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Development, Standardization, Physico-chemical and Nutritional Analysis of Biscuits with Different Levels of Pumpkin (*Cucurbita maxima* L.) Peel Powder

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Abstract. Fruits and vegetable's peels which are usually discarded during consumption and processing and good source of nutrients. Pumpkin is extensively grown and consumed vegetable in subcontinent. Pumpkin peel is considered as waste material and discarded, which contains essential nutrients in sufficient quantities. In present study pumpkin peel powder (PPP) biscuits were developed by the replacement of straight grade flour (SGF) of wheat, with 0, 5, 10 and 15% of PPP and standardized. Physico-chemical analyses of PPP, SGF and developed biscuits which were performed. Ash, fat and fibre contents were higher in PPP as compared to SGF whereas, moisture and protein contents were lesser. By increasing the replacement level of PPP with SGF, a significant increase in ash, fat and fibre in biscuits was observed, whereas, moisture and protein contents were slightly decreased. Colour analysis of SGF and PPP revealed that a* (redness) and b* (yellowness) values of PPP were higher than SGF, whereas, L* (lightness) values of PPP were less than SGF. By increasing replacement level of PPP with SGF, a* and b* values significantly increased. Mineral analysis revealed that Na, K and Fe were higher in PPP and increased in biscuits by increasing the level of PPP, whereas Ca, Mg and P were lesser in PPP as compared to SGF. Upon sensory evaluation, biscuits developed with 5% level of PPP, got highest scores, close to the control, whereas 15% level was not liked by the judges. Biscuits incorporated with pumpkin peel powder could be a good choice in market as functional food products demanded by health-oriented consumers.

Keywords: pumpkin peel powder, by-product, straight grade flour, value addition, physico-chemical

Introduction

Nowadays, fruit and vegetable industries produce large quantities of by-products possessing huge economic potential. Almost 25 to 60% of the weight of fruits and vegetables are comprised of by-products including greater percentage of peels. These by-products are composed of an interesting chemical composition, leading their potential use in food products (Rico *et al*., 2020). Use of synthetic additives in foods is a serious concern of consumers therefore, this is need of food industry to include medicinal plants and their parts in the forms of extracts and powders to produce functional foods (Peanparkdee and Iwamoto, 2019). In Brazil, comparative studies on peel, pulp and seeds of vegetables revealed that peels and seeds contain more nutrients such as vitamins, minerals and phytochemicals, than pulp. Due to this fact flours prepared from peels of fruits and vegetables are used in bakery products production such as breads, biscuits, cakes and cereal bars. This addition of fruits and vegetable's peels flours in wheat flour not only improves the nutritional values of the bakery products but also reduces the cost of production as peels are considered as waste material (Mishra and Sharma, 2019). Fruits and vegetables have important role in human health in aspect of diet as these are healthy source of nutrients such as carbohydrates, vitamins, minerals and fibre. Due to these elements fruits and vegetables possess elite status among food crops. Presence of oxygen radical scavengers like ascorbic acid, calcium, fiber and β carotene makes fruits and vegetables important part of human diet as these nutrients reduce risk of heart diseases, cancer and early

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aging process. Among fruits and vegetables pumpkin is considered an important vegetable crop due to its nutritional and medicinal uses (Abd El-Aziz and Abd El-Kalek, 2011).

Production of pumpkins, squashes and gourds in 2019 was estimated above 23 million tons cultivated all over the world comprising an area of 1.54 million hectare, while in Pakistan this production was estimated 2.7 lac tons cultivated on 26515-hectare area (FAO, 2019). Pumpkin is one among the most consumed vegetables in subcontinent (Mishra and Sharma, 2019). It is cultivated throughout the world for use as vegetable as well as medicine. It has been used traditionally as medicine in many countries such as China, Argentina, India, Mexico, Brazil and America (Andrade-Cetto and Heinrich, 2005).

Different pumpkin fruit fractions (seeds, peels and flesh) are important sources of dietary fibers, minerals, antioxidants, carotenoids and phenolics. The intake of these compounds has beneficial effects on human health (Tlili *et al*., 2020). Pumpkin is a rich source of phenolics, flavonoids, vitamins (vitamin A, vitamin B_2, vitamin C, vitamin E, β carotene and α tocopherol), carbohydrates, amino acids and minerals (potassium, calcium, selenium, magnesium etc.). It contains large amount of dietary fibre and very low amount of energy. Pumpkin fruits are considered excellent source of pro-vitamin A carotenoids, which are very helpful in prevention of vitamin A deficiency (Kim *et al*., 2012). As a valuable nutrients source, it is used in a variety of foods by humans, it is also a food of animals. The edible portion of fruit (pulp) is cooked as a vegetable and also incorporated into different foods like bakery products, pies, jams and soups. Pumpkin powders and flakes are used in sauces and soups as colouring agent, thickening agent and flavouring agent (El-Adawy and Taha, 2001). This high value food possesses economic value indirectly and due to its role in maintaining good health of living body (Kocyan *et al*., 2007). Peel, pulp and seeds may contribute in economics of the pumpkin crop by its increased use and provided health benefits. One of the possible uses of this fruit is in snacks and breakfast cereal products which are gaining importance in this modern and busy lifestyle in emerging countries, due to their ready to eat nature, ease in preparation and conveniences (Perez-Navarrete *et al*., 2006).

Dietary fibres such as pectin from pumpkin peels have been reported to slow down the starch digestion, which helps to cure diet-related diseases, such as diabetes (Bai *et al*., 2020). Peel of this fruit contain significant amount of fibre, protein, minerals such as calcium, magnesium, whereas lesser amounts of carbohydrates, lipids and potassium, as compared to pulp, which is commonly consumed portion of pumpkin (Monteiro, 2009). Flour of pumpkin peel is characterized by high contents of minerals and dietary fibre and addition of this flour improved the physicochemical, sensory and cooking characteristics of bovine burger (Hartmann *et al*., 2020). This peel flour was analyzed for proximate composition and functional properties and was utilized at different replacement levels with wheat flour and developed biscuits with improved physical and sensory characteristics (George, 2020). Biscuits developed with addition of pumpkin peel puree when analyzed for physico-chemical properties, exhibited prominent results in terms of minerals, fibre, β carotene and vitamin C (Saleh and Ali, 2020). Production of flour from local pumpkin peel and its utilization in preparation of biscuits may increase the nutritional value of biscuits, the commonly consumed snacks by every age of people. Research on biscuits has been geared up for increment of nutritional and pharmacological characteristics, through addition of non-wheat flours from fruits and vegetables wastes, and current trials could add valuable contribution in this field. Objectives of present study were to develop and investigate pumpkin peel flour for its physico-chemical properties and to develop and standardize pumpkin peel flour-based biscuits and analyses their physico-chemical composition.

Materials and Methods

Procurement of raw materials. Straight grade flour and other raw materials for biscuits preparation were purchased from local market of district Sargodha, Pakistan. Mature pumpkins (n=50) with an average weight of 5 ± 0.5 Kg, were collected from the fields directly and sample was submitted to Botany Department, University of Sargodha for identification. All chemicals used in this research were of reagent grade and were purchased from Sigma-Aldrich, Germany. Same trade ingredients were used in each trial.

Preparation of pumpkin peel powder. Pumpkins were washed manually, peeled with knife to remove flesh and seeds portion. Pumpkin peels were dried in hot air oven (BIOBASE HAS-T105 China) at 60 °C till constant moisture content was achieved. After drying grinding

of pumpkin peel was done with spice grinder (NIMA NM-8300 Japan), to obtain pumpkin peel powder as described by Pongjanta *et al*. (2006), with some modifications. Final powder was packed in polyethylene bags and stored at ambient conditions.

Preparation of composite flours. The composite flours containing different percentages of straight grade flour (SGF) and pumpkin peel powder (PPP) were prepared as presented in Table 1.

Preparation of biscuits. By replacing SGF with PPP at 0, 5, 10 and 15% levels, biscuits were prepared according to the method described by Kulkarni and Joshi (2013) with some modifications. Briefely explaining, butter and sugar with equal proportion were mixed first in four different bowls and then eggs were added and again mixed well. Then flours with different proportions of SGF and PPP were added in each bowl and batter was developed for each flour, which were separately sheeted, moulded and then baked at 160 °C in oven. Prepared biscuits were packed in polythene bags and kept inside labouratory shelf at ambient conditions. From preparation of PPP to development of composite flours and then biscuits with different proportions of SGF and PPP, an overview of the work in the form of systematic diagram has been presented in Fig. 1.

Physico-chemical analysis of SGF, PPP and developed biscuits. SGF, PPP and developed biscuits were analyzed to determine moisture, protein, fat, fibre and ash contents, according to AACC (2000) methods and also determined width, thickness and spread factor of prepared biscuits. PPP, SGF and biscuits were analyzed with colour meter to determine L*, a* and b* colour values. Colour values were measured according to the method described by Rocha and Morais (2003).

Mineral's analysis of SGF, PPP and developed biscuits. Estimation of some important minerals like Na, K, Fe, Ca, P and Mg in PPP, SGF and biscuits was carried out in high Technical Laboratory, University of Sargodha.

Table 1. Composition of composite flours

Treatments	Straight grade flour (SGF) (%)	Pumpkin peel powder (PPP) (%)
T_0	100	0
T_1	95	5
T_2	90	10
T_3	85	15

Concentration of mineral was determined by running the diluted samples through Atomic Absorption Spectrophotometer using air acetylene flame by following the procedure described by Abdel-Hameed *et al*. (2014), with some modifications. Briefly explaining, PPP and SGF samples each (1 g), were digested with 10 mL mixture of perchloric acid and Nitric acid, at temperature range of 180-200 °C until the solution turned transparent. Then dilution of this digested matter was made upto 100 mL through double distilled water. These diluted samples were run through atomic absorption spectrophotometer for measuring mineral contents concentration using air acetylene flame. Trials were conducted in triplicate and mean values were calculated.

Sensory evaluation of biscuits. Twenty-five semi-trained judges from the Food technology department were chosen to serve on the panel that assessed the biscuit's colour, flavour, taste, texture and overall acceptability. The method outlined by Larmond (1977) was used to determine sensory qualities. The trained taste panel was first informed on the project as a whole. On a 9-point hedonic scale, the judges assigned grades to various biscuits preparations: 1 for extremely poor, 2 for very poor, 3 for poor, 4 for below fair and above fair, 5 for fair, 6 for below fair and below poor, 7 for good, 8 for very good and 9 for excellent. Data obtained was calculated as means ± standard deviations.

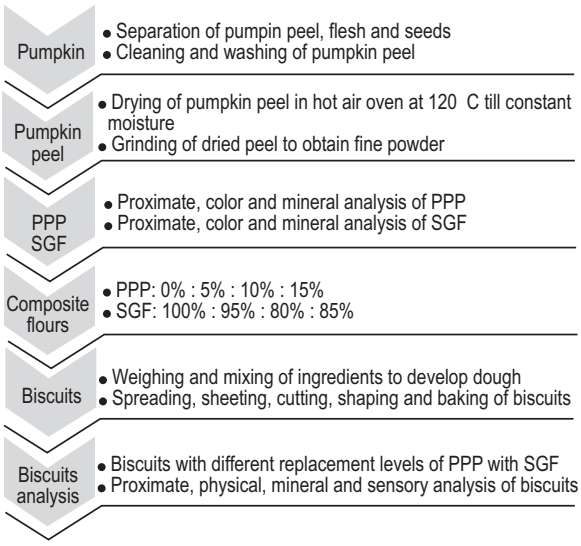

Fig. 1. An overview of research work plan in the form of systematic diagram.

Statistical analysis of data. All analyses, except sensory evaluation, were performed in triplicate and results were expressed as means ± standard deviations. For sensory scores means of scores of 25 experts were calculated for each parameter. The statistical analysis was done using one-way ANOVA. Duncan's multiple-range test was used to differentiate between the mean values.

Results and Discussion

Proximate analysis of PPP and SGF. SGF and PPP were analyzed for proximate composition and values have been presented in Table 2, where chemical composition of SGF could be seen as moisture contents 13.56±0.04%, ash contents 1.06±0.04%, fat 0.97±0.05%, fibre 0.72±0.03% and protein 10.11±0.05%, whereas, from the proximate composition of PPP results were: moisture 10.79±0.03%, ash 3.61±0.04%, fat 1.77±0.04%, fibre 3.10±0.03% and protein 1.90±0.03%. From the proximate analysis results, it was clear that PPP contained greater ash, fat and fibre contents and lesser moisture and protein contents, as compared to SGF and this fact was behind the reason of incorporation of PPP in SGF for development of nutritional biscuits. High ash in PPP provides sufficient amount of important minerals, whereas high fiber has been found associated with good hydration properties of the flour, leading to good quality product.

Wheat flour is a major raw material used in baking industry as wheat is a staple food used worldwide but lack of certain nutrients in wheat flour is an obvious drawback for this ingredient to be utilized in food industry. Proximate composition of wheat flour determined by Ocheme *et al*. (2018), provided values as, moisture 9.1%, ash 0.70%, fat 1.93%, fibre 0.84% and protein 14.70%. Certainly, this wheat flour was deficient in ash, fat and fibre contents and incorporation of PPP in SGF in current trials was useful to increase the ash and fiber contents of the final product. Proximate composition of SGF determined in present study was very close to proximate composition of white flour provided by Siddique and Hashmi (1995), in which moisture was 12.46%, ash 0.85%, fat 1.18%, fibre 0.58% and protein was 11.58%. Saeid *et al*. (2015) determined proximate composition of commercial wheat flours and described results range, as moisture 9.90-12.48%, protein 8.67-12.47%, fat 0.89-1.39% and ash 0.39-0.71%. On the other hand, results of PPP in our study also did not differ too much as were described by Kim *et al*. (2012) in his research work, in which chemical composition of three parts (peel, flesh and seeds) of pumpkin was analyzed. Kim's findings for pumpkin peel were as: moisture 75.68%, ash 1.120%, fat 0.869%, fibre 2.24% and protein 1.65% and in these results greater amount of moisture was due to pumpkin peel analyzed instead of PPP. George (2020) evaluated pumpkin peel powder for its chemical composition and supportive results, matching with current study were found. Staichok *et al*. (2016) found almost the same results for proximate composition of pumpkin peel powder. Nyam *et al*. (2013) reported moisture 5.96%, fat 5.77%, protein 23.89% and ash 0.41% in pumpkin peel powder.

Table 3. Colour values of SGF and PPP

Raw materials	L*	a*	b*
SGF	85.50±0.06a	-1.05±0.04a	22.15±0.03b
PPP	71.85±0.07b	-2.51±0.06b	31.93±0.08a

Mean values accompanied with same small alphabetical letters are statistically non-significant and with different small alphabetical letters are statistically significant (P>0.05). SGF = straight grade flour; PPP = pumpkin peel powder.

Colour analysis of SGF and PPP. Colour analysis revealed that a* (redness) and b* (yellowness) values of PPP were higher than SGF whereas L* (lightness) values of PPP were less than SGF (Table 3). This probably was due to presence of more carotenoids in PPP as compared to SGF. Peels of fruits and vegetables have different colours, which find their source carotenoids, the colour pigments. Different wheat flours when tested for total carotenoid contents, provided more

Table 2. Proximate composition of SGF and PPP

Raw materials	Moisture (%)	Ash (%)	Fat (%)	Fibre (%)	Protein (%)
SGF	13.56±0.04a	1.06±0.04b	0.97±0.05b	0.72±0.03b	10.11±0.05a
PPP	10.79±0.03b	3.61±0.04a	1.77±0.04a	3.14±0.03a	1.90±0.03b

Mean values accompanied with same small alphabetical letters are statistically non-significant and with different small alphabetical letters are statistically significant (P>0.05). SGF = straight grade flour; PPP = pumpkin peel powder.

or less values of carotenoids, the agents responsible for a* and b* values of wheat flour but due to presence of lesser amount of carotenoids L* value is always higher of white flour (Hidalgo *et al*., 2014). Results similar to the results of colour analysis of SGF in our study, were provided by Park and Baik (2014). Singh *et al*. (2008) found L*, a* and b* values of wheat flour as 94.43, 2.73 and 9.23, respectively and these results were slightly different then current ones, which probably was due to the difference in the wheat variety used and differences in the grades of the flours. Staichok *et al*. (2016) determined L*, a* and b* values of pumpkin peel flour as; 66.95, 1.39 and 23.09, respectively, and these results were in line with current findings. In another similar study reported by Aydin and Gocmen (2015) the influence of drying method and pre-treatment, on the colour of pumpkin four and found values of L*, a* and b* for oven dried pumpkin flour as; 77.38, 3.32 and 50.53, respectively. Natural pigments such as carotenoids present in wastes of fruits and vegetables, especially peel of pumpkin, improves aesthetic value and eye appeal of the food products by increasing redness and yellowness. Addition of pumpkin peel in wheat flour may fulfil the huge global demand of plant derived natural pigments, which are also rich in antioxidant capacity (Sharma and Bhat, 2021).

Mineral's analysis of SGF and PPP. Values of important minerals, determined in PPP and SGF, have been shown in Table 4 and amounts of Na, K, Fe, Ca, Mg and P in SGF were 1.25±0.01, 320.75±0.50, 2.85±0.02, 24.25±0.04, 53.50±0.06 and 142.50±0.08 mg/100 g, respectively. Whereas values of Na, K, Fe, Ca, Mg and P in PPP were 8.96±0.08, 457.67±6.64, 4.04±0.06, 4.58±0.06, 4.57±0.02 and 1.84±0.02 mg/100 g, respectively. From Table 4 it was clear that, SGF possessed greater amounts of Ca, Mg and P as compared to PPP, while PPP exhibited greater amounts of Na, K and Fe, as compared to SGF.

Murphy *et al*. (2008) reported that white flour (SGF) contains relatively lesser quantities of mineral contents when compared to whole wheat flour and this deficiency of minerals in SGF can be overcome by incorporating fruits and vegetables peel flours to develop food products. Rao and Deosthale (1981) determined mineral contents of different wheat varieties at different extraction rates and results for Fe, Ca, Mg and P were in the range of 2.72-4.49, 25-30, 54-132 and 145-360 mg/100 g, respectively. Arshad *et al*. (2007) in their research work found Ca, Fe and P as 32.9, 0.3 and 125 mg/100 g, respectively, in wheat flour, which was used for cookies development. These results were not much different than current ones, whereas small variation in individual values of trace minerals might be due to differences in the cultivars, varieties, processing techniques and genotypes. Amin *et al*. (2019) determined mineral contents in three different parts *i.e*. peel, flesh and seeds of indigenous variety of pumpkin and values of Na, K, Fe, Ca, Mg and P were 9.652, 687.467, 4.004, 1.360, 3.353 and 1.419 mg/100 g of peel, respectively. Lima *et al*. (2019), in their research work stated that pumpkin peel flour contained high levels of Fe (152.5 mg/Kg) and K (19.1 g/Kg), in addition to other minerals, such as Mn (28.7 mg/Kg), Zn (28.2 mg/Kg), Mg (4.7 g/Kg), Ca (4.3 g/Kg) and Cu (3.1 mg/Kg). Mala and Kurian (2016) reported that pumpkin peel and pulp are good sources of P and Fe and incorporation of these pumpkin parts in wheat flour to develop bakery and expanded snack products could bring nutritional food products in the market. Results supporting to our study were also presented by (Hussain *et al*., 2021; Zhivkova *et al*., 2021) determined mineral contents in peels of some other members of *Cucurbitaceae* family like melon, watermelon and squash, and found appreciable amounts of mineral contents, which proved that peels of the fruits from the same family as was of pumpkin, have sufficient amounts of minerals, thus could be used in different combinations with wheat flour to develop bakery products with high mineral contents.

Colour analysis of biscuits developed with different replacement levels of PPP. Colour analysis of biscuits

Table 4. Mineral's analysis of SGF and PPP

Raw materials	Minerals mg/100 g					
	Na	K	Fe	Ca	Mg	P
SGF	1.25±0.01b	320.75±0.50b	2.85±0.02b	24.25±0.04a	53.50±0.06a	142.50±0.08a
PPP	8.96±0.08a	457.7±6.64a	4.05±0.06a	4.58±0.06b	4.57±0.02b	1.84±0.02b

Mean values accompanied with same small alphabetical letters are statistically non-significant and with different small alphabetical letters are statistically significant (P>0.05). SGF = straight grade flour; PPP = pumpkin peel powder.

prepared from SGF, containing different substitution levels of PPP, revealed that L* (lightness) values decreased with increasing the level of PPP in SGF, whereas a* (redness) and b* (yellowness) values increased, as has been given in Table 5. This increase in a* and b* values might be due to presence of more amount of *â* carotene and other carotenoids in PPP, as compared to SGF. Results in line with current ones were obtained when Park (2012) prepared cookies at 0, 10, 20 and 30% replacement level of sweet pumpkin powder with wheat flour. Salehi (2020) reported that powdered fruits and vegetables incorporation in biscuits increase the nutritional value of biscuits, however affects the quality of baked items, as often a decrease in lightness, and increase in redness and yellowness of biscuits has been observed. Saleh *et al*. (2020) developed pumpkin peel puree fortified biscuits and witnessed that by increasing the pumpkin incorporation level, L* value was decreased whereas, a* and b* values were significantly increased, just as was observed in current trials. The results of present study also got support from the research work of Baltacioglu and Ulker (2017), when they studied the effect of whole pumpkin powder on quality of biscuits.

Physical characteristics of biscuits developed with different replacement levels of PPP. Mean values for physical characteristics of biscuits have been presented in Table 6. It was evident from the results that width of biscuits was significantly decreased by increasing the level of PPP in SGP, while thickness was significantly increased and due to this decrease in width and increase in thickness, spread factor was also decreased. Literature has several examples, that whenever wheat flour has been added with sone non-wheat flours, variations in physical characteristics of the developed bakery products occurred, which have been reported due to the disturbance in gluten network and hydration properties of the flours. Similar results were obtained when Turkosy and Ozkaya (2011) supplemented wheat flour with pumpkin pomace powder, to check cookie quality. Giami *et al*. (2005) added fluted pumpkin seeds powder at 5, 10, 15, 20 and 25% level in wheat flour for cookie preparation and observed a decrease in width, thickness and spread factor of cookies. Park (2012) prepared cookies at 0, 10, 20 and 30% replacement level of sweet pumpkin powder with wheat flour and observed slight increase in width and spread ratio and slight decrease in thickness of cookies. Similar results were noticed when George (2020) evaluated biscuits developed with different replacement levels of pumpkin peel powder. Similar results were also presented by Goswami *et al*. (2017), during development of mango peel incorporated functional cookies. Peel flour from another member of *Cucurbitaceae* family, melon was added to wheat flour to develop biscuits and an increase in diameter and spread ratio was observed, while thickness was decreased (Ertas and Aslan, 2020). Due to addition of pumpkin peel powder, continuous formation of gluten network is affected, which might be the reason of decrease in width and increase in thickness of biscuits. Recent earlier investigations of Hussain *et al*. (2023) also proved similar outcomes, as a result of incorporation of pumpkin parts powders to develop cookies.

Table 5. Colour analysis of biscuits developed with different replacement levels of PPP

Treatments	L*	a*	b*
T_0	64.38±0.23a	0.64±0.01d	18.44±0.07d
T_1	53.59±0.26b	0.80±0.02c	22.17±0.08c
T_2	51.32±0.24c	0.96±0.01b	23.28±0.17b
T_3	50.57±0.27d	1.23±0.02a	24.05±0.05a

Mean values accompanied with same small alphabetical letters are statistically non-significant and with different small alphabetical letters are statistically significant (P>0.05).

Proximate analysis of biscuits developed with different replacement levels of PPP. From the results presented in Table 7 it was clear that by increasing the substitution level of PPP upto 15%, ash, fat and fibre contents were significantly increased in biscuits, while moisture and protein contents were slightly decreased,

Table 6. Physical characteristics of biscuits developed with different replacement levels of PPP

Treatments	Width (mm)	Thickness (mm)	Spread factor (mm)
T_0	257.33±1.45a	45.67±0.75bc	59.17±0.95a
T_1	236.17±2.62b	44.90±0.67c	52.57±0.41b
T_2	222.33±1.86c	48.47±1.04a	45.80±0.52c
T_3	204.33±2.19d	48.90±0.47a	41.85±0.01d

Mean values accompanied with same small alphabetical letters are statistically non-significant and with different small alphabetical letters are statistically significant (P>0.05). T_0; biscuits with 100% SGF; T_1 = biscuits with 95% SGF and 5% PPP; T_2 = biscuits with 90% SGF and 10% PPP; T_3 = biscuits with 85% SGF and 15% PPP; SGF = straight grade flour; PPP = pumpkin peel powder.

as compared to the control. Higher ash, fat and fiber contents in PPP, as compared to SGF, were responsible for increase of these parameters in the PPP incorporated biscuits.

Fruits and vegetables by products are sources of nutritional compounds, which when added to bakery products may affect the quality of final product but obviously, they enhance the nutritional value of food items (Gomez and Martinez, 2018). The used of pumpkin peel, pulp and seeds flours reported by Norfezah *et al.* (2011) at different replacement levels to develop different expanded snack products and performed proximate analysis, which showed increment in ash and fibre contents, just as was observed in current study. Sharma *et al.* (2019) reported an increase in fibre, ash and fat of pumpkin peel powder biscuits. Al-Demery (2011) replaced wheat flour with pumpkin flour at 5, 10, 15 and 20% level to evaluate the physico-chemical properties of bread, and similar results were obtained, where carbohydrate and protein contents were decreased, while ash, fiber and moisture contents were increased. Kulkarni and Joshi (2012) reported that moisture and protein contents were lower whereas ash and fibre contents were higher in biscuits, in which pumpkin powder replaced white flour. Some more similar results were found when Bhat and Bhat (2013) incorporated pumpkin powder into wheat flour for preparation of cake and reported that moisture, crude fibre, ash and β carotene contents were increased and crude protein, crude fat and carbohydrates were decreased.

Another member of *Cucurbitaceae* family, melon peel flour was added to wheat flour to develop biscuits and proximate analysis of biscuits provided much similar results to our study (Ertas and Aslan, 2020). The watermelon added in rind flour at different replacement levels in wheat flour to develop cookies and observed significant increase in protein, ash, fat, fibre and carbohydrate contents reported by Ashoka *et al.* (2021). By-products of food processing industries, such as peels are when incorporated in bakery products, have been found successful at a replacement level of 10% for optimum quality products and cause significant increase in ash, fiber and protein contents of breads, biscuits and cakes (Martins *et al*., 2017).

Mineral analysis of biscuits developed with different replacement levels of PPP. Addition of PPP in SGF at different levels, significantly increased Na, K and Fe contents, as was evident from Table 8, values of these three minerals in control biscuits (T_0) were, 95.88±0.30, 46.62±0.31 and 2.44±0.03 mg/100 g, which were significantly increased in (T_3) as, 101.98±0.59, 78.92±0.59 and 3.88±0.02 mg/100 g respectively. On the other hand, a slight decrease in Ca, Mg and P contents of biscuits was occurred by replacing SGF with PPP.

Food industry by-products such as peels, incorporated in bakery products are normally suitable at 10% replacement level and increase mineral contents of bakery products (Martins *et al*., 2017). Powdered fruits and vegetables are novel ingredients in biscuit industry, incorporation of these powders boosted the nutritional value of biscuits, making them a perfect food for the health-conscious consumers (Salehi, 2020). Nutritional biscuits rich in Fe and Zn, were developed by Hussain *et al*. (2023), through incorporation of pumpkin peel powder. Santos *et al*. (2015) successfully incorporated pumpkin peel in wheat biscuits and concluded that these biscuits has promising market potential due to economic, sensory and nutritional appeal. Dhiman *et al*. (2018) determined mineral contents in pumpkin powder, pumpkin seeds powder and wheat flour and prepared nutritional cookies with improved ash and mineral

Table 7. Proximate analysis of added PPP biscuits

Treatments	Moisture (%)	Ash %	Fat (%)	Fibre (%)	Protein (%)
T_0	7.04±0.02a	0.57±0.01d	30.36±0.03c	0.37±0.01d	6.62±0.02a
T_1	6.80±0.01b	1.68±0.02c	30.88±0.05b	0.86±0.01c	6.44±0.02b
T_2	6.70±0.01c	1.88±0.01b	30.99±0.04ab	1.25±0.02b	6.38±0.01c
T_3	6.58±0.02d	2.20±0.02a	31.07±0.04a	1.57±0.01a	6.32±0.02d

Mean values accompanied with same small alphabetical letters are statistically non-significant and with different small alphabetical letters are statistically significant (P>0.05). T_0 = biscuits with 100% SGF; T_1 = biscuits with 95% SGF and 5% PPP; T_2 = biscuits with 90% SGF and 10% PPP; T_3 = biscuits with 85% SGF and 15% PPP; SGF = straight grade flour; PPP = pumpkin peel powder.

contents by replacing pumpkin powder and pumpkin seeds powder with wheat flour at different levels. The breads prepared by replacing white flour with pumpkin flour, from 0 to 20% levels and found significant increase in Na, K, Fe, Ca, Mg and P in breads developed with 20% pumpkin flour, as compared to control. Another member of Cucurbitaceae family, melon peel flour was added to wheat flour to develop biscuits and significant increase in mineral contents of peel flour enriched cookies were noticed by (Ertas and Aslan, 2020; El-Demery, 2011). Ashoka *et al*. (2021) added watermelon rind flour at different replacement levels in wheat flour to develop cookies and observed significant increase in calcium, iron and phosphorus contents, providing results just in line with current findings.

Sensory evaluation of biscuits developed with different replacement levels of PPP. Biscuits prepared with 100% SGF got highest scores for all sensory parameters, whereas 5% and 10% replacement level of PPP got reasonably high scores, close to the control, which indicated that up to 10% replacement level of PPP with SGF was acceptable in biscuits preparation. On the other hand, 15% replacement level got less score for color, taste, flavor, texture and overall acceptability, as can be seen from the results presented in Table 9. These lower sensory scores with increased level of incorporation of PPP might be due to the increased contents of fibre, carotenoids and polyphenols, which might have disturbed the physical and sensorial features of the biscuits.

To characterize the quality of biscuits, one parameter is appearance. For example, developed biscuits must be shaped correctly and crispy and for this purpose right combination of the flours is very crucial (Oluwamukomi *et al*., 2011). The biscuits prepared by different replacement levels of PPP with SGF and declared that 20% level of biscuits which liked more by the judges than 30% replacement level of biscuits (Mishra and Sharma, 2019). Similar to our results were obtained when Park (2012) prepared cookies at 0, 10, 20 and 30% replacement level of sweet pumpkin powder with wheat flour. Pongjanta *et al*. (2006) reported that 10% replacement of wheat flour with pumpkin powder expressed best scores for sensory parameters of prepared biscuits. Kulkarni and Joshi (2012) reported that biscuits prepared with 2.5% replacement level of pumpkin powder scored maximum numbers during sensory evaluation. In different studies different combinations of pumpkin

Table 8. Mineral analysis of added PPP biscuits

Treatments	Minerals mg/100 g					
	Na	K	Fe	Ca	Mg	P
T_0	95.88±0.30d	46.62±0.31c	2.44±0.03d	60.30±0.15a	10.14±0.05a	85.41±0.27a
T_1	98.86±0.08c	71.61±0.61b	2.90±0.02c	56.12±0.12b	8.85±0.02b	70.19±0.13b
T_2	99.33±0.20b	72.92±0.46b	3.20±0.02b	55.08±0.16c	8.78±0.01b	70.09±0.05b
T_3	101.98±0.59a	78.92±0.59a	3.88±0.02a	54.42±0.25d	8.67±0.01c	70.03±0.01bc

Mean values accompanied with same small alphabetical letters are statistically non-significant and with different small alphabetical letters are statistically significant (P>0.05). T_0 = biscuits with 100% SGF; T_1 = biscuits with 95% SGF and 5% PPP; T_2 = biscuits with 90% SGF and 10% PPP; T_3 = biscuits with 85% SGF and 15% PPP; SGF = straight grade flour; PPP = pumpkin peel powder.

Table 9. Sensory evaluation of added PPP biscuits

Treatments	Colour	Taste	Flavour	Texture	Overall acceptability
T_0	7.40±0.22a	7.40±0.22a	7.50±0.22ab	7.30±0.21a	7.40±0.22a
T_1	6.90±0.18ab	6.70±0.21b	7.20±0.20bc	6.80±0.24b	7.30±0.15a
T_2	6.60±0.22b	6.30±0.21b	6.60±0.22de	5.80±0.20c	6.40±0.22b
T_3	5.40±0.16c	5.00±0.15c	6.10±0.18f	5.20±0.20d	5.20±0.20c

Mean values accompanied with same small alphabetical letters are statistically non-significant and with different small alphabetical letters are statistically significant (P>0.05). T_0 = biscuits with 100% SGF; T_1 = biscuits with 95% SGF and 5% PPP; T_2 = biscuits with 90% SGF and 10% PPP; T_3 = biscuits with 85% SGF and 15% PPP; SGF = straight grade flour; PPP = pumpkin peel powder.

flour and wheat flour have provided different scores for sensory evaluation, which possibly was due to difference in the varieties of pumpkin used, as well as variations in genotype, phenotype and climatic and cultivation conditions, which affect physical and sensory characteristics of the pumpkins. El-Demery (2011) reported that 5 and 10% substitution of pumpkin powder for bread preparation got good scores for colour, taste, flavour, texture and overall acceptability. The findings of this research work were much similar with the findings of George (2020), when biscuits developed with 3, 6, 9 and 12% replacement level of pumpkin peel powder were subjected to sensory evaluation. The acceptability of novel candies developed from pumpkin peel with an acceptance rate of 80 to 90%. The decreased scores for sensory parameters, with greater replacement levels might be due to presence of colour pigments in pumpkin peel, strong aroma and flavour of pumpkin peel and fiber contents present in pumpkin peel.

Conclusion

Present research has proven pumpkin peel as a good source of fibre, ash, fat and minerals. Pumpkin peel powder developed after drying of pumpkin peel could be used in production of bakery products to improve their nutritional value. The results show that the formulated biscuits could be used to improve the nutritional status of populations as a food rich in fiber and minerals. Although increasing the level of PPP in SGF significantly increased the nutritional contents of the biscuits and 15% substitution level provided highest values of ash, fat, fibre and important minerals, however a decrease in sensory scores was noticed at this high-level substitution. Biscuits developed from the wheat flour in which 5% PPP was substituted, got highest scores for colour, taste, flavour, texture and overall acceptability. The addition of pumpkin peel powder in bakery products will also be useful to manage waste part of pumpkin, production of new range of value-added products and may reduce cost of production of bakery products.

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