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## مجلة البحوث في مجالات التربية النوعية

معرف البحث الرقمي DOI: 10.21608/jedu.2021.71343.1321

المجلد الثامن العدد ٣٨ . يناير ٢٠٢٢

الترقيم الدولي

P-ISSN: 1687-3424

E- ISSN: 2735-3346

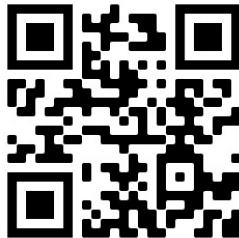
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موقع المجلة

العنوان: كلية التربية النوعية - جامعة المنيا - جمهورية مصر العربية





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### Abstract

Prickly pear, pomegranate and banana peels are considered as a waste by-products which obtained during feeding/processing of such fruits. Such activities generated huge amount of peels and their disposal is a major problem and causes environmental pollution. In the present study, Prickly pear, pomegranate and banana peels were dried in an oven at 40 °C- 60 °C. These by-products were analyzed, incorporated into bread and crackers at 2.5 and 5% levels as a potential source of bioactive compounds. The water holding capacity (WHC) and oil holding capacity (OHC) of pomegranate peel powder (PGPP), banana peel powder (BPP) and Prickly pear peel powder (PPP) and their mixture were, 7.89, 9.51, 6.01 and 8.12 g water.g-1, and 3.11, 4.65, 2.41 and 3.87 g oil g-1 respectively. Content of total flavonoids (PGPP), (PPP) and (BPP) was ranged 14.311 - 28.277 mg/100g and total phenolic was range from 516 -1267 mg GAE.100 g-1. Dough contained 5% (BPP) recorded highest score while dough contained 2.5% (PPPP) recorded the lowest score of water absorption. Bread prepared from the mixture of (PPPP, PGPP and BPP) had higher rating scores than PGPP and BPP . crackers which replacement of 5% of (PPPP) had higher rating scores than the other for sensory properties.

**Keywords:** prickly pear peel, pomegranate peel, banana peel, phenolic, carotenoids, crackers ,bread.

## Introduction

In the food industry, waste is attributed to the high product-specific waste ratio. This not only means that the production of this waste is inevitable, but also that if the quality of the finished product is to remain constant, the quantity and form of waste produced, which mainly consists of organic residues of manufactured raw materials, can scarcely be altered (**Mashal, 2016**). By-products of food production have become an essential substance to be researched for sanitary problems. Many attempts have been made to turn these rejected goods into beneficial materials (**El-sayed, 2016**). Fruit peels have not been explored so much for their antioxidant activity in the past. There is little information on the antioxidant activity in fruit peels (**Bashir et al., 2016**). Cactus, usually known as prickly pear (*Opuntia ficus-indica*). They are also known as Indian fig, Barbary fig, naghphani in Hindi and findla or hathla in Gujarati (**Roghelia and Panchal, 2016**). Many of research has been conducted in recent years on prickly pear as an exporter of bioactive compounds for health diseases and nutrition (**Toure et al., 2016**). **Anwar and Sallam, (2016)** were found the major components of prickly pear peel was a large number of cellulose (29 percent dry matter), minerals (12.13 percent dry matter), protein (8.3 percent dry matter) hemicelluloses (8.5 percent dry matter) polysaccharides (25 percent dry matter), pectin (3 percent dry matter). **Koubaa et al., (2015)** said that peels of prickly pear representing around the 2/3 of the fruit weight. Pomegranate (*punica granatum L., puniceae*) it an old, loved plant and fruit, accompanied by the Latin name "Pomegranate". The use of pomegranate is profoundly rooted in human history and is used as food and as a medicinal remedy in several ancient human cultures (**Holland et al., 2009**). It is deemed one of the ancient recognized eaten fruits and also for thousands of years several cultures have reckon that pomegranate has useful impacts on health, fertility, immortality and regeneration as a sign of abundance and prosperity (**Deswal et al., 2016**). The 'Baladi' pomegranate (*punica granatum L.*) it an Egyptian variety grown in the country's northern area. Because of the sweet taste and tenderness, the edible seeds are a beloved

snake and its fruits are primarily used for direct consumption. It could also be used for production of fruit juice (Shalaby, 2015). Each and every portion of pomegranate fruit supply health benefits, which is that these substances provide vital nutrients and else biologically active components for a nutraceutical food that provides many important health benefits (Priyadharshini *et al.*, 2017). On average, pomegranate peel and internal membranes account for 50 percent; this has led to a rise in waste effluent in several countries (Bhardwaj *et al.*, 2017). It is an inedible component obtained throughout pomegranate juice processing and it might be seen that the portion for pomegranate fruit peel powder contained a much of greater content of (aromatic fatty acids, lysine, threonine leucine and a valine ) (Mehder, 2013). Also its contains a wide variety of phytochemical compounds such as gallotannins, gallic acid, ellagic acid, punicalins, punicalagins (Farag and Emam, 2016), ferulic acid and querectin (Abdel-Salam *et al.*, 2018). Pomegranate cortices its used as a common remedy worldwide and its used due to their strong mordancy properties in traditional medicine. (Kumar *et al.*, 2018).

The banana refers to the Musaceae family and the Musa genus, Musa SPP. which has already provided human with food, tools and shelter prior to recorded history (Ngwang, 2015). Its play an important role in the economy and food security of many wet tropical regions in the world (Coulibaly *et al.*, 2007). Banana (Musa SPP.) is considered to be one of Egypt and around the world's most important appropriate and common fruits. The total cultivated regions in Egypt cross 5500 feddan, producing approximately 1,100,000 ton for banana fruits. with an average of 28.4 thousand ton/feddan (Mohammed *et al.*, 2015), There are three kinds of edible bananas, first 'dessert' bananas with a high sugar content; secondly, cooking bananas with a high starch content at ripeness; thirdly, the triploid collection is represented by more hardy bananas that can be cooked and eaten (Luyckx *et al.*, 2016).

Banana fruit has been investigated as an essential food crop for household consumption and market provide (Wilaipon, 2009). The techniques used to prepare bananas and plantains usually do

not require complex procedures, which are prepared by backing or roasting, boiling or evaporating and frying (**Pereira and Maraschino, 2015**). Waste banana cortices play an important part in polluting our climate and when they are decomposed and biodegraded, all bio waste emits toxic gases. The best choice use of banana cortices for the development of biofuels is to consume them to resolve this problem (**Khan et al., 2015**). Banana cortices, on mean, contain 6-9 percent dry protein and 20-30 percent fiber. After ripening, green plantain cortices produce 40 percent starch that is processed into sugars. When green, green banana cortices contain many low starch (about 15 percent), while ripe banana cortices include up to 30 percent free sugar (**Hassan et al., 2018**). All the fundamental amino acids are also wealthy in polyunsaturated fatty acids, hemicellulose and cellulose (**Wu et al., 2015**). Banana fruit peel has a wide diversity of biological activities and is a perfect exporter of antioxidants and antitumor factor (**Kumar et al., 2019**). Bakery products are gaining wide popularity among people of different age groups in various regions world – wide due to their taste and easy accessibility (**Tharshini et al., 2018**). Fruit and vegetable flour has a rise oil holding capacity (OHC), water holding capacity (WHC) and is rich in protein, minerals and fiber . It may therefore be applied for a new least -calorie and costly food ( **Eshak, 2016** ). Bread can be characterised by a chain of processes including, baking, proofing, shaping, blending and kneading as fermented confectionary products manufactured principally from wheat flour, salt, yeast and water ( **Baba et al., 2015**). Prickly pear seed flour (PPS) and centered protein have outstanding functional properties and can be included in food formulation system (**Nassar, 2008**). Pomegranate skins flour improves its baking properties in wheat flour dough and the bread generated has an appropriate sensory quality, especially the bread fortified with low levels for pomegranate peels flour (**Sulieman et al., 2016** ). The flour produced from banana fruit has useful physiological effects because it functions in the form of fiber because of the high digestion-resistant starch content and provides improved glycemic and insulin responses ( **Loza et al., 2017**).

## Materials and Methods: -

### Materials

From local market of Minia city, Egypt in 2018 were purchased fresh fruit (prickly pear, banana and pomegranate), Wheat flour 72 percent, yeast, corn oil, shortening ,salt and baking soda.

### Methods

#### Preparation of sample

Fresh pomegranate (PG), prickly pear (PP) and banana (B) were washed in running water to remove latex and dirt in Photo (4). The cortices were separated from the pulp and cut into slices using stainless steel knives . Then the slices were derided in an oven at 40 °C- 60 °C. pomegranate peel ( PGP) for ( 6 ) hour, prickly pear peel ( PPP ) for 8 hour and banana peel ( BP ) for ( 4 ) hour. Then the dried peels were founded using a blade grinder ( moulinex type L M 207, 220 – 240 V, 50 – 60 HZ, 500 W – France ) at room temperature. Banana peel powder ( BPP ), Prickly pear peel powder (PPPP) and pomegranate peel powder (PGPP), it was store in glass jar at 18 °C to use.

### Analytical methods

#### Water holding capacity (WHC) and oil (OHC) holding capacity:-

The holding capacity for water (WHC) and oil (OHC) was calculated in accordance with the method of (Larrauri *et al.*, 1996). To 0.5 g of PGPP, PPPP and BPP 25 ML for distilled water or industrial maize oil was applied vigorously for 1 min and then centrifuged for 15 min at 10,000 g. The remains was weighed and the WHC and OHC are respectively measured as g of water or oil per g for dried specimen.

## Phytochemical analysis

In selected fruit products (PGPP-PPPP-BPP) specimen, flavonoids and total phenolics were parsed as follows: Fruit products (PGPP-PPPP-BPP) specimens were extracted for 80 percent acetone, one gram of powdered sample was extracted with 20 ml from 80 percent acetone and centrifuged at chamber temperature at 8000 g. In the study of overall flavonoids and phenolics the supernatant obtained of both specimens was used.

### Total phenolics.

Total phenolics was calculated with the reagent Folin-Ciocalteu (**Singleton and Rossi, 1965**). With 2 mL of 80 percent MeOH containing 1 percent hydrochloric acid at chamber temperature through an tropical shaker set to two hundred rpm, 200 milligrames of specimen (PGPP-PPPP-BPP) was obtained for 2 hours. At 1000 g over fifteen min, the blend was centrifuged and the supernatant decanted to 4 mL vials. The pellets were obtained and used for the overall assay phenolics. 0.75 ml for Folin-Ciocalteu reagent (formerly 10 times diluted with distilled water) was combined with 100 microliters of the extract obtained and Permissible to stand at 22 0C to 5 min; 0.75 ml from sodium bicarbonate (60g / L) solution was applied to the admixture after 90 min at 22 0C; absorption was estimated at 725 nm. The findings are expressed as equivalents of ferulic acids. In 80 percent acetone extract, total carotenoids were calculated using the method stated by (**Litchenthaler, 1987**). The total purport of dietary fibre in the (PGPP-PPPP-BPP) was estimated according to the method defined by (**Asp et al., 1983**).

### Total flavonoid content.

The total flavonoids content of Pomegranate peel powder (PGPP), banana peel powder (BPP) , prickly pear powder (PPPP) extract was determined use a colorimetric technique specified by (**Zhishen et al., 1999**). A 0.5 ml pepper specimen solution was jumbled with 2 mL from distilled water, followed by a 5 percent NaNO<sub>2</sub> solution from 150 mL. 150mL of 10% AlCL<sub>3</sub> solution was added next 6 min and Permissible to stand about 6 min, then 2



mL of 4% NaOH solution was added to the blend. To raise the final volume around 5 mL, water was promptly added, and then the admixture was thoroughly mixed and permissible to stand for another 15 minutes. The mixture absorbance was estimated at 510 nm against the blank prepared. Quercetin has been used for the quantification of overall flavonoids as a gauge compound. All values per 100 grams for PGPP, BPP, PPPP were represented as milligrams of quercetin equiv). For three duplicates, the data was identified as mean (SD).

## Technological methods.

### Crackers making:

Crackers were prepared appropriate to the way of (Mashal, 2016 ):-

Ingredient s (g)	Traditio nal	2.5% PPPP	5% PPPP	2.5% PGPP	5% PGP P	2.5% BPP	5% BPP	2.5% Mix	5% Mix
Wheat flour	100g	97.5g	95g	97.5g	95g	97.5g	95g	97.5g	95g
Shortenin g	9.64g	9.64g	9.64g	9.64g	9.64g	9.64g	9.64g	9.64g	9.64g
Salt	2.02g	2.02g	2.02g	2.02g	2.02g	2.02g	2.02g	2.02g	2.02g
Sodium bicarbona te	0.16g	0.16g	0.16g	0.16g	0.16g	0.16g	0.16g	0.16g	0.16g
Moist Yeast	3.48g	3.48g	3.48g	3.48g	3.48g	3.48g	3.48g	3.48g	3.48g
Water	50ml	50ml	50ml	50ml	50ml	50ml	50ml	50ml	50ml

Water was combined with yeast and then blended and kneaded to form a downy dough with the else ingredients (shortening , sodium bicarbonate ,wheat flour and salt ). Wheat flour was substituted for 2.5% and 5% of (PGPP), (PPPP) or (BPP) for the weight of wheat flour. The dough uses a dough sheeter to calm for 2 hours after the dough is then individualised to 1.0 mm thickness. The dough was then sliced into 3 cm cm x 3 cm squares and spread and cocked at 170 & about 30 min prior for backing.

### Preparation for bread

Bread was prepared according to (Eshak, 2016)

Ingredients	Traditio nal	2.5% PPPP	5% PPPP	2.5% PGPP	5% PGPP	2.5% BPP	5% BPP	2.5% Mix	5% Mix
Wheat flour	100g	97.5g	95g	97.5g	95g	97.5g	95g	97.5g	95g
Corn oil	3.5g	3.5g	3.5g	3.5g	3.5g	3.5g	3.5g	3.5g	3.5g
Sugar	6g	6g	6g	6g	6g	6g	6g	6g	6g
Salt	2g	2g	2g	2g	2g	2g	2g	2g	2g
Water	50 ml	70 ml	76 ml	70 ml	78 ml	70 ml	76 ml	80 ml	84 ml
Moist Yeast	3g	3g	3g	3g	3g	3g	3g	3g	3g

Flour and other ingredients (water, corn oil, sugar, salt and yeast) were mixed and kneaded to form smooth dough, and after that the dough is left to be cut into pones at room temperature and rested for 10 minutes, baked in the oven at 260 Co about 4 minutes, then air-cooled and Placed in polyethylene bags to use for sensory evaluation. shows the bread with different supported.

### Determiration of physical properties

Both control specimens of wheat flour and samples (BPP-PGPP-PPPP) with the addendum of chosen fruit by-products were

calculated using farinographic, extensographic and amylographic tests as follows (A.A.C.C., 1969) methods.

## Rheology

In chosen fruit by-products, 2.5 percent and 5 percent additions were performed in individual measurements. As per to their chemical structure and their impact on the rheological properties of dough, the quantities of the 2.5 percent and 5 percent fruit by-products were chosen.

### 4.2.7.1. Farinograph mensuration

Before the effective measurement of the farinograph, moisture assessment is needed. The calculation was carried out by means of ISO standard 5530-1 (1997). Flour moisture was measured in accordance with ISO standard 712 (2009). A Brabender R Farinograph (Co, Duisburg, BrabenderR GmbH & Germany) was used for the determination of water absorption, dough production time, farinograph quality number and dough stability, The Farinograph Data Correlation software (BrabenderR GmbH & Co, Duisburg, Germany) conducted a visual comparison of the curves.

#### • Farinograph test- :

The Farinograph test was performed on a Bra bender R Farinograph Co, Duisburg, & GermanyBrabenderR GmbH) to evaluate the absorption of water, the development time of the dough, the consistency of the dough and the weakening of the control sample for wheat flour and sample samples (PPPP-BPP-PGPP) with GA additions in accordance with the following procedure: 300 grams of wheat flour were put in the farinograph vessel. And at room temperature, the burette was filled with water and set at zero change. The machine was adjust at a high speed and ran for one minute until there was a zero minute thread. Water was applied from the burette promptly to the side of the vessel almost to the amount expected to be the proper flour absorption. The sides of the vessel were scraped down as the dough was

starting to shape. More water was applied when the blending curve leveled off at a value greater than 500 Brabender units (B.U), and the vessel was sealed with a glass plate to avoid evaporation. For definitive titration, subsequent titration was necessary to change the absorption curve at 500 B.U. The total volume for water was applied within 25 seconds after the stopcock of the burette was unlock. Absorption values were rounded to the nearest 0.1% or were measured on a 14% humidity basis. by way of the next equation:

$$\text{Absorption \%} = (x + y - 300) / 3$$

wherever:

x, ml of water needed to generate curve with maximum matchmaking entered on 500 B.U. Line and y, flour grams equal to 300 grams of 14 percent moisture foundation.

#### 4.2.7.2. Extensograph test-:

Extensograph tests were performed on a Bra bender R Extensograph (Co, Duisburg, Germany & Bra bender R GmbH ) in order to determine the higher resistance to extensibility and power of the dough (energy) for the control specimen of wheat flour and samples with GA addendum in accordance to the next procedure: standard running of the farinograph was performed in order to estimate the ability of water absorption. 300 grams of flour was added to the measured water containing 6 grams of salt to shape a dough with a consistency of 500 B.U. The ingredients were then blended for a minute and after 5 minutes of rest mixture, the mixing was halted and resumed until the farinograph 's maximum production time. The dough for 150 grams was scaled off when blending was completed and 20 revolutions were given in the extensograph rounder. Carefully cent rated at the shaping unit, the dough ball was twist into a cylindrical test piece, that was then clamped with a lightly greased dough stand and stocked for testing in a humidified chamber. The test specimen was placed on the balance arm for the extensograph after a rest time of almost 45 minutes after the shaping operation, and the pen was adapted horizontally from the zero line on the chart. The stretching hook was initiated exactly 45 minutes after the end of the shaping

operation. When the test specimen broke, it was halted. The dough was then separated from its holder, reshaped and pliable for a 45-minute rest time, and then stretched again. By repeating this process, the cumulative time for checking the dough was 45 minutes, 90 minutes and 135 minutes. Extensograms, resistance to extension, extensibility and energy (region under curve, cm<sup>2</sup>) were calculated, to test the consequence of the Extensograph.

### **Sensory Assessment.**

With 24 panelists including staff members, College employees and postgraduate students of the college of Specific Education of Minia University, Egypt, sensory assessment was achieved. In the Home Economics section in the college of Special Education, research was carried out.

Each panelist was served with 9 randomly crackers and bread samples at a concentration of 2.5% and 5% on round glass dish and gave water between the specimens was given for rinsing.

The samples produced were as follows

- control sample: (100% wheat flour)
- (PGPP): (2.5 g or 5 g of PGPP + 97.5 g or 95 g wheat flour)
- (PPPP) : ( 2.5g or 5 g of PPPP + 97.5 g or 95 g wheat flour)
- (BPP) : ( 2.5g or 5 g of BPP + 97.5 g or 95 g wheat flour)

Bread and cracker panelists were asked to use the 10-point to determine the odour ,taste, general admission , texture and colour of the bread and crackers.

### **Analysis of Statistical**

The data was analysed using a statistical analysis method using the GLM (General Linear Model) software (**SAS, 2003**). double range tests (**Duncan, 1955**) compared average value.

## Result and Discussion

### Physical properties:-

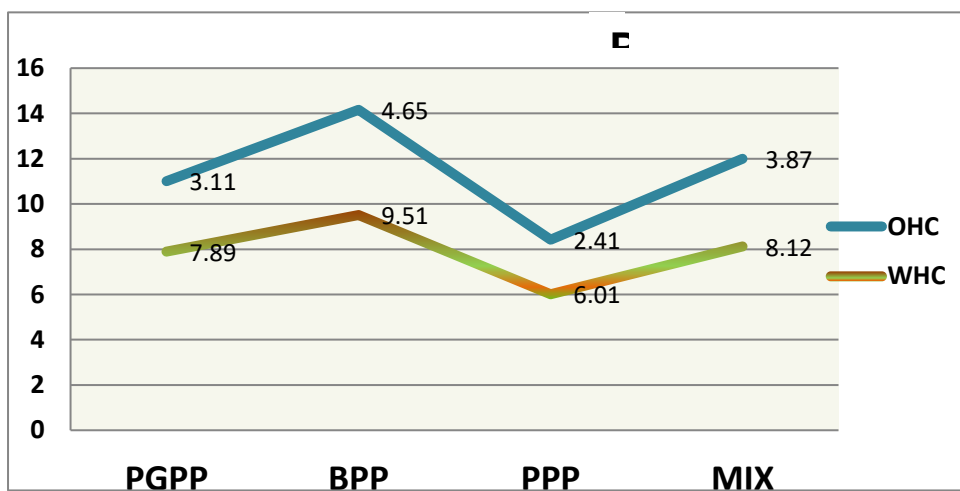
The water holding capacity (WHC) and oil (OHC) holding capacity of fruits by-products PGPP, BPP, PPPP and their mixture were arranged in Table (1) and figure (1). It can be observed from such data that (BPP) recorded the highest WHC and OHC followed by Mixture (PGPP + BPP + PPPP), (PGPP) and (PPPP) being 9.51, 8.12 , 7.89 and 6.01 g water.g<sup>-1</sup>, and 4.65 ,3.87, 3.11 and 2.41 and g oil g<sup>-1</sup> respectively, This suggests that contrast to remnant fruits by-products, the higher fiber purport in BPP retains more water. As a result, the water raises around 50 ml to 70 ml as the concentricity of banana peel flour for the bread increases. This result agrees with (**Bandal et al., 2014**) whom reported that the WHC for banana peel flour to be greater than those of wheat and pomegranate flour, because as banana had a higher fiber content. And result was agree with (**Eshak, 2016**) who discovered that the WHC and OHC of Egyptian balady loaf with enhanced banana peel concentration than the control bread .While (**Mahloko et al., 2019**) showed that (WHC) ranged in banana and prickly pear cortices flours between 3.99 to 4.29 g / ml and in wheat flour and composite flours between 2.03 to 2.17 g / ml.

In similar study for fruits by-products, (**Mashal , 2016**) who reported that Potato peel powder recorded the higher WHC than prickly pear powder being 8.01and 5.33 g H<sub>2</sub>O.g<sup>-1</sup>, respectively. This means that, relative to prickly pear powder, the increasing fiber content of potato peel powder retains more water. Furthermore, (**Wachirasiri et al.,2009**) whom found that banana peel dietary fiber concentrate have elevated WHC (9.25 and10.52 g water/g arid matter) and OHC (5.17-5.77 g oil / g dry matter). The WHC of whole banana peel flour heightened with temperature and ranged from 4.1 to 8.2 g / g dry specimen(**Alkarkhi et al., 2010**).

**Table (1):** Physical properties of fruit by-products PGPP, BPP, PPPP and their mixture.

Parameters	Pomegranate peel powder (PGPP)	Banana peel powder (BPP)	Prickly pear peel powder (PPPP)	Mixture (PGPP + BPP + PPPP)
Water holding capacity (WHC, g H <sub>2</sub> O.g <sup>-1</sup> )	7.89 ± 0.34 <sup>b</sup>	9.51 ± 2.11 <sup>a</sup>	6.01 ± 1.14 <sup>c</sup>	8.12 ± 0.13 <sup>ab</sup>
Oil holding capacity (OHC, g oil.g <sup>-1</sup> )	3.11 ± 0.21 <sup>b</sup>	4.65 ± 0.68 <sup>a</sup>	2.41 ± 0.19 <sup>c</sup>	3.87 ± 0.47 <sup>a</sup>

<sup>E</sup> Each value reflects the mean value of three ±SD replicates. <sup>E</sup> Mean values of various letters in the same row average at  $p \leq 0.05$ .



**Figure (4):** The water (WHC) and oil (OHC) holding capacity of fruits by-products PGPP, BPP, PPPP and their mixture.

### Phytochemical analysis

Gross phenolics and flavonoids tenor of fruits through-products PGPP, BPP, PPPP and their mixture are shown in Table (2) and figures (2) (3). The results appeared that the total content for total phenolics was ranged 516-1267 mg EGA.100 g<sup>-1</sup> and total flavonoids was ranged 14.311 - 28.277 mg/100g. The PGPP recorded the highest content of total phenolics followed by

mixture , BPP and PPPP respectively. Total flavonoids recorded high content in BPP followed by mixture, PGPP and PPPP respectively.

**Khojah and Hafez, (2018)** reported that the pomegranate fruits peel powder had the highest amounted from total dietary fiber; soluble and insoluble dietary fibers were 56.23, 43.54 and 12.69%, respectively and the pomegranate fruits peel powder had higher amounted from total phenolic compounds was 58.63 mg/g GAE.

And result nearly with **Anwar and Sallam, (2016)** whom showed that total dietary fiber in prickly pear peel was 32.67 and total Phenolics as gallic acid was 441.11. **Elhassaneen et al ., (2016)** found that the largest content of total phenolics and total dietary fiber of 1388, 421 mg EGA.100 g- and 145.91g.100g-1 was reported in the potato peel powder (PPPP). Also **(Dewit et al., 2015)** indicated that cactus pears are rich in minerals, phenol content, dietary fibre and have better technological potential of fat absorption and water binding capability.

**Al-Mashkor , ( 2014)** who confirmed that the highest content for total phenolics content (TPC) and total flavonoids content (TFC) was contained in 50% of acetone extracts. For pomegranate cortices, the TPC was between 84.15 and 168.26 mg gallic acid/100 g dry weight, and TFC is around 42.40 and 87.21 mg QE/100 g dry. While **(Shalaby et al., 2019)** showed that total phenol content in pomegranate peels (61.63 GAE mg/g) is higher than in juice (15.93 GAE mg/g). Also total flavonoids in peels (49.32QE mg/g) are higher than in juice (25. 85QE mg/g). **Aboul-Enein et al., (2016 )** was found that Methanolic extract (80%) from banana skin have the largest total flavonoid, tannin and phenolic content of 21.04, 24.21 and 17.89mg /g DW respectively. **El-Mostafa et al., (2014)** showed that the total flavonoids and phenolic of skin fruits of *O. ficus-indica* were 6.95 and 45, 70. And **Mahloko et al ., (2019)** whom reported that total flavonoid content (TFC) in banana, prickly pear flour and wheat ranged between 15.78 and 23.19 mg / g g respectively in PPF and BPF and between 0.75 and 13.32 mg / g respectively in control wheat



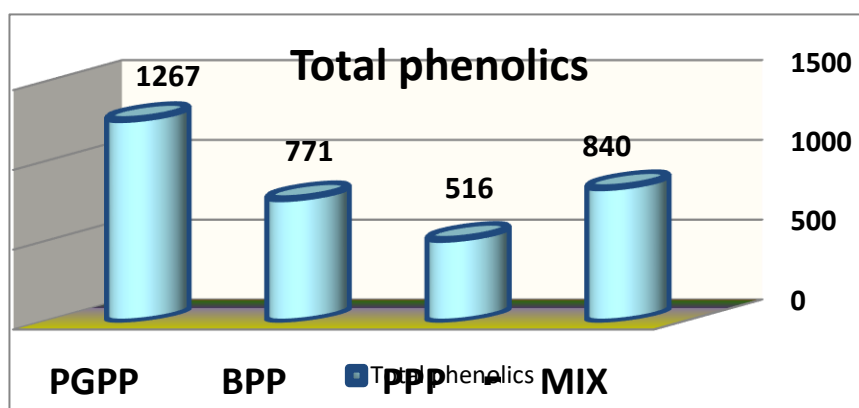
flour and composite flour, which composite flour that includes both BPF and PPF.

Bioactive compounds like flavonoids, anthocyanins, alkaloids, tannins and terpenoids were found in banana peels, different biological and pharmacological effects have been documented for these substances, like antibacterial , antihypertensive activities , antidiabetic and anti-inflammatory (Thomas and Krishnakumar , 2017).

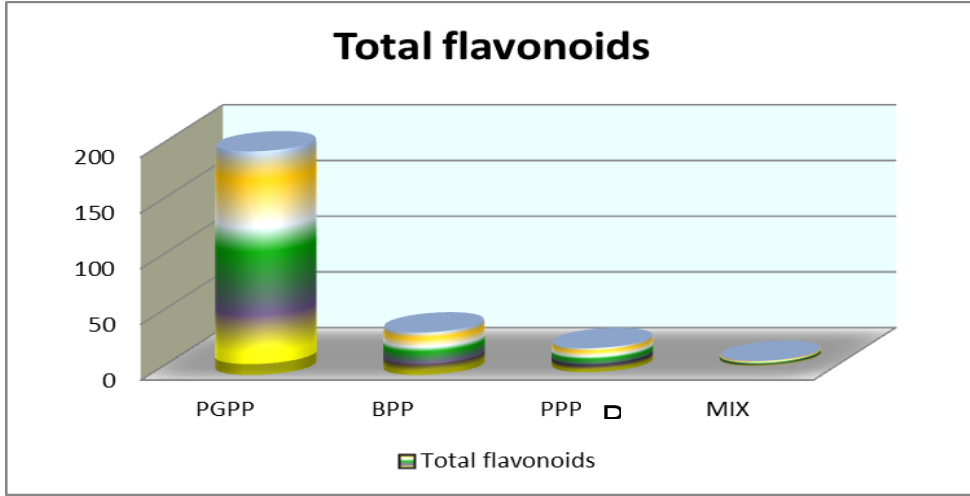
**Table (2):** phenolics and flavonoids tenor of fruit by-product (PGPP-BPP-PPPP) and their mixture.

Parameters	Pomegranate peel powder (PGPP)	Banana peel powder (BPP)	Prickly pear peel powder (PPPP)	Mixture (PGPP + BPP + PPPP)
Total phenolics (mg GAE100 g <sup>-1</sup> )	1267 ± 130 <sup>a</sup>	771 ± 142 <sup>c</sup>	516 ± 59 <sup>d</sup>	840 ± 67 <sup>b</sup>
Total flavonoids (mg/g)	19.833 ± 1.153 <sup>b</sup>	28.277 ± 0.347 <sup>a</sup>	14.311 ± 0.534 <sup>c</sup>	22.867 ± 0.86 <sup>ab</sup>

The mean of three duplicates ±SD is expressed by each e value. Mean values with various letters in the same raw average at p≤0.05. level are substantially different



**Figure (2):** Total phenolics (mg EGA.100 g<sup>-1</sup>) of fruits by-products PGPP, BPP, PPPP and their mixture.



**Figure (3):** Total flavonoids of fruits by-products PGPP, BPP, PPP and their mixture.

## Effect of fruit by-products on the rheological parameters:-

### Farinograph parameters:-

The results which presented in Table (3) and photo (1) (2), illustrated all farinograph parameters for wheat and Flour of wheat replaced for 2.5 and 5% (PGPP), (BPP), (PPPP) and their mixture (PGPP, BPP, PPPP). The blending of fruit by-products (PGPP, BPP, PPPP) in dough increased the water absorption from 62.03% for control to 65.32, 67.03, 63.65, 66.91% and 67.76, 71.60, 65.87, 69.88% for dough contained 2.5 and 5% PGPP, BPP, PPPP and mixture, respectively. Dough contained 5% (BPP) recorded highest score while dough contained 2.5% (PPPP) recorded the lowest score. This rise can be due to the high dietary fiber content for PGPP, BPP, PPPP and mixture.

In similar study of (Anwar and Sallam, 2016) whom reported that farinograph data for wheat flour incorporated of

prickly pear cortices powder presented an improvement in water absorption compared to control sample of 55 percent between 57.0 percent and 58 percent to level 1 and 2 percent

**Sulieman et al ., (2016)** found that the mixed of Pomegranate peels in wheat flour improve the dough's water absorption. For wheat flour, it was raised from 55.5 percent for control to 70.4, 79.2 and 88.1 percent, and with 5 percent, 7.5 percent and 10 percent for pomegranate skins added. And dough stability from 11.5 to 11.67, 12.21 and 12.35% respectively for wheat flour and, together the addition of 5%, 7.5% and 10% of pomegranate skins.

And (**Babiker et al., 2013**) reported that orange peels raised the absorption of dough water around 55.5, 60.5, 63.4 and 67.5 percent to wheat flour and added 5, 7.5 and 10 percent for orange cortices, respectively to wheat flour.

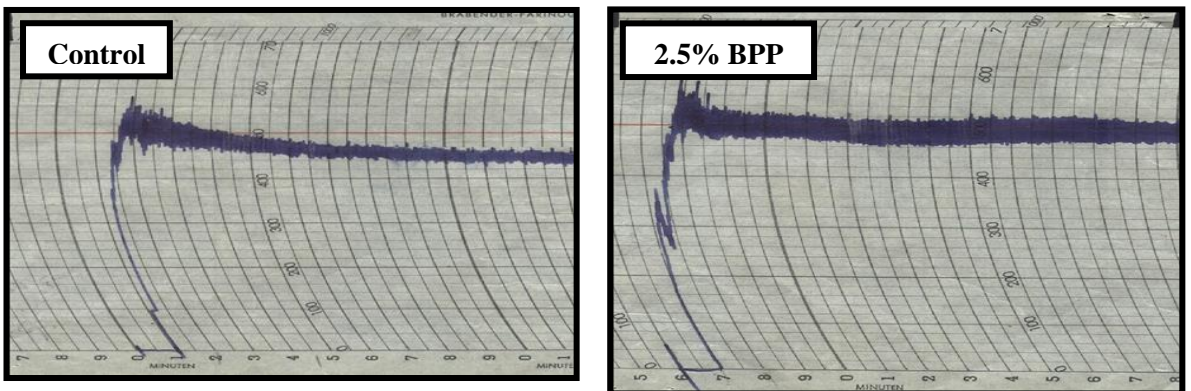
The mounting development time of dough shows that the dough for the addendum of fruits by-products from 3.48,4.63,3.86,4.57min and 3.47,4.84,3.87,4.63 min with 2.5% and 5% respectively incorporation of PGPP, BPP, PPPP compare to wheat flour 2.74 min a longer relaxation time (the dough is tougher).The highest score recorded in dough contained 5% BPP. And the dough stability increased from 4.46 for control to 5.35, 6.93, 5.96, 6.72 min and 5.42, 7.27, 6.01, 6.90 min for dough contained 2.5 and 5% PGPP, BPP, PPPP and mixture, respectively. In each of these fruit by-products and pectin, which act as a food hydrocolloid, this can be due to increasing content for dietary fibers.

The most significant measure for dough force is dough stability in minutes. The addition with fruit by-products (PPPP, PGPP BPP and their mixture) of flour specimen showed significantly longer stability times than control specimen (without the addendum for PGPP, BPP, PPPP fruit by-products).This affect was significantly with the addition of 2.5 and 5% of fruits by-products PGPP, BPP, PPPP for wheat flour. This affect could be refer to the effect of fruits by-products PGPP, BPP, PPPP

addendum on the quality for protein and dietary fiber of flour in special the binding force idiosyncrasy.

Our information is in line with that defined by (**El-Safy, 2013**), dough development time (min) was constant at 1min and increased to 1.5 min . The variations in the development time of the dough can be due to changes in the physicochemical properties for the fruit by products PGPP, BPP, PPPP flour and that of wheat flour. **Loza et al., (2017)** whom illustrated that It is probable that a period of prolonged mass production, linked to the quality and quantity for gluten, may result in a longer development time for a flour with a larger gluten content.

A statistically significant variation(  $P < 0.05$ ) was identified from the dough of farinograph quality number (FQN) point of view between the control specimen (with the inclusion of fruit by-products) and the dough with the inclusion of 2.5 percent and 5 percent of fruit by-products, including PGPP, BPP, PPPP and their mixtures of 153 to 157, 166, 159, 163 and 160 175, 162, 168, respectively. This is because after the addition of 2.5 percent and 5 percent of these by-products, an increase in the consistency of the dough occurred as the FQN value substantially improved compared to the control sample. Like that aforesaid by (**Pecivova et al., 2011**), the consistency of dough is decided by FQN and thus affects the quality of the last bakery products. Such data are in accordance with that confirmed by (**Mashal, 2016**).



**Photo (1) :** Effect of adding PGPP, BPP, PPPP at level 2.5%

**Table ( 3 ):** Farinograph parameters of the control and composite flour breads and crackers.

Values in the same column with diverse letters mean significantly various at level  $p \leq 0.05$  and mixture powder on the farinograph parameters of dough.

Treatment	Water absorption (WA, %)	Arrival time (AT, min)	Dough development time (DDT, min)	Dough stability (DS, min)	Farinograph quality number (FQN)
Control flour (CF)	62.03 <sup>d</sup>	1.51	2.74	4.46	153
CF +2.5% PGPP	65.32 <sup>b</sup>	1.76	3.48	5.35	157
CF + 5% PGPP	67.76 <sup>ab</sup>	1.74	3.47	5.42	160
CF +2.5% BPP	67.03 <sup>ab</sup>	2.73	4.63	6.93	166
CF +5% BPP	71.60 <sup>a</sup>	2.84	4.84	7.27	175
CF + 2.5% PPPP	63.65 <sup>c</sup>	1.94	3.86	5.96	159
CF + 5% PPPP	65.87 <sup>b</sup>	1.94	3.87	6.01	162
CF + 2.5% Mix	66.91 <sup>ab</sup>	2.43	4.57	6.72	163
CF + 5% Mix	69.88 <sup>a</sup>	2.47	4.63	6.90	168

Pomegranate peel powder (PGPP), Banana peel powder (BPP), Prickly pear peel powder (PPPP) and their mixture (PGPP, BPP, PPPP).

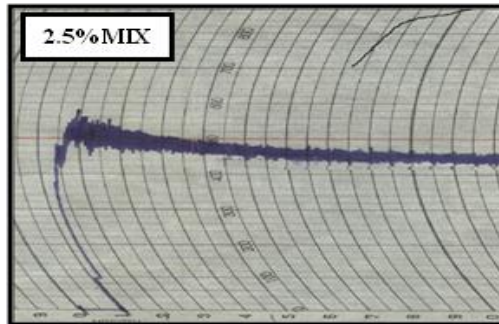
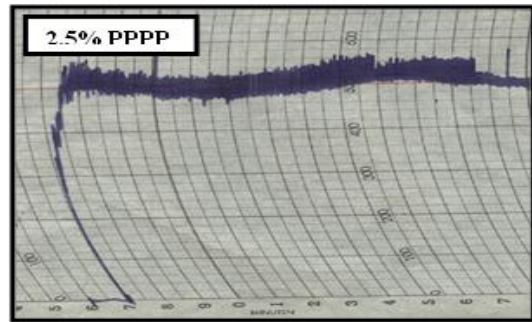
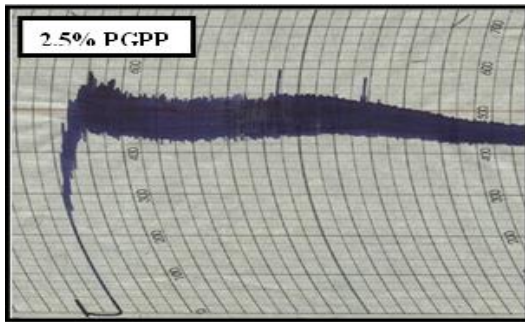
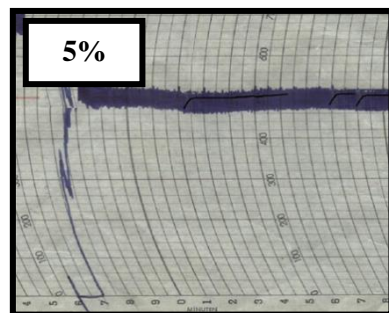
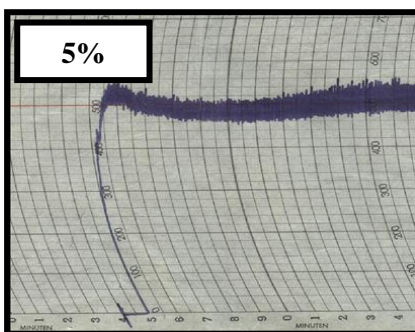
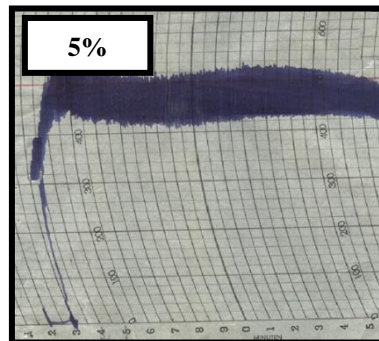
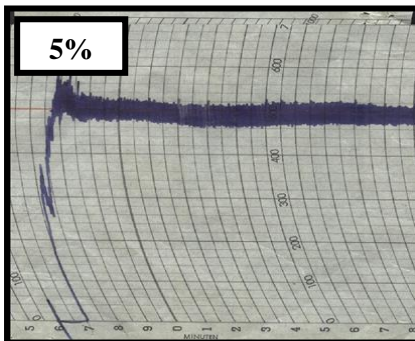


Photo (2) : Effect of adding PGPP, BPP, PPPP at level 5% and mixture powder on the farinograph parameters of dough.



Pomegranate peel powder (PGPP), Banana peel powder (BPP), Prickly pear peel powder (PPPP) and their mixture (PGPP, BPP, PPPP).



## Parameters of Extensograph

Information from the table (4) also photo (3)(4) Show the extensograph outcomes of wheat flour control dough and dough's for addendum of selected fruits by-products (PGPP, BPP, PPPP and their mixture). Dough strength Specific extensibility by the region under the curve and proportional to an energy required to cause rupture. The mixing of fruit by-products (PGPP, BPP, PPPP and their mixture) in dough d the extensibility from 181 mm for control to 184,199,186,194 mm and 189, 207, 191 , 203 for dough contained 2.5% and 5% PGPP, BPP, PPPP and their mixture respectively. Addition of fruit by-products (PGPP, BPP, PPPP and their mixture) Flour specimens exhibited substantially greater extension resistance than control samples (without the addendum of fruit by-products) from 519 for control to 525, 551, 531,540 and 540, 573, 545, 565 for dough contained 2.5% and 5% PGPP, BPP, PPPP and their mixture, respectively. Dough expansion resistance is the most significant measure of the ability of dough to maintain gas. The addendum of PGPP, BPP, PPPP and their mixture to wheat flour caused increased energy from 111 to 114, 125,116,121 and 117,130,120,127 for wheat flour and dough contained 2.5% and 5% PGPP, BPP, PPPP and their mixture, respectively.

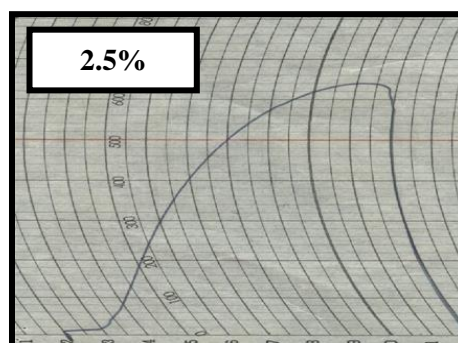
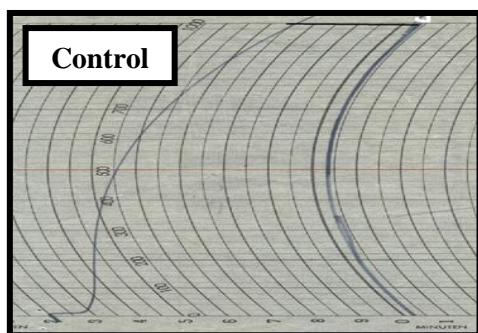
The dough's extensibility is the dough's capacity to expand or stretch it relies on the proportion for gliadin throughout the dough (El-Safy, 2013). Elhassaneen *et al.*, (2018) found that PPPP in dough increased the extensibility from  $167 \pm 3.7$  mm for control to  $175 \pm 4.1$  and  $184 \pm 2.8$  mm for dough contained 5 and 10% of PPPP, respectively.

And this disagree with (Ali , 2013) indicated that addition op prickly pear peels to wheat flour caused decreased extensibility from 115,105 and 75mm for flour of wheat and with addendum of 0 percent , 5 percent and 10 percent of prickly pear skins respectively and PPPP caused decreased energy from 75 to 68 for weat flour and with addition of 0% ,5% and increased to 98 with addition 10% of prickly pear peels.

Approximately 80 percent of wheat flour's total protein is gluten, which is responsible for dough extensibility because its contain of gliadins and glutenins (El-marassy *et al.*, 2016).

**Table (4) :** Extensograph of the control and composite flour breads and crackers. Values in the same pillar of various letters average significantly different at the  $p \leq 0.05$  level.

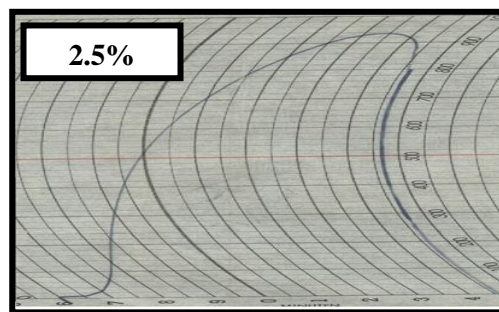
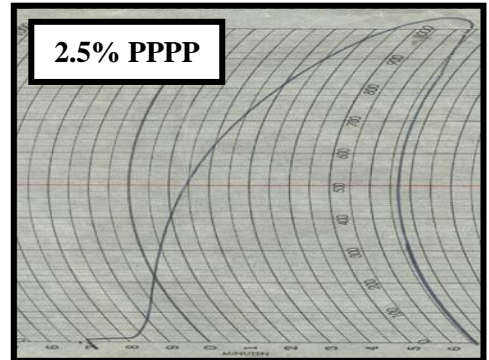
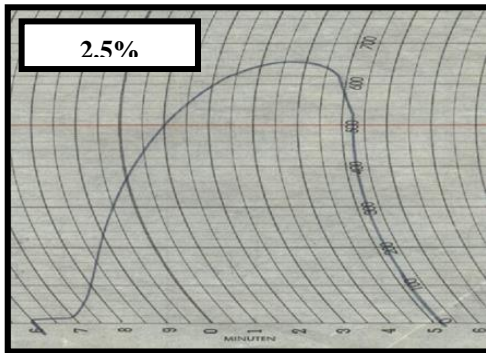
Treatment	Extensibility (mm)	Relative resistance to extension (BU)	Proportional number	Energy (cm <sup>2</sup> )
Control flour (CF)	181 <sup>e</sup>	519	2.8	111
CF +2.5% PGPP	184 <sup>d</sup>	525	2.71	114
CF + 5% PGPP	189 <sup>cd</sup>	540	2.81	117
CF +2.5% BPP	199 <sup>b</sup>	551	2.84	125
CF +5% BPP	207 <sup>a</sup>	573	2.96	130
CF + 2.5% PPPP	186 <sup>cd</sup>	531	2.76	116
CF + 5% PPPP	191 <sup>c</sup>	545	2.84	120
CF + 2.5% Mix	194 <sup>c</sup>	540	2.82	121
CF + 5% Mix	203 <sup>ab</sup>	565	2.92	127



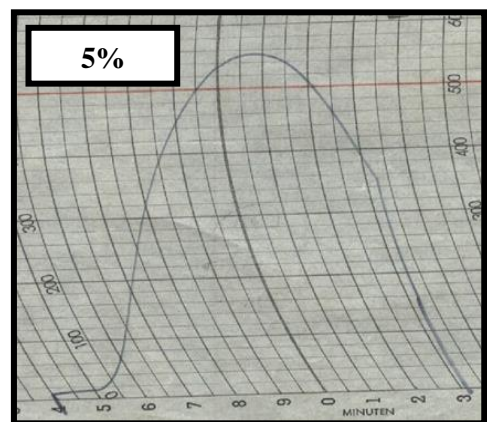
**Photo (3):** Effect of adding PGPP, BPP, PPPP and mixture powder at 2.5% on the extensigraph parameters of dough.

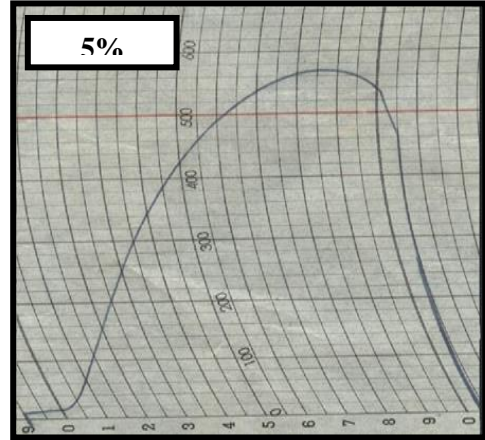
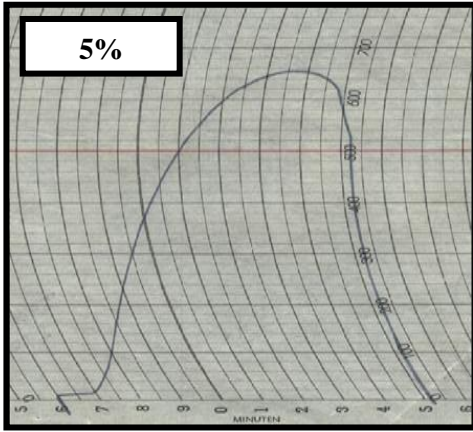


Pomegranate peel powder (PGPP), Banana peel powder (BPP), Prickly pear peel powder (PPPP) and their mixture (PGPP, BPP, PPPP).



**Photo (4): Effect of adding PGPP, BPP, PPPP and mixture powder at 5% on the extensigraph parameters of dough.**





**Pomegranate peel powder (PGPP), Banana peel powder (BPP), Prickly pear peel powder (PPPP) and their mixture (PGPP, BPP, PPPP).**

### Sensory evaluation

**Sensory evaluation of bread prepared for 2.5% and 5% level from prickly pear, pomegranate and banana peels powder (PPPP, PGPP, BPP).**

Data presented in table (5) and figure (4) (5) show the sensory properties of bread which supplemented with different levels (2.5 %- 5%) of pomegranate, banana and prickly pear peels powder and their Mixture in colour, texture, odor, taste and overall acceptability. Bread prepared with prickly pear peel powder (PPPP) at level 2.5% and 5% had higher rating scores than the control for sensory properties in colour , texture , odor ,taste and overall acceptability they equal with control scores followed by bread supplemented with PGPP at level 2.5% and in odor at level 5% . Bread prepared from the mixture of (PPPP,PGPP, BPP) had higher rating scores than PGPP and BPP in colour, texture, taste and overall acceptability at level 5% after bread supplemented with PPPP. Bread supplemented with BPP 2.5 and 5% shown least liked by the panelists.

It's similar to (**Bandal et al., 2014**) noticed that The sensory estimate of bread done in department indicates that pomegranate skin powder bread is very good in colour ,texture and taste

compared to another bread and also monitoring bread and decides that the rise in bread fiber content contributes to a degradation in the structure for gluten, so that the deranged gluten structure shows its impact on the small segment of bread structure. And (Sayed, 2014) found that among all fortified pan breads, all sensory grades of pomegranate peel powder of texture, appearance ,colour , general, overall acceptability and taste were insignificantly 7.5 percent of total acceptability of pomegranate peel powder ( $77.17 \pm 11$ ), which was significantly reduce than 2.5 percent ( $88.21 \pm 9.8$ ) and 5 percent ( $81.9 \pm 12.74$ ) of PPPP reinforced pan bread.

**Sulieban *et al.*, (2016)** who observed that enrichment of bread with different amounts of pomegranate cortices significantly ( $P < 0.05$ ) decreased approbation of its organoleptic properties by human panelists who gave lower m for the sensory attributes of wheat bread merger with pomegranate peels flour as compared to control.

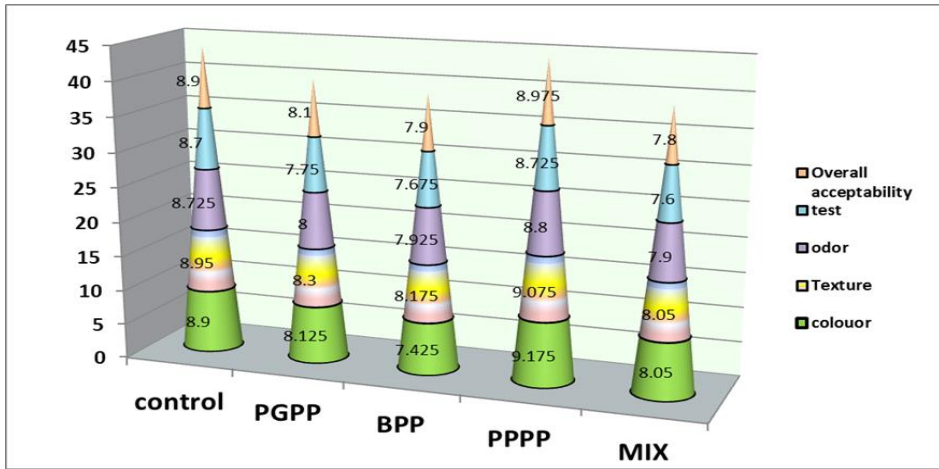
**Msaddak *et al.*, (2017)** stated that the mean real volume rose between  $1.2 \text{ cm}^3 / \text{g}$  (control bread) to  $1.6 \text{ cm}^3 / \text{g}$  at bread which supplemented with 7.5% with cladodes powder on dough and Then at 10% trade, it reduced to  $1.3 \text{ cm}^3 / \text{g}$ . Also (Mehder, 2017) revealed that Textureure and general appearance of 1.0 and 2.0% of pomegranate peel pan bread were nearly to the consumer preference of control bread. And all 5.0% pomegranate peel pan bread attributes were significantly difference than the control bread sample attributes in a narrow expand difference.

**Sodchit *et al.* , (2013)** mentioned the result of adding 1.5, 3.0 and 4.5 percent of butter cakes by banana peel cellulose (BPC) had comparable moisture and odour properties. The butter cakes with mercantile CC and BPC cellulose-added had "like mildly" overall admission and had greater moisture, fiber content, volume and viscosity than that of the control.

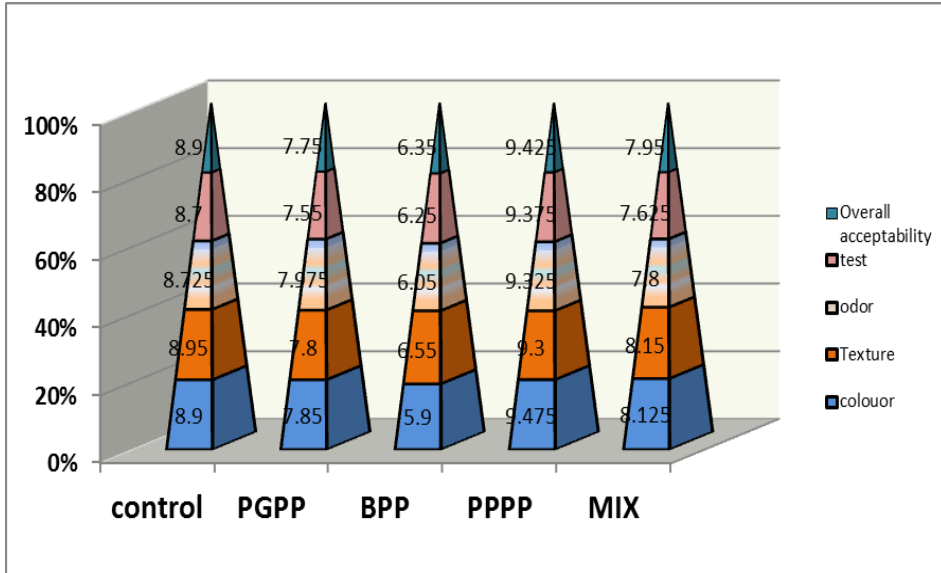
Sensory properties	Control	Pomegranate peel (PGPP)		Banana peel (BPP)		Prickly pear peel (PPPP)		Mixture of (PGPP-BPP-PPPP)	
	0%	2.5%	5%	2.5%	5%	2.5%	5%	2.5%	5%
Colour	8.9±1.7 <sup>a</sup>	8.12±0.89 <sup>b</sup>	7.85±0.653 <sup>c</sup>	7.425±0.855 <sup>b</sup>	5.9±0.768 <sup>b</sup>	9.175±0.657 <sup>a</sup>	9.475±0.486 <sup>a</sup>	8.05±1.071 <sup>b</sup>	8.125±1.023 <sup>b</sup>
Texture	8.95±1.829 <sup>ab</sup>	8.3±0.953 <sup>ab</sup>	7.8±0.8124 <sup>c</sup>	8.175±1.040 <sup>c</sup>	6.55±1.071 <sup>b</sup>	9.075±0.869 <sup>a</sup>	9.3±0.781 <sup>a</sup>	8.05±1.160 <sup>c</sup>	8.15±1.013 <sup>b</sup>
Odor	8.725±1.684 <sup>a</sup>	8±1.612 <sup>a</sup>	7.97±0.749 <sup>c</sup>	7.925±1.287 <sup>a</sup>	6.05±1.116 <sup>b</sup>	8.8±1.238 <sup>a</sup>	9.325±0.840 <sup>a</sup>	7.9±1.220 <sup>a</sup>	7.8±1.122 <sup>b</sup>
taste	8.7±1.926 <sup>a</sup>	7.75±1.089 <sup>b</sup>	7.55±1.071 <sup>c</sup>	7.675±1.306 <sup>b</sup>	6.25±1.299 <sup>b</sup>	8.725±1.279 <sup>a</sup>	9.375±0.849 <sup>a</sup>	7.6±1.0677 <sup>b</sup>	7.625±1.149 <sup>b</sup>
Overall acceptability	8.9±1.729 <sup>a</sup>	8.1±1.044 <sup>b</sup>	7.75±0.698 <sup>c</sup>	7.9±1.055 <sup>b</sup>	6.35±1.013 <sup>b</sup>	8.975±0.980 <sup>a</sup>	9.425±0.657 <sup>a</sup>	7.8±1.122 <sup>b</sup>	7.95±1.160 <sup>b</sup>

**Table (5):** Sensory evaluation of bread prepared with 2.5% and 5% level of, pomegranate , banana and prickly pear peels powder:

\* The mean ± SD is expressed in each value. Mean values in the same pillar with various letters mean significantly various at level  $P \leq 0.05$



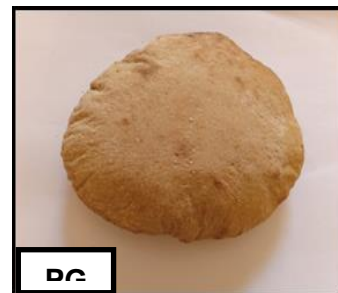
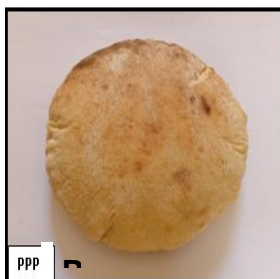
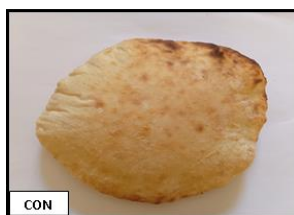
**Figure (4):** Sensory evaluation of bread prepared with 2.5% of (PPPP, PGPP, and BPP)



**Figure (5):** Sensory evaluation of bread prepared with 5% of (PPPP,PGPP,BPP)



**Photo (5) :** Control bread and bread supplementing with 2.5 %  
PPP P,PGPP , BPP and MIX



**Photo (6) :** Control bread and bread supplementing with 5 % PPPP,PGPP ,  
BPP and MIX



## Sensory evaluation of crackers prepared for 2.5% and 5% level from prickly pear, pomegranate and banana skin powder ( PPPP,PGPP,BPP).

Sensory properties, included taste, color, odor, Texture and Overall acceptability of supplemented crackers with 2.5 and 5% fruit by products pomegranate, banana and prickly pear peels and their mixture (PGPP, BPP ,PPPP) presented in Table (5) and figure (6)(7). crackers which replacement of 2.5% of prickly pear peel powder had higher rating scores than the other for sensory properties in colour , Texture , odor , taste and Overall acceptability 8.95 , 9.15 , 8.85 , 8.7 , and 8.7 respectively followed by crackers supplemented with BPP at level 2.5% 8.2, 8.35 , 8.35, 8.35 and 8.1 respectively. Followed by crackers which replacement of 2.5% from the mixture (PPPP, PGPP, BPP) 8, 8.25 , 7.95,7.8 and7.95 respectively. crackers which replacement of 5% of prickly pear peel powder had higher rating scores than the other for sensory properties in colour , Texture , odor , and Overall acceptability 8.7, 8.05, 8.05, and 8 respectively . While crackers which replacement of 5% of banana peel powder had higher rating scores than the other for sensory properties in taste 8.05 . The result showed that crackers which supplemented with 5% pomegranate pear peel was the lowest acceptable of the rest of the samples.

**Anjali et al., (2019)** indicated that significant higher marker was noticed for taste, appearance, flavor, color, texture and overall acceptability in cookies containing 60:30:5:5 ratio of wheat flour : multigrain flour : banana peel powder : date powder. (**Thnaa and Gouda, 2018**) stated that Sensory properties, included taste, color, flavor, Texture and Overall acceptability of enriched samples (Biscuit, cookies and Cake) with (20%) banana peel by substitute (20%) wheat flour .The supplemented of (20%) banana peel hadn't different significant, but it improved sensory evaluation, the results of mean values were (4.7, 4.7, 4.9) respectively compared to control (4.9,4.8, 4.8). It is possible to use

biscuit flour formulation with the addition of banana peels since it has the same acceptance level.

Compared with (**Zoair et al., 2016**) he studied orange peels (OP), banana peels (BP) and potato peels (PP) in preparing functional cupcake and crackers in level 10, 15, and 20%. The highest score of banana peels recorded in crackers at Concentration 10% in colour, texture, taste, odor, and overall acceptability 5.7, 6.0, 6.2, 6.8 and 6.9 respectively.

It was also observed that unlike most of the other enriched product with pomegranate peel powder like cookies, breads where the maximum amount of powder used for enriching is 5%, it can add product has 7.5% of pomegranate peel powder by weight. And it achieved acceptable range for the overall likeability for the addition of 7.5% pomegranate peel powder (**George et al., 2019**).

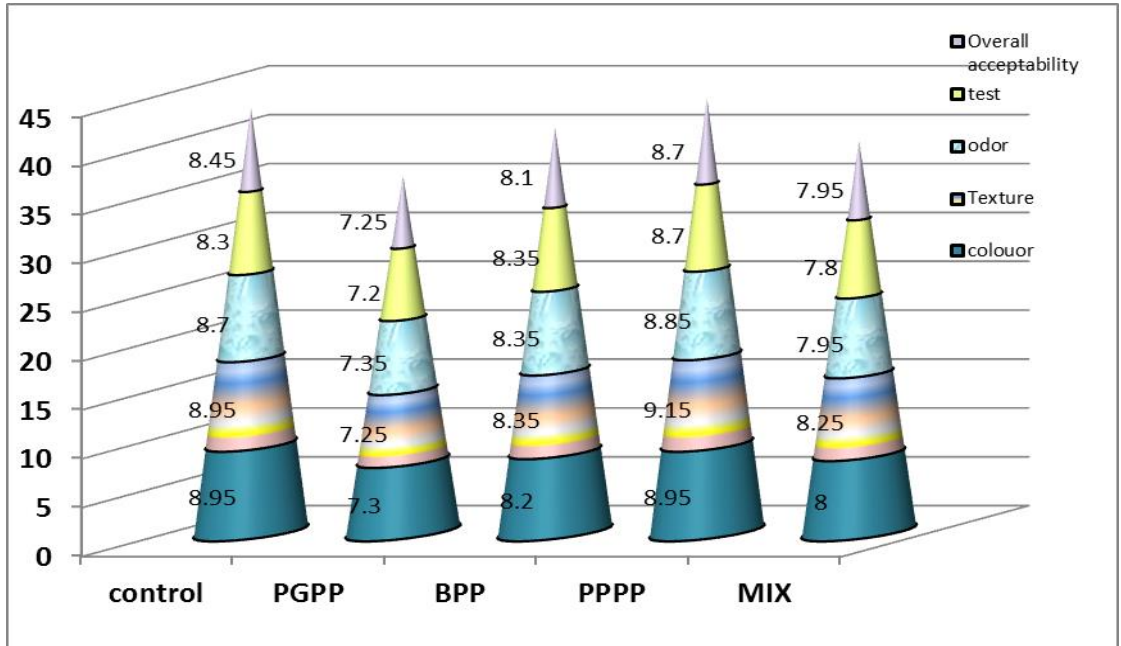
The assessment of a product's sensory quality is a very critical instrument for evaluating the acceptability of the user. Human elements play a major role in the determination of a product's organoleptic characteristics. Consumer acceptability has to be tested first at the laboratory level for a new product (**Ranjitha et al., 2018**).



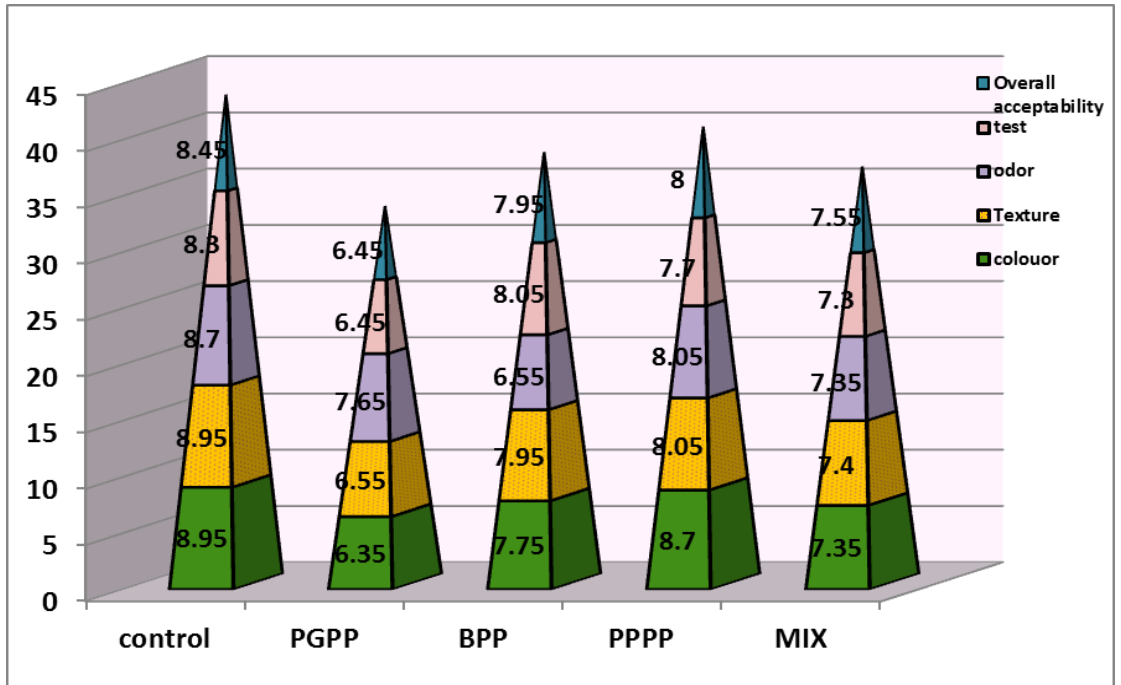
Sensory properties	control	Pomegranate peel (PGPP)		Banana peel (BPP)		Prickly pear peel (PPPP)		Mixture of (PGPP-BPP-PPPP)	
	0%	2.5%	5%	2.5%	5%	2.5%	5%	2.5%	2.5%
colour	8.95±0.973 <sup>3a</sup>	7.3±1.452 <sup>c</sup>	6.35±1.45 <sup>c</sup>	8.2±0.979 <sup>b</sup>	7.75±1.37 <sup>B</sup>	8.95±0.9733 <sup>a</sup>	8.7±1.345 <sup>a</sup>	8±1.095 <sup>b</sup>	7.35±1.525 <sup>b</sup>
Texture	8.95±0.668 <sup>a</sup> <sub>b</sub>	7.25±1.40 <sup>c</sup>	6.55±1.24 <sup>b</sup>	8.35±1.061 <sup>b</sup>	7.95±1.43 <sup>a</sup>	9.15±0.9096 <sup>a</sup>	8.05±1.395 <sup>a</sup>	8.25±1.17 <sup>b</sup>	7.4±1.562 <sup>ab</sup>
odor	8.7±1.417 <sup>a</sup>	7.35±1.55 <sup>c</sup>	7.65±1.15 <sup>b</sup>	8.35±0.909 <sup>a</sup> <sub>b</sub>	6.55±1.20 <sup>a</sup>	8.85±1.235 <sup>a</sup>	8.05±1.395 <sup>a</sup>	7.95±1.11 <sup>bc</sup>	7.35±1.768 <sup>a</sup> <sub>b</sub>
taste	8.3±1.552 <sup>a</sup>	7.2±1.326 <sup>b</sup>	6.45±0.97 <sup>b</sup>	8.35±0.9630 <sup>a</sup>	8.05±1.35 <sup>a</sup>	8.7±1.268 <sup>a</sup>	7.7±1.486 <sup>a</sup>	7.8±1.248 <sup>ab</sup>	7.3±1.705 <sup>ab</sup>
Overall acceptability	8.45±1.321 <sup>a</sup>	7.25±1.25 <sup>b</sup>	6.45±1.20 <sup>b</sup>	8.1±0.9433 <sup>a</sup>	7.95±1.35 <sup>a</sup>	8.7±1.228 <sup>a</sup>	8±1.341 <sup>a</sup>	7.95±1.20 <sup>ab</sup>	7.55±1.56 <sup>a</sup>

**Table (5):** Sensory evaluation of crackers prepared for 2.5% and 5% level from prickly pear, pomegranate and banana skin squished (PPPP, PGPP, BPP).

\* The mean ± SD is expressed by each value. Mean values with various letters in the same pillar mean that at level  $P \leq 0.05$  they vary significantly.

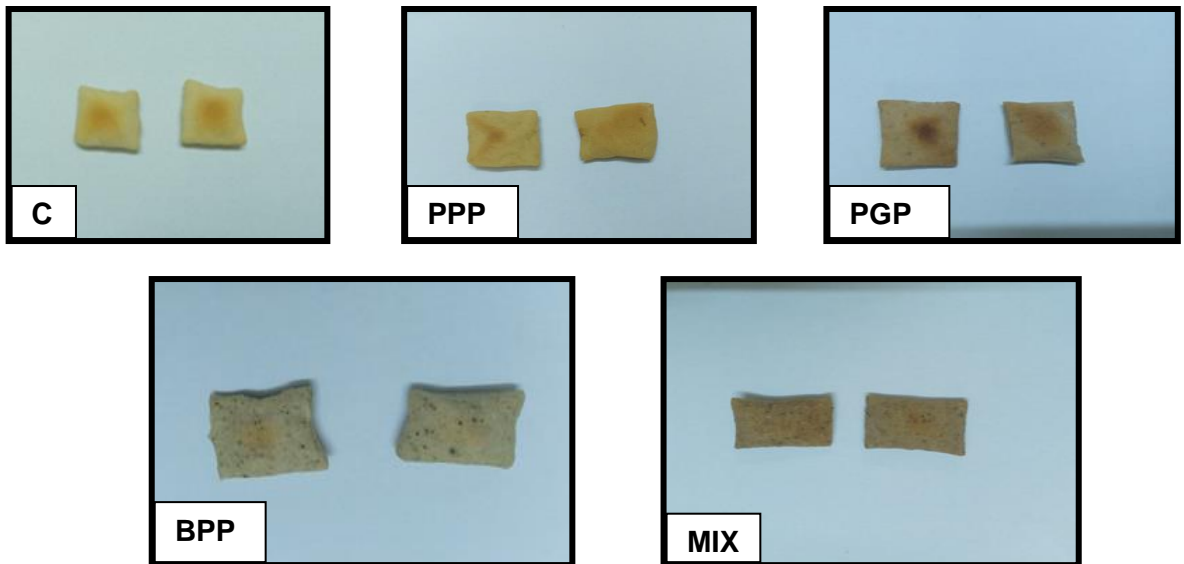


**Figure (6):** Sensory evaluation of crackers prepared with 2.5% of (PPPP, PGPP, and BPP)

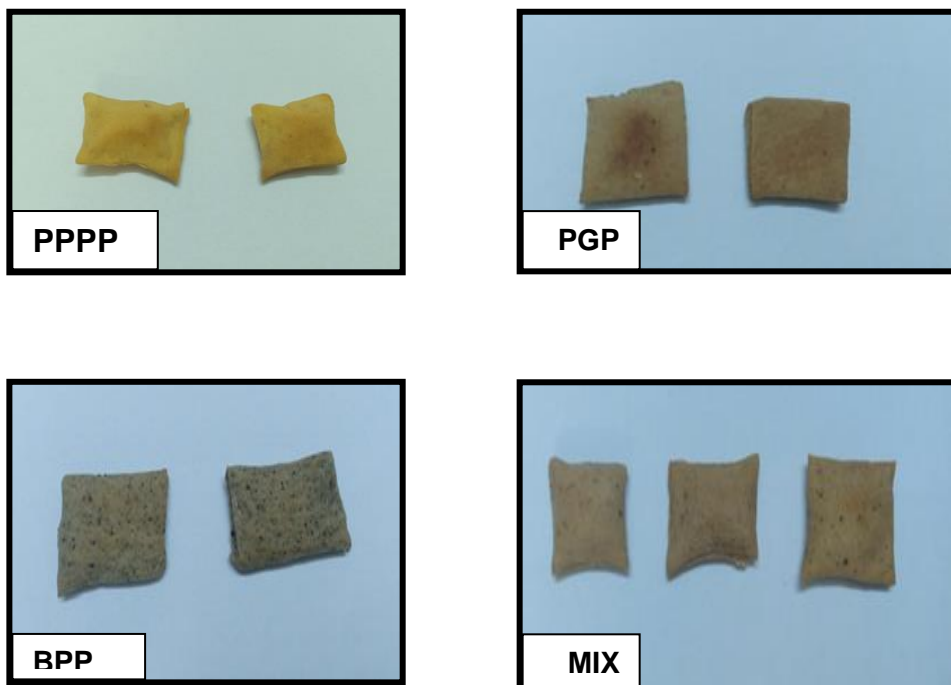


**Figure (7):** Sensory evaluation of crackers prepared with 5% of (PPPP, PGPP, BPP)

**Photo (7) :** crackers supplementing with 2.5 % of PPPP, PGPP, BPP and MIX.



**Photo (8):** crackers supplementing with 5 % of PPPP, PGPP, BPP and MIX



**In conclusion**

fruits peel powder PGPP, BPP, PPPP a good source of flavonoids and Phenolic . The mixed of fruits peel powder PGPP, BPP, PPPP at level 2.5 and 5% in dough increased the water absorption at PGPP, BPP, PPPP and mixture which with significant difference with control. Sensory properties of bread and crackers prepared with prickly pear peel powder (PPPP) at level 2.5% had higher rating scores than bread and crackers prepared with PGPP, BPP and mixture.

**المستخلص العربي**

يعتبر قشر التين الشوكي والرمان و الموز من المخلفات الثانوية التي يتم الحصول عليها أثناء تغذية / معالجة هذه الفاكهة. تنتج مثل هذه الأنشطة كمية هائلة من القشور والتخلص منها يمثل مشكلة رئيسية ويسبب تلوثاً بيئياً. في هذه الدراسة، تم تجفيف قشور التين الشوكي والرمان والموز في فرن عند ٤٠ - ٦٠ درجة مئوية ثم تم التحليل الكيميائي لهذه المنتجات الثانوية ، وتم تدعيمها في الخبز والمقرمشات عند مستويات ٢,٥ و ٥٪ كمصدر محتمل للمركبات النشطة بيولوجياً. كانت سعة تخزين الماء (WHC) والزيت (OHC) من قشور الفواكه PGPP و BPP و PPPP وخليطها ، ٧,٨٩ و ٩,٥١ و ٦,٠١ و ٨,١٢ جرام ماء g-1 و ٤,٦٥ و ٢,٤١ و ٣,١١ و ٣,٨٧ على التوالي. وتراوح محتوى المنتجات الثانوية للفاكهة -PGPP- PPP- BPP من الفلافونويد بين 14.311 - 28.277 مجم / ١٠٠ جم وتراوح إجمالي الفينولات من ١٢٦٧-٥١٦ مجم / GAE.100. العجين الذي يحتوي على ٥٪ من مسحوق قشر الموز (BPP) سجل أعلى درجة في امتصاص الماء بينما العجين الذي يحتوي على ٥,٢٪ من مسحوق قشر التين الشوكي (PPPP) سجل أقل درجة في امتصاص الماء. بينما الخبز المعد من خليط (BPP ، PGPP ، PPPP) له درجات أعلى من الخبز المدعم بقشور PGPP و BPP. والمقرمشات المدعمة ٥٪ من مسحوق قشر التين الشوكي لديها درجات تصنيف أعلى من غيرها من حيث الخصائص الحسية.

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