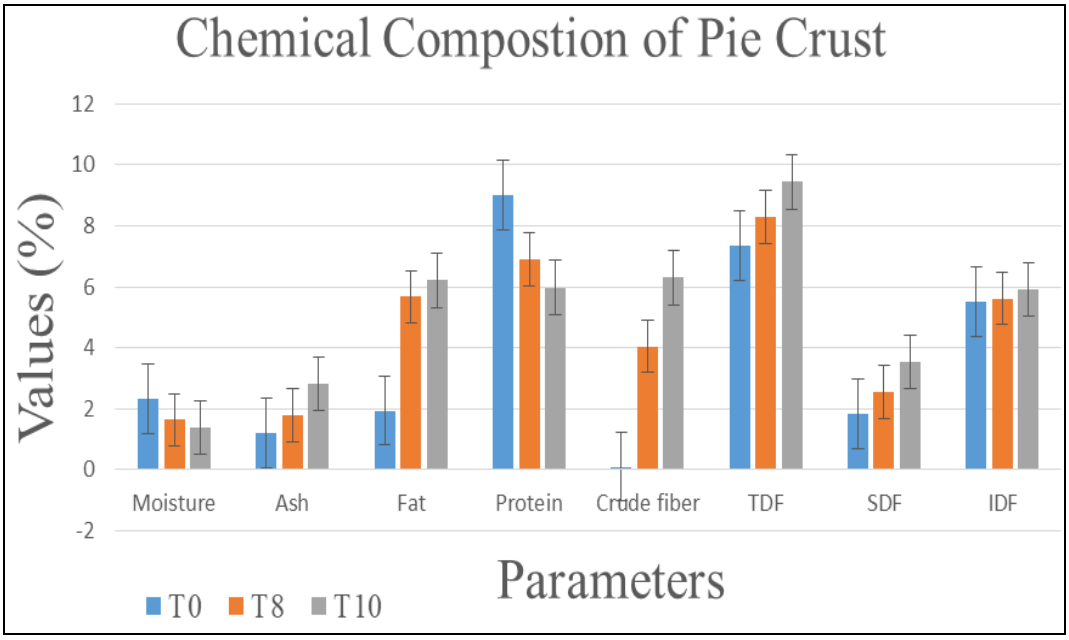


Fig 2: Graphical results shown the Chemical composition of pie crust with variety 1 of BPP

The results (Table 4.6) showed that banana with peel flour treated pie crust contained significantly better proximate composition. It is observed from (Table 4.6) that protein and fat, ash, and crude fiber increased with increasing levels of substitution of BPP variety 2. There is significant difference ($p < 0.05$) in crude fat, crude fiber and ash contents between BPF formulated pie crust and control pie crust. Banana peel flour contained higher amount of fiber and ash which attributed to higher amount of ash and fiber in the formulated pie crust compare to the control sample. The moisture content of pie crusts made with BPP variety 2 varies from 2.13±0.30 to 2.66±0.65, however the ash content has increased significantly from 1.23±0.55 to 2.56±0.58. The BPP variety 2-treated pie crust had a considerably greater protein content (9.45±0.4 to 10.95±0.27) than the wheat flour-treated pie crust. All treatments had significantly higher protein content when the BPP concentration was increased.

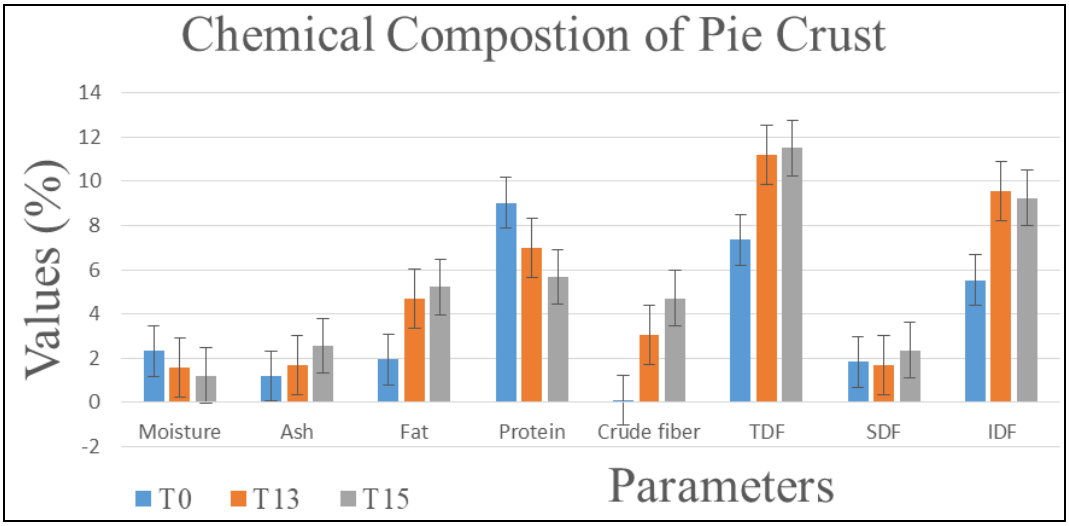


Fig 3: Graphical results shown the Chemical composition of pie crust with variety 2 of BPP

Sensory evaluation of pie crust

The results of sensory analysis on the BPP and whole wheat pie crust samples are presented in table 4.9. The mean score of sensory properties is significantly varied among control sample, pie crust (BPP variety 1 with BPP variety 2), pie crust (BPP variety 1), and pie crust (BPP variety 2) and the post-hoc test (DMRT) has suggested the mean significant in case of all formulated products compared with the control product ($p < 0.05$). There is significant difference in attributes including color, flavor, texture, and taste between the banana peel flour using products and control products.

Regarding the taste attribute, the formulated BPP (variety 1) pie crust and formulated BPP (variety 2) obtained the highest average. Color and Flavor of all samples are significantly different ($p < 0.05$). One of the most significant quality criteria for pie crust is its texture. All of the formulations are compared to the texture of a 100 percent wheat flour pie crust, which is considered a commercial style pie crust. The textural parameters of the pie crust did not alter much. There is no significant difference between taste and internal texture in all BPP using samples.

Flavor is the major criterion for liking or disliking of a product. The statistical results clearly manifested that the flavor scores of the pie crusts were significantly ($p < 0.05$) affected by the variations in the concentration levels of BPP (Table 4.20). The data regarding average scores for flavor clearly indicated that the panelists accepted the pie crusts from all the treatments with respect to the flavor scores. The judges also accepted the pie crusts from all the treatments with respect to the texture and color scores.

Table 2: Sensory Evaluation of Pie Crust

Treatments	Color	Taste	Flavor
T_0	4.46±1.53	5.21±1.07	5.15±1.49
T_1	3.91±0.90	4.42±1.06	4.59±1.31
T_2	2.80±1.52	3.67±1.29	3.60±1.36
T_3	2.26±1.20	3.32±0.97	2.59±1.03
T_4	4.87±1.52	4.70±1.32	5.05±1.41
T_5	3.98±1.30	4.67±0.89	4.90±1.33
T_6	3.07±0.99	3.75±0.48	3.98±0.93
T_7	3.01±0.90	4.0±1.05	4.2±1.3
T_8	2.6±1.52	3.5±1.29	3.67±1.36
T_9	2.7±1.20	3.4±0.97	3.02±1.03
T_{10}	5.01±1.52	5.0±1.32	5.05±1.41
T_{11}	3.98±1.30	5.01±0.89	4.90±1.33
T_{12}	3.56±0.99	3.8±0.48	4.01±0.93
T_{13}	2.7±1.20	3.4±0.97	3.02±1.03
T_{14}	3.98±1.30	4.67±0.89	4.90±1.33
T_{15}	2.6±1.52	3.5±1.29	3.67±1.36

Treatment values for color, odor, flavor, and texture are represented as *mean SD*.

Summary

Due to the increase in the world's population, people are looking for new nutritional products. The baking industry is filling this gap with new products at a very slow pace. Pie crust is a popular bakery product that is consumed all around the world. It could be used as a beneficial supplementation source for improving the nutritional profile and has acceptability in a large population from all over the world. Very little data have been published in the scientific literature for the preparation of pie crust using various fiber sources. Scientific researchers and the baking industry may work together to bring new value-added products in the market that may meet consumer demand.

Banana peels, which are commonly discarded after eating the banana pulp, are causing wastage issues. These are considered a rich source of dietary fiber and some other valuable nutrients, which can offer a significant role in enhancing the nutritional profile and shelf life of the product. These results indicated that banana peels contain valuable functional ingredients for human consumption, especially to be incorporated in bakery products such as whole meal bread, and cake. Besides adding nutritional value to food products, BPF also stands out for not creating production waste, thus representing the complete use of the fruit, increasing the yield, and reducing manpower costs due to peeling which is not required.

The present study is to introduce Food applications of banana peel flour for achieving two goals; first, helping the environment through sustainability by utilizing secondary processing products, and second, creating a new outlook for consumers and producers for generating value-added food products. Keeping in these applications, this research was planned to study the different levels of banana peel powder on rheological, chemical, antioxidant, physical, and sensory properties of pie crusts. For quality evaluation parameters like water holding capacity, farinograph assay, moisture, crude proteins, crude fat, ash, crude fiber, and dietary fiber nitrogen-free extract was analyzed. Physical properties such as width, thickness, spread factor, and sensory parameters were also part of the study.

The mean score of taste was significantly varied among all samples of pie crust and the post-hoc suggested the mean significant in case of all formulated products compared with the control product ($p < 0.05$). There was significant difference in all attributes including color, flavor, texture, and taste between the banana peel flour using products and control products. Sensory evaluation showed that BPP variety 1 was more preferred compared to that of the BPP variety 2. In addition, high concentration BPF Treated pie crusts are lower in protein and moisture when compared to the control pie crust sample from wheat flour. Proximate composition of the BPP formulated pie had significantly ($p < 0.05$) higher contents of protein, ash and fiber. The carbohydrate content in BPP pie crusts were significantly higher than the control. The developed products appear to be an additional benefit for human health and can be appropriate parts in diet plan. The results of this

study suggest that the pie crusts of acceptable physical characteristics can be produced by the supplementation of banana peel powder into wheat flour.

The results clearly showed that the proximate composition and antioxidant content of banana peel flour (Pakistani and Indian) were greater than wheat-created pie crust. Pie crusts supplemented with banana peel flour reduce banana peel loss while also boosting nutritional quality. Instead of using 100 percent wheat flour, banana peel flour is used to improve the texture of pie crusts. Among the fifteen formulations, the formulation by treatments 6 to 10 achieved the highest performance.

Recommendations

Overall acceptance of bakery food products is usually influenced by its making method, ingredients and how they baked. So, the modern instruments, standard procedure and quality control assessment should be ensured for consumer acceptance.

Also, further studies, especially clinical trials are needed to be considered in order to confirm the health benefits of banana flour enriched food product.

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