

Preparation of Pumpkin Pulp and Peel Flour and Study Their Impact in the Biscuit Industry

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Abstract

Pumpkin pulp and peels were processed into flour after drying each part separately. The two types of flour were analyzed for their proximate composition and functional properties. Ash, fat and carbohydrates contents in pulp and peel flour were not significantly different ($P < 0.05$), in contrast, significant differences ($P < 0.05$) in moisture and protein content were found in both types of flour. Pumpkin pulp flour and peel flour differed significantly ($P < 0.05$) in water absorption and oil binding. No significant difference was observed between two types of flour for swelling index. Biscuits prepared by replacement of wheat flour with pumpkin flour (pulp and peel) (0%, 3%, 6%, 9% and 12%) were analyzed for their physical measurements and sensory evaluation. There was a slight significant decrease ($P < 0.05$) in the mean diameter and thickness with increasing the ratio of pulp flour compared with the standard treatment (0%), also, a significant increase was recorded in spread ratio by increasing ratio of replacing. There was a significant decrease ($P < 0.05$) in mean diameter and spread ratio with increasing the replacement ratio of peel flour compared with standard treatment. The mean thickness increased by increasing the ratio of replacement compared with standard treatment and biscuit of pulp flour. Significant differences ($P < 0.05$) were recorded for sensory characteristics such as appearance, color, odor, taste, texture and overall acceptability between biscuits. Biscuits with a replacement ratio of 3% of pulp and peel flour were the most acceptable for all sensory evaluation parameters. There was a slight significant decrease ($P < 0.05$) for the previously mentioned sensory parameters among biscuits prepared with different ratios of pumpkin peel flour, the replacement ratio of 3% gave the highest mean values.

Keywords: Pumpkin flour, pumpkin composition, functional properties, biscuit, sensory evaluation, pumpkin biscuit, pumpkin pulp, pumpkin peel, physical properties, Spread ratio.

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Introduction

Consumers tend to consume high nutritional value foods, even if they are not very popular. Vegetables offer a wide range of products in the marketplace, including pumpkins that have become increasingly popular recently. Until recently, pumpkins were usually considered to be an ornamental plant even though they have high nutritional value. Recently, pumpkins have become an essential ingredient in various meals (Nawirska-Olszańska *et al.*, 2011). Pumpkin (*Cucurbita* sp.) is one of the most important agricultural products, belonging to the Cucurbitaceae family, the latter of which is considered one of the largest families in the plant world. Pumpkins belong to three varieties *pepo*, *moschata* and *maxima*, which grow widely in tropical and subtropical regions around the world (Toan and Thuy, 2018).

Pumpkins importance as a food source for humans stems from its containing many important nutrients such as carbohydrates, trace minerals like zinc, pectin, dietary fibers, and vitamins such as tocopherol and β -carotene, the source of vitamin A, which gives the fruit its yellow color. Pumpkins also contain plant sterols, unsaturated fatty acids and antioxidants which are considered important to human health (Pongjanta *et al.*, 2006; Pasha *et al.*, 2013). Flesh is the most used part of pumpkin fruit; it can be used in food preparation (Mujaffar and Ramsumair, 2019). Plant peels can improve nutritional aspect of the food products because they are rich in fibers (Batista *et al.*, 2018). Pumpkin seeds are eaten by many peoples, either raw or roasted; also they can be used in preparing salads and in baking industry as an ingredient of bread and cakes (Sathiya Mala *et al.*, 2018).

The color of pumpkin flour may vary from dark yellow to orange. As a result of its color, good flavor, and sweet taste, pumpkin flour represents a major ingredient for use in the baking industry. This flour has a long shelf-life, which makes it suitable as a natural ingredient in many food products, such as pasta, instant noodles, sauces, spices and soups. Adding pumpkin flour helps to improve nutritional value, giving good color and high quality to many baked products. Therefore, using 5% of the pumpkin flour to such products should provide a good result (Pasha *et al.*, 2013).

Biscuits are one of the most popular baked goods in the world. They are rich in carbohydrates, fat and energy, but their content of fibers, vitamins and minerals makes biscuits a non-integrated diet for daily use (Mishra and Chandra, 2012). In order to increase the nutritional value of some baked products like biscuits, cakes, cookies and pancakes and to improve their overall quality, it is achievable by adding pumpkin flour and fresh fruits to the mixture during the manufacturing process. Due to the increased demand of a large number of consumers for food products with high nutritional value and rich in fiber content and other components, this

study considered preparing pumpkin flour from pulp and peel, and observing and analyzing its physicochemical and functional properties. The resulting flour was used with different concentrations to produce and assess biscuits.

Materials and Methods

Preparing of Pumpkin Flour

The study purchased fruits of pumpkin from Qarmat Ali local market in Basrah City, south of Iraq. They were prepared in accordance with the method outlined by Cerniauskiene *et al.*, (2014). Ten ripe fruits were used with weights ranging from 2 to 3 kg. They were washed initially with tap water, then with distilled water, and dried carefully thereafter. Following their cleaning, the pumpkin fruits were peeled and cut with sharp knives, fibers and seeds were removed, the pulp and peel were cut into pieces 2-3 mm thick, and finally, each sample was dried at 60°C in the laboratory drying oven (Heraeus- Germany). After this process, the samples were grinded and sifted using a fine sieve to obtain a very fine powder, and kept in freezer at a temperature of -18 ± 2 °C - after placing in sealed containers - until the required tests were performed.



Fig. 1 Pumpkin fruit



Fig. 2 Flour of pumpkin pulp



Fig. 3 Flour of pumpkin peel

Proximate Analysis of Pumpkin Pulp and Peels Flour

Moisture content and total ash were analyzed according to standard methods in AOAC (1984). Crude protein (% Nitrogen $\times 6.25$) was performed using the procedure recommended by Pearson (1970). Crude fat was calculated as mentioned in AOAC (1975), while carbohydrate content was estimated by difference.

Functional Properties of Pumpkin Pulp and Peels Flour

Water absorption ability and oil binding capacity were measured as recommended in Beuchat (1977). Swelling characteristic was measured according to the procedure of Verma *et al.* (2014). 1 g of pumpkin flour was weighed and placed in to standard test tubes, then 25 ml of distilled water was added and was shaken vigorously every 10 min for one hour, by vortex (VM-300- Taiwan). The sample was left to settle in the test tube for 24 hours at room temperature and then the final size of the swelling sample was measured, the swelling index calculated according to the following formula:

$$\text{Swelling index\%} = \left\{ \frac{\text{final volume} - \text{primary volume}}{\text{final volume}} \right\} \times 100$$

Preparation of Biscuits

Biscuits were prepared in accordance with the standard method in AACC (2000), with some modifications. The refined wheat flour was replaced with the pumpkin flour (pulp and peels) with 3%, 6%, 9% and 12% respectively. For each 100 g flour, 35 gm of ground sugar, 20 g of shortening vegetable fat, 0.5 gm of salt, 0.5 g of sodium bicarbonate, 1 gm of baking powder and 2 gm of powdered milk were add. The proportion of water

was variable according to the ratio of pumpkin flour in the mixture. All solid components were sieved three times to ensure uniformity, then the shortening vegetable fat was added followed by water, the contents were mixed well to make the dough which was covered with a polyethylene, and kept in the refrigerator for half an hour. Following this procedure, the dough was sheeted by using a wooden rolling pin with a thickness of 2-3 mm, then cut into circular biscuits of 6 cm diameter, and baked in oven at 180°C for 10-12 minutes. A standard biscuit (control) was prepared by using all ingredients mentioned above except for the pumpkin flour (0% pumpkin flour).

Physical Properties of Biscuit

The Physical measurements of biscuits (diameter, thickness and spread ratio) were calculated as mentioned in AACC (1976). The diameter (D) of biscuits was calculated by laying six biscuits edge-to-edge then measuring to the nearest mm. The thickness (T) of the biscuits was measured by putting six pieces one above the other and the average value was calculated as mm by vernier. The spread ratio (D/T) was done by partitioning the average value of diameter (D) by the average value of thickness (T) of biscuits.

Sensory Evaluation of Biscuits:

Biscuits were analyzed for sensory properties. Sensory quality characteristics were evaluated by a group of 10 panelists from department of food sciences, using a 9-point Hedonic scale (ranging from “like extremely” = 9 to “dislike extremely” =1). The study also evaluated the biscuits for appearance, color, odor, taste, texture, and overall acceptability (watts *et al.*, 1989).

Statistical Analyses

In the current study, the data were subjected to one-way analysis of variance (ANOVA) using XL Stat program for Windows. Differences between the means were tested by Duncan’s multiple range tests. The level of significance was set at $P < 0.05$. The results are presented as means (Steel *et al.*, 1996).

Results and Discussion

Proximate Composition and Functional Properties

Table 1 shows the mean concentration (%) of the proximate composition of pumpkin pulp and peel flour. No significant differences ($P < 0.05$) were observed in ash, fat and carbohydrates concentrations between two types of flour, while concentrations of moisture and protein were differed significantly ($P < 0.05$) for pumpkin pulp and peel flour.

The moisture, ash, protein, fat, and carbohydrates in pumpkin pulp flour formed 9.647%, 9.293%, 1.930%, 2.343%, and 76.793%, respectively. These study results are similar and comparable to results reported in earlier studies conducted by others. For example, according to Roongruangsre and Bronlund (2016), they discovered that when pumpkin pulp was dried at 60°C, the flour moisture content was 7.46%. In addition, they found out that by increasing the temperature during the pumpkin dehydration process could reduce the moisture level and water activity of the pumpkin flour product. Application of these findings will improve significantly the quality of the flour product and increase its shelf life, as well. Low moisture content and low water activity are two vital factors having an impact on inactivation of enzymes during storage. This process may also have an impact on and possibly prevent non-enzymatic browning reactions, fat oxidation, and microbial growth.

Table 1. Proximate Composition of Pumpkin Pulp and Peel Flour

Analyses (%)	Pumpkin Pulp Flour (Mean ±Standard Error)	Pumpkin Peel Flour (Mean ±Standard Error)
Moisture	9.647 ±0.080 ^a	7.523 ±0.320 ^b
Ash	9.293 ± 0.160 ^a	9.570 ±0.325 ^a
Protein	1.930 ± 0.095 ^b	3.680 ±0.210 ^a
Fat	2.343 ± 0.595 ^a	3.533 ±0.240 ^a
Carbohydrates	76.793 ± 0.550 ^a	75.700 ± 0.460 ^a

All data are means of triplicate concentrations. Means with different letters are significantly different ($P < 0.05$).

Further, pumpkin peel flour reportedly contained a moisture level of 7.523%, ash at 9.570%, protein at 3.680%, fat at 3.533%, and carbohydrates at 75.700%. Staichok *et al.* (2016) found almost the same results as this study. The proximate composition of pumpkin peel flour in the mentioned study included a moisture level of 8.58%, ash at 5.56%, protein at 17.99%, fat at 7.02%, and finally carbohydrates at 61.85%. In addition, Nyam *et al.* (2013) reported that their study’s pumpkin peel flour had the following ingredient percentages: moisture at 5.96%, fat at 5.77%, protein at 23.89, ash 0.41%, and carbohydrate at 49.11%. Researchers stated that pumpkin peel flour is a proper ingredient for use in the baking industry, especially for baking products low in fat and calories. It should be noted that “volatilization” a progression that could happen during chemical analysis of food could impact and result in differences in the level of ash content in the original food specimen than the one

analyzed (Pratyush *et al.* (2015).

Table 2 and figure 4 show mean values of some functional properties of pumpkin flour. Pumpkin peel flour differed significantly ($P < 0.05$) with pumpkin pulp flour, and exhibited less water absorption capacity (5ml/ gm) compared with pumpkin pulp flour (8ml/ gm). Water absorption is an essential physiochemical and functional property of protein. It might have an enormous impact on food properties and a variety of things can happen during preparation, processing, and storage of food (Appiah *et al.*, 2011). It can also affect its nutritional content. Water absorption is one of the vital properties of pumpkin flour that can enhance the possibility of using it as a thickener to fix liquid or semi-liquid food such as sauces and soups. Pumpkin contains a high percentage of insoluble fibers such as cellulose, hemi-cellulose, pectin and lignin, which all have a good capacity to absorb water. Therefore, using pumpkin flour will improve the stability of the food product. In addition, plant fibers contain more pectin, which make it more capable of linking water than fibers of grain (cereals) and legumes. Hydration properties depend on the chemical composition of food. The presence of hydrophilic pectin with side chains that lead to high water absorption and swelling. The high content of lignin produces hard and non-permeable fibrous molecules (Păucean and Man, 2014).

Table 2. Functional Properties of Pumpkin Pulp and Peel Flour

Functional properties	Pumpkin Pulp Flour (Mean +Standard Error)	Pumpkin Peel Flour (Mean +Standard Error)
Water Absorption (ml water/gm)	5.000 ±0.100 ^b	8.000 ± 0.100 ^a
Swelling Index (%)	87.497 ±0.250 ^a	85.503 ±0.590 ^a
Oil Binding (ml oil/gm)	1.500 ± 0.050 ^b	1.997 ±0.005 ^a

All data are means of triplicate measurements. Means with different letters are significantly different ($P < 0.05$).

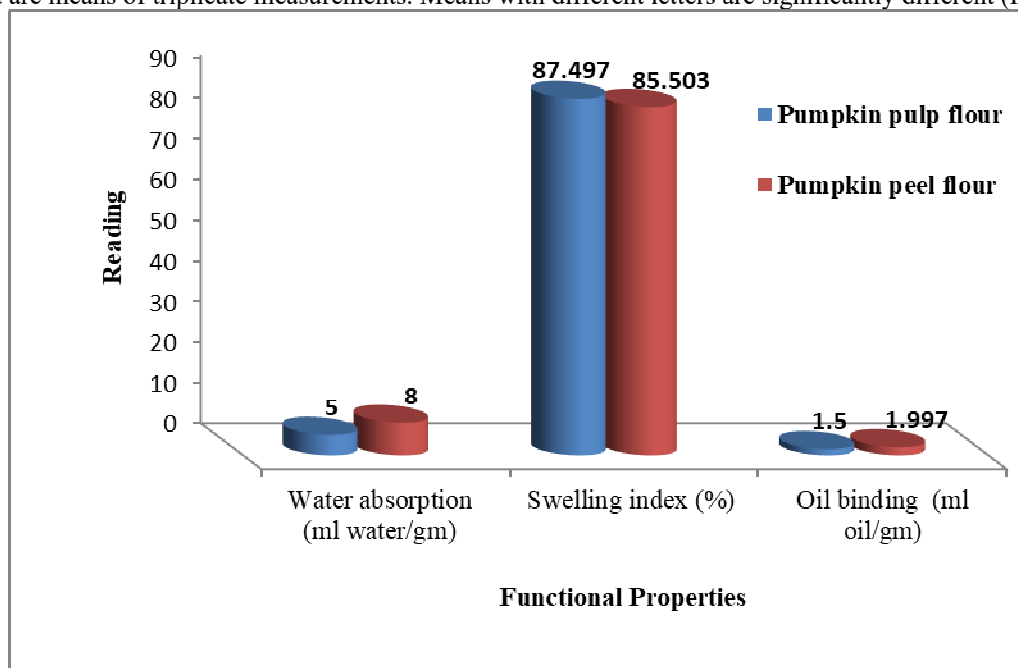


Fig. 4. Functional Properties of Pumpkin Pulp and Peel Flour

The results didn't show significant differences ($P < 0.05$) in swelling index. Pumpkin flour recorded a very good ability to swelling, 87.497% for pulp flour versus 85.503% for peel flour. There is an inverse relationship between fat fiber content and its ability to swelling. When fat is high the fiber loss ability to swell- the presence of fat within fibers- restricts water molecules from entering the sample and therefore decrease the swelling. In this study, both pulp and peel flour had a high capacity to swell because of the low content of fat. This caused water molecules to penetrate within fibers and increase swelling (Nyam *et al.*, 2013).

For oil binding, the results showed significant differences ($P < 0.05$) pulp flour bound 1.5 ml/gm as compared to peel flour, 1.997 ml/ gm. The high percentage of insoluble fibers in pumpkin peel flour as compared to pulp flour may be the reason for this phenomenon. This was recorded by Nyam *et al.* (2013), when they experimented with the ability of pumpkin seed and peel flour to bind oil. In addition, heat treatment enhances flour ability to bind oil, it seems that temperature of oven during drying process of pulp and peel increased the ability of pulp and peel flour to bind oil (Fagbemi *et al.*, 2005). Researchers mentioned the above finding after they measured the ability of powder of boiled and roasted pumpkin seeds, the denaturation helped in deterioration the hydrophobicity of protein.

The functional properties; oil binding and water absorption of pumpkin powder are considered critical

parameters in controlling the quality of bakery products. Researchers noticed that pumpkin flour has good ability to bind oil and absorb water. In addition, pumpkin powder is a suitable alternative emulsifier and can be possibly used in food mixes (Roongruangsri and Bronlund, 2016).

Physical Measurements of Biscuit

The study conducted a physical analysis of biscuits prepared by replacing wheat flour with pumpkin flour (0%, 3%, 6%, 9% and 12%). The mean measurements of the physical analysis appear in table 3 and figures 5 and 6.

Table 3. Physical Measurements of Biscuit Prepared with partial replacement of wheat flour with pumpkin pulp and peel flour

Treatments		Physical Analyses (Reading+Standard Error)		
		Diameter (mm)	Thickness (mm)	Spread ratio (D/T)
Control	0%	40.667 ± 0.05 ^a	5.997 ± 0.005 ^b	6.783 ± 0.015 ^{cd}
Biscuit prepared with pumpkin pulp flour	3%	42.827 ± 0.035 ^a	6.170 ± 0.005 ^b	6.940 ± 0.010 ^c
	6%	42.007 ± 0.050 ^a	4.997 ± 0.000 ^c	8.407 ± 0.010 ^b
	9%	40.827 ± 0.030 ^b	4.500 ± 0.050 ^d	9.077 ± 0.100 ^a
	12%	40.173 ± 0.020 ^c	4.330 ± 0.085 ^d	9.287 ± 0.180 ^a
Biscuit prepared with pumpkin peel flour	3%	40.827 ± 0.055 ^b	5.993 ± 0.005 ^b	6.810 ± 0.010 ^{cd}
	6%	39.673 ± 0.115 ^d	6.017 ± 0.010 ^b	6.597 ± 0.010 ^{cd}
	9%	39.663 ± 0.095 ^d	6.163 ± 0.015 ^b	6.433 ± 0.035 ^{de}
	12%	39.663 ± 0.110 ^d	6.497 ± 0.130 ^a	6.110 ± 0.145 ^c

All data are means of triplicate measurements. Means with different letters are significantly different ($P < 0.05$).

Control: 100% wheat flour/ 0% pumpkin flour.

3%: 97% wheat flour/ 3% pumpkin pulp flour.

6%: 94% wheat flour/ 6% pumpkin pulp flour.

9%: 91% wheat flour/ 9% pumpkin pulp flour.

12%: 88% wheat flour/ 12% pumpkin pulp flour.

3%: 97% wheat flour/ 3% pumpkin peel flour.

6%: 94% wheat flour/ 6% pumpkin peel flour.

9%: 91% wheat flour/ 9% pumpkin peel flour.

12%: 88% wheat flour/ 12% pumpkin peel flour.

A slight significant decrease ($P < 0.05$) was found in mean of diameter and thickness of biscuit with increasing the ratio of pumpkin pulp flour compared to the standard treatment (0%). The lowest averages were found to be 40.173 mm for diameter and 4.33 mm for thickness. While there was a significant increase ($P < 0.05$) in spread ratio by increasing the replacement ratio of wheat flour with pumpkin pulp flour, 9.077 and 9.287 for the ratios 9% and 12% respectively.

Toan and Thuy (2018) found that the spread ratio increased from 6.49 to 9.27 in processed biscuits by increasing the ratio of replacing wheat flour with pumpkin pulp flour. The reason is that the continuous formation of gluten network is affected by protein of flour, which in turn increases the viscosity of the dough and stops the flow.

In biscuits prepared by replacing wheat flour with pumpkin peel flour, there was a significant decrease ($P < 0.05$) in the mean diameter and spread ratio with increasing replacement ratio, compared with the standard treatment. The lowest mean diameter and spread ratio were 39.663 mm and 6.110 respectively for the ratio 12%. The mean thickness increased by increasing the replacement ratio compared with standard treatment and the pumpkin pulp biscuit, (Table 3). Differences in protein quality and water absorption may alter the flour ability to absorb water and may alter the spread ratio (Gurung *et al.*, 2016). The spread ratio is an important characteristic in estimating the quality of flour used in the preparation of biscuits and its ability to rise (Adeola and Ohizua, 2018) the higher the value of the spread ratio, the product is highly desirable. Chauhan *et al.* (2016) found that spread ratio increased by increasing the replacement ratio of wheat flour with amaranth flour. Figures 7 and 8 illustrate samples of prepared biscuits.

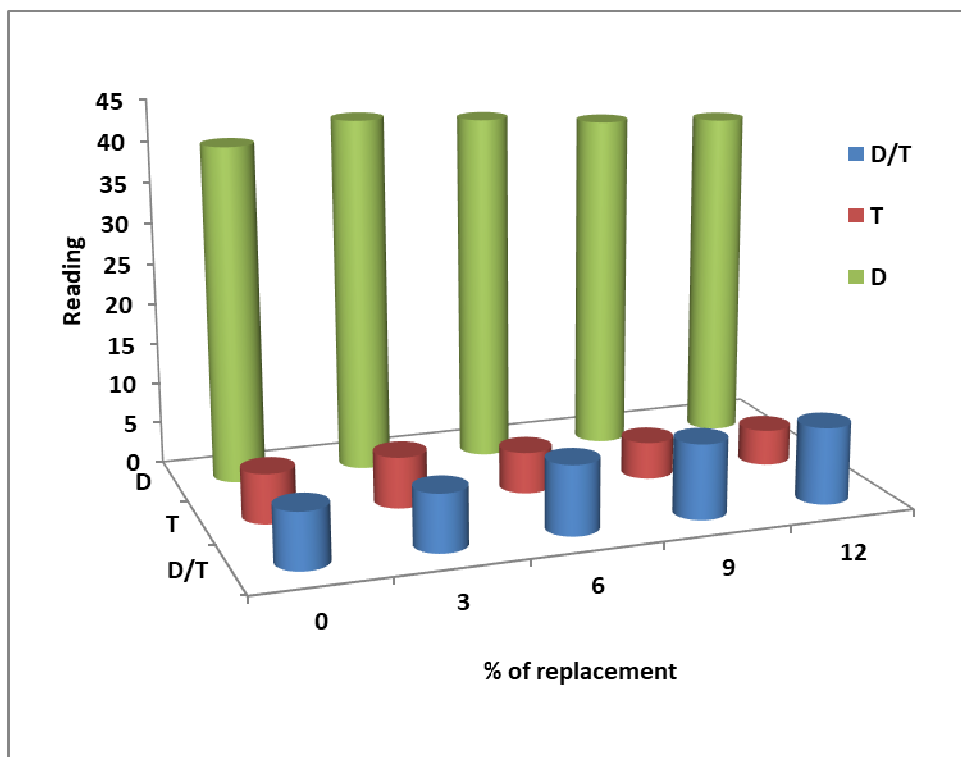


Fig. 5. Effect of Replacement Wheat Flour with Pumpkin Pulp Flour on Physical Analysis of Biscuit

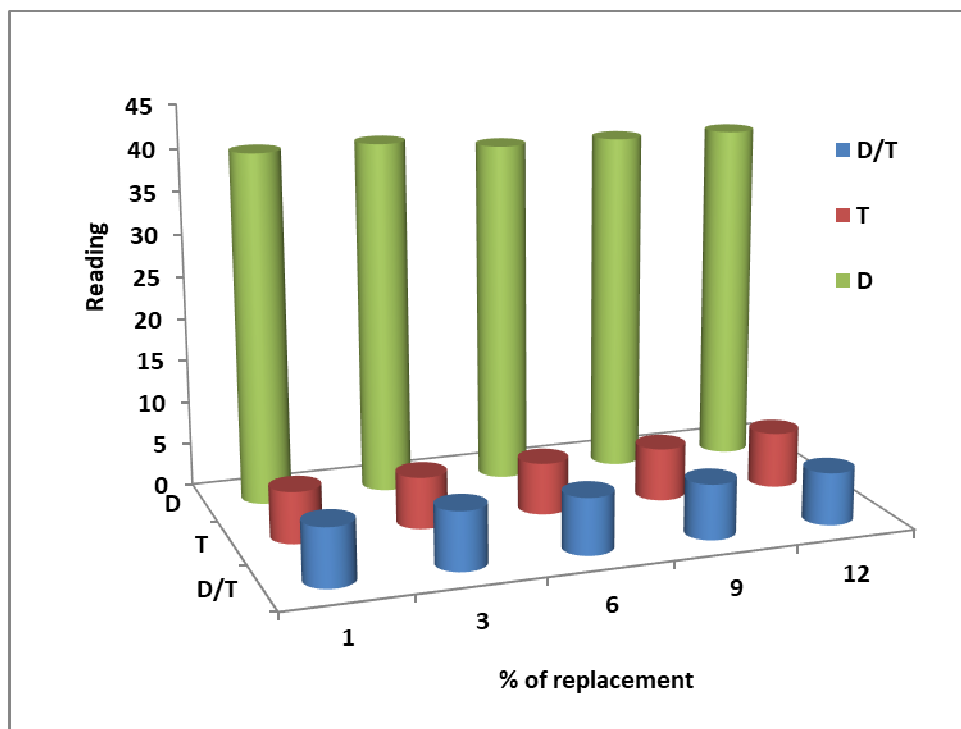


Fig. 6. Effect of Replacement Wheat Flour with Pumpkin Peel Flour on Physical Analysis of Biscuit

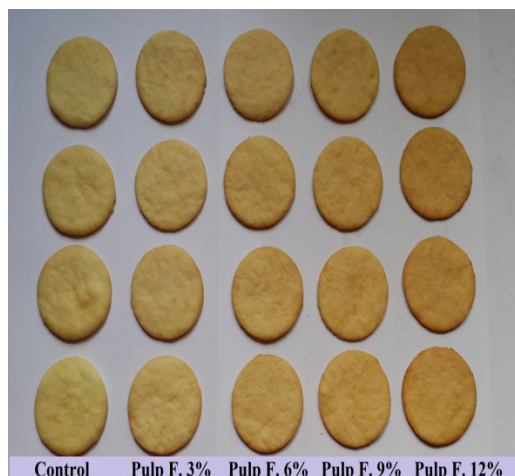


Fig. 7 Biscuit Prepared with Different Ratios of Pumpkin Pulp Flour

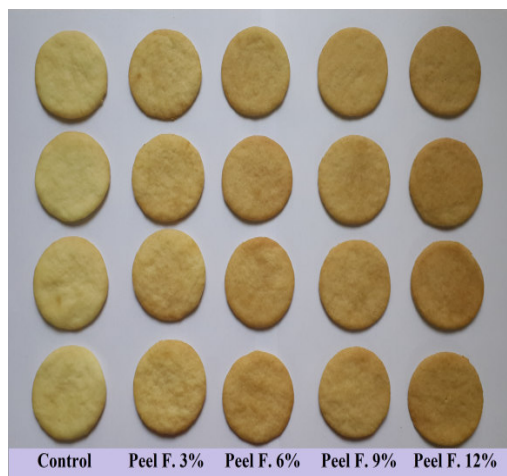


Fig. 8 Biscuit Prepared with Different Ratios of Pumpkin Peel Flour

Sensory Evaluation of Biscuits

Table 4 shows mean values of the sensory evaluation of biscuits prepared from replacement of wheat flour with pumpkin flour (pulp and peel) (0%, 3%, 6%, 9% and 12%). Significant differences ($P < 0.05$) were recorded for sensory characteristics like appearance, color, odor, taste, texture and overall acceptability between biscuits. The study observed that biscuits prepared with a ratio of 3% pumpkin pulp and pumpkin peel were the most acceptable for all sensory parameters. This was followed by biscuits with 6% pumpkin pulp flour. A significant decrease ($P < 0.05$) was recorded for the mentioned sensory characteristics with increasing replacement of wheat flour with pumpkin pulp flour. A slight significant difference ($P < 0.05$) was recorded for the sensory characteristics between biscuits prepared with different ratios of pumpkin peel flour, the ratio 3% gave high mean values (8.95, 8.85, 8.60, 8.55 and 8.80) for appearance, color, odor, taste, texture and overall acceptability respectively comparison with control treatment.

Appearance is one of the measures that characterize biscuit quality. For example, individual biscuits must be crispy and formed correctly (Oluwamukomi *et al.*, 2011). Colour intensity of biscuits improved by increasing the replacement ratio of pumpkin pulp flour. The samples prepared with 12% pulp flour were the most telling in that they were less accepted by evaluators than with biscuit prepared with 3% pulp flour. Food color is one of the important quality parameters; this may indicate changes that occur in food quality because of processing, storage and other impacts, the yellow color attributed to carotene pigment in pumpkin fruit, the color value of the product is increased by the incorporation of pumpkin flour in batter (Usha *et al.*, 2010 and El-Demery, 2011).

Table 4. Mean Values of Sensory Evaluation of Biscuits Fortified with Pumpkin Pulp and Peel Flour According to the 9-Points Hedonic Scale

Treatments		Parameters					
		Appearance	Color	Odor	Taste	Texture	Overall acceptability
Control	0%	8.90 ^{abc}	9.25 ^a	9.00 ^a	8.90 ^a	8.90 ^a	9.05 ^{ab}
Biscuit prepared with pumpkin pulp flour	3%	9.20 ^a	8.90 ^{ab}	9.15 ^a	8.90 ^a	8.85 ^a	9.15 ^a
	6%	8.55 ^{abcd}	8.70 ^{ab}	8.50 ^{ab}	8.30 ^{abc}	8.40 ^{abc}	8.75 ^{ab}
	9%	8.55 ^{abcd}	8.20 ^{bc}	7.95 ^{bc}	8.20 ^{abc}	8.35 ^{abc}	8.40 ^{bc}
	12%	7.80 ^{cd}	8.00 ^{bc}	7.80 ^{bc}	7.95 ^{bc}	7.80 ^{abc}	8.05 ^{cd}
Biscuit prepared with pumpkin peel flour	3%	8.95 ^{ab}	8.85 ^{ab}	8.75 ^{ab}	8.60 ^{ab}	8.55 ^{ab}	8.80 ^{ab}
	6%	8.85 ^{abc}	8.75 ^{ab}	8.40 ^{ab}	8.30 ^{abc}	7.90 ^{abc}	8.60 ^{abc}
	9%	8.00 ^{bcd}	8.00 ^{bc}	7.40 ^c	7.50 ^{cd}	7.30 ^{bc}	7.75 ^{de}
	12%	7.60 ^d	7.70 ^c	7.10 ^c	6.95 ^d	7.05 ^c	7.30 ^e

All data are means of ten values. Means with different letters are significantly different ($P < 0.05$).

The color of biscuits prepared with peel flour tends to be greenish-yellow with increasing the replacement ratio. Color in biscuits is due to the presence of carotene and chlorophyll pigments in fruit peels. The study noted that the results of sensory evaluation of the control treatment (0% pumpkin flour) were close to the results of samples with 3% replacement for both pulp and peel flour. Changes occurring in carotenoids and other dyes affected the color and quality of the product may result from temperature and oxidation process during the

drying stage. Similarly, the hot drying period may cause the loss of pigment as result of degradation that happens due to heat (Roongruangsri and Bronlund, 2016). Sensory evaluation of odor decreased significantly with the increase of the replacement ratio beyond the ratio 3% and 6% (pulp flour) and 6% (peel flour). This may be due to the strong aroma and flavor of pumpkin tested in high concentrations. This analysis is supported by See *et al.* (2007) when bread was using different concentrations of pumpkin flour. A strong odor of pumpkin increased noticeably at 5% and 10% levels of pulp flour.

The texture of biscuits produced satisfied the evaluators initially, and then satisfaction decreased significantly with increasing the replacement ratio. Biscuits became hard with the increase of the replacement ratio. This result agreed with findings of Kulkarni and Joshi (2013), who produced biscuit with replacement ratios 2.5%, 5%, 7% and 10% pumpkin flour. The flavor decreased because increases resulted in an oily flavor. Nyam *et al.* (2013) prepared bread with different replacement ratios of pumpkin peel and pulp flour (0%, 5% and 10%). They found that products of 5% were the most acceptable and had a strong aroma and soft texture because of good ability of peel flour to hold water better than wheat flour. A 6% replacement ratio of peel flour gave the biscuits a smell like tea because pumpkin peel contains catechins, a flavonoid compound presence in tea and cacao beans (Yilmaz, 2007).

The mean values of overall acceptability of biscuits showed that biscuits with replacement ratio 3% of pulp and peel flour were the highest, followed by standard treatment and other treatments.

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