*Plant Archives* Volume 20 No. 2, 2020 pp. 9029-9038 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

# EVALUATION OF PAN BREAD QUALITY ENRICHED WITH ONION PEELS POWDER

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## Abstract

The impact of substituting wheat flour with yellow onion peels powder (OPP) at 1, 2, 3, 4 and 5% levels on pan bread quality and shelf life was investigated. OPP had higher content of dietary fiber, phenols, flavonoids and antioxidant activity (37.00%, 932.12, 747.34 mg/100g and 79.98% as DPPH and 82% as ABTS, respectively) compared with wheat flour. The highest phenolic and flavonoid compounds were pyrogallol, benzoic acid, salicylic acid, naringin, quercitrin, rutin and quercetin. Water and oil holding capacity (463.43 and 238.64%, respectively) was higher in OPP than wheat flour. Substitution with OPP significantly increased moisture, fiber and ash content in pan bread. In addition, all pan bread samples exhibited higher phytochemical compounds and antioxidant activity than control. Wheat flour could be substituted up to 2% of OPP without adverse effect on the sensory attributes of pan bread. Supplementation of pan bread with OPP delayed pan bread staling. OPP inhibited the growth of yeast and mould and prolonged the storage period of pan bread to five days compared with control. In general, substitution of wheat flour with onion peels powder to produce pan bread extended the shelf life of pan bread and increased the freshness and antioxidant activity.

***Key words:*** Onion peels; Pan bread; Antioxidant activity; Quality properties; Sensory evaluation; Freshness; Shelf life.

## Introduction

Consumers estimate food products not only in terms of nutritional needs, but also with regard to the improvement of health. Presently, interest in the production and consumption of functional foods is growing steadily. These foods defined as innovative and biologically active, provide additional health benefits beyond traditional foods (Abdel-Salam, 2010 and Œwieca *et al.*, 2014).

Bakery products are widely consumed and are becoming a major component of the food market (Kotsianis *et al.*, 2002). Bread is a daily staple food in the world and wheat bread has an important part in the human diet for growth and maintenance of health. Physicochemical changes and microbiological spoilage shorten the shelf life of bread (Gray and Bemiller, 2003 and Axel *et al.*, 2017). Staling of bread decreased consumer acceptance of bakery products and the consumer demand for healthy bread has increased which led to considerable efforts aimed at developing bread with combined health benefits and good quality properties (Foschia *et al.*, 2013 and Vasileva *et al.*, 2018). Recently, the current trends are the enhancement of the antioxidant activity of wheat bread by using plant materials rich in phenolic compounds, such as cereals spices, herbs, fruit and by-products from the food industries (Dziki *et al.*, 2014).

Food manufacturers and researchers do great efforts in optimizing technology to improve the quality, taste, functionality and bioavailability of food products such as bakery goods (Balestra *et al.*, 2011).

Egypt is one of the top world onion producers with an annual average production 2.96 million tons (FAO, 2018). Food industry produces approximated 15% onion wastes of the total production a large amount. The yield of industrial onion wastes is changeable annually, making it necessary to find possible ways for their utilization, because if not properly discarded may cause environmental pollution. Onion wastes could be used as a natural source of high-value functional ingredients, since onion are rich in several groups of compounds, which have perceived benefits to human health. The onion wastes, including the brown skin, the outer fleshy scales and roots, are significant by-products of the industrial preparation (peeling, undersized and damaged bulbs) of onions and are mostly discarded. Onion wastes could be used as functional ingredient rich in dietary fiber, phenols and flavonoids with high antioxidant activity (Shon *et al.*, 2004; Benítéz *et al.,* 2011 and Ifesan, 2017).

Using of industrial onion waste powder (IOWP) in bread formula (1–5%) was significantly increasing the antioxidant activity of bread; however, when applied at levels higher than 3% it weakened bread quality compared to control bread (Prokopov *et al.,* 2018a). Addition of IOWP may have negative influence on the bread crumb structure or sensory features; because it incorporates such components as dietary fiber (Khalid *et al.*, 2017) or volatile organic compounds (Choi *et al.,* 2017).

The objective of this study was to investigate the effect of substitution of wheat flour with onion peels powder as natural source of antioxidant and dietary fiber on physical, chemical and sensory characteristics of produced pan bread.

## Materials and Methods

### Materials

Yellow onion peels (*Allium cepa* L., outer dry layers) were obtained from local markets in Giza, Egypt. Wheat variety (*Triticum aestivum* L., Sids 13 variety) was obtained from Field crops Research Institute, Giza, Egypt. Baking ingredients (salt, milk powder, instant active dry yeast and corn oil) were purchased from local markets in Giza, Egypt. DPPH (2, 2-diphenyl-1-picrylhydrazyl), ABTS [2, 2×-azino-bis-(3-ethylbenzotiazoline-6-sulphonic acid)], sodium carbonate ($Na_2CO_3$), gallic acid and catechin were purchased from Sigma–Aldrich Chemical Co. (St. Louis, USA), Folin-Ciocalteu reagent was obtained from LOBA Chemie, India. Chemicals were of the analytical reagent grade.

### Preparation of onion peels powder and wheat flour

Onion peels were sterilized by immersing them in a 0.1% solution of sodium hypochlorite for 3 min, rinsing in distilled water and dried at 50±5°C overnight (Özer and Köycü, 1998). The dried onion peels were ground to a fine powder by using a high speed grinder (Grinder AR1044; Moulinex Egypt, Al-Araby Co., Egypt), sieved using 60 mesh/inch sieve to get fine powder (the most particle sizes range are around 250 microns). Wheat grains were conditioned to 14% moisture content for 16h and milled by using fractionation Laboratory mill (Brabender Duisburg roller mill, Germany) to obtained 72% extraction rate flour. Then onion peels powder and wheat flour were packed in polyethylene bags and kept until further analysis.

### Pan bread making

A straight dough bread making process was performed according to AACC (2002) with some modification. Basic dough formula was consisted of 100 g flour, 2 g salt (NaCl), 3 g dry yeast, 5 g sugar (sucrose), 10 g full fat milk powder, 3 g corn oil. Wheat flour was substituted with onion peels powder at levels 1, 2, 3, 4 and 5% (based on preliminary tests) and a required amount of water. The dough was put into greased fermentation bowel and placed in a fermentation cabinet at 37°C for and a relative humidity 80-85% for 20 min and then dough divided into pieces of 125 g. The dough was proofed for 30 min in a fermentation cabinet under controlled temperature and a relative humidity and then baked at 220ºC for 20 min in an electric oven. The pan bread was separated from the pans, left for cooling at room temperature, packed in polyethylene bags and stored at room temperature for 7 days (the stored bread used for staling and total fungal plate count) and kept for further analysis.

### Analytical methods

#### Proximate chemical analysis of wheat flour, onion peels powder and pan bread samples

Moisture, protein, fat, crude fiber and ash contents of the ingredients and pan bread samples were measured (AOAC, 2012). Total carbohydrate was calculated by difference [100-(Protein + Fat + Ash + Crude fiber)].

#### Determination of dietary fiber

The total dietary fiber contents of the wheat flour (72% extraction rate) and onion peels powder samples was determined by the enzymatic-gravimetric method according to Lee *et al.*, (1992).

#### Extraction and determination of phytochemicals in wheat flour, onion peels powder and pan bread samples

0.50-1 g of samples were extracted with 10 ml 1% methanol/HCl solution, shaken, filtrated and the volume was made up to a known volume. Total phenols were determined colorimetrically as described by Singleton and Rossi (1965) with some modification and gallic acid was used as a standard. Total flavonoids were determined according to the methods of Marinova *et al*., (2005) and catechin was used as standard.

### Antioxidant activity assays in wheat flour, onion peels powder and pan bread samples

**DPPH Free Radical Scavenging Assay**

The antioxidant activity was determined using the radical scavenging activity in reacting with DPPH free radical according to Brand-Williams *et al.*, (1995) and the radical scavenging percentage was calculated using the following equation:

Radical scavenging (%) = $[(A_0 - A_1/ A_0)] \times 100$

$A_0$= Absorbance of the control reaction (containing all reagents except the test compounds).

$A_1$= Absorbance in the presence of the tested extracts after 30 min.

**Radical scavenging activity by using ABTS method**

The ABTS assay was carried out according to Re *et al.*, (1999). The calculation of the radical scavenging percentage was made using the above formula as mentioned in DPPH method.

**Identification of phenolic acids and flavonoid compounds using HPLC**

The phenolic acid and flavonoid compounds of the samples were extracted according to the method described by Goupy *et al.*, (1999) and Mattila *et al.*, (2000). HPLC analysis was performed using an Agilent 1200 chromatograph (Agilent Technologies Inc., USA) composed of column C18 Zorbax ODS (with particle size 5µm, 4.60mm × 250mm). Elutes were monitored using UV detector set at 280 nm for phenolic acids and 330 nm for flavonoids. The separation was carried out with methanol and acetonitrile as a mobile phase, flow with 1 ml/min. Chromatographic peaks were identified by comparing the retention times with the respective retention times of known standard reference material. Retention time and peak area were used to calculation of phenolic acid and flavonoid compounds concentration by the data analysis of instrument software based on the standards and were expressed as mg/100g sample on dry weight basis.

**Physical measurements of pan bread**

Bread loaf weight (g) was recorded after cooling for 1 h, bread loaf volume ($cm^3$) was determined by rapeseed displacement method as described by AACC (2002). Specific volume ($cm^3/g$) of bread was calculated by dividing the volume by weight. Specific gravity ($g/cm^3$) was calculated by dividing weight by volume. Moisture content of fresh baked pan bread samples was evaluated.

**Water Activity ($a_w$) of pan bread**

Water activity ($a_w$) of pan bread samples were measured using Rotronic Hygrolab 3 instrument (Model CH-8303, Switzerland) as stated by Cadden (1988). Water activity ($a_w$) was measured using HygroLab3 (Rotronic, Switzerland). Samples were cut into small pieces immediately before water activity measurement at 21.27-22.26°C.

**Color measurement**

Crumb color of pan bread samples was measured by a hand-held Tristimulus reflectance colorimeter Minolta Chromameter (CR-400 model, Konica Minolta, Japan). Results recorded in the L* a* b* color system. Values reported are the means of triplicate determinations.

**Sensory evaluation of pan bread**

Pan bread samples were evaluated for crust color, crumb color, taste, odor, texture and overall acceptability using a 9-point unstructured hedonic scale by 10 panelists from Food Technology Research Institute staff according to the method of Stone and Sidel (1993).

**Freshness of pan bread**

The freshness of each pan bread sample was measured at room temperature during storage (0, 24, 48 and 72 h) by alkaline water retention capacity (AWRC) according to the method of Yamazaki (1953) as modified by Kitterman and Rubenthaler (1971) and was calculated using the following equation :

Reduction of freshness = $(AWRC_{\text{in zero time}} - AWRC_{\text{in n time}} / AWRC_{\text{zero time}}) \times 100$

Where n = time of storage

**Total fungal plate count of pan bread**

Total fungal count of pan bread was determined using malt yeast agar media according to APHA (2001). The total fungal count during storage $\geq 10^5$ $cfu.g^{-1}$ indicated the spoilage of the pan bread samples at zero time and stored samples during 7 days. Fungal growth was periodically determined during storage time and the results were expressed as log cfu/g.

**Statistical analysis**

For the analytical data, mean values and standard deviation are reported using Costat statistical software according to Steel and Torrie (1980). The obtained data were subjected to one-way analysis of variance (ANOVA) at $P$<0.05 followed by Duncan's new multiple range tests to assess differences between samples mean.

## Results and Discussion

**Physico-chemical analysis, phytochemicals and antioxidant activity of wheat flour and onion peels powder**

Table 1 shows physico-chemical analysis, phytochemicals and antioxidant activity of wheat flour (72% extraction rate) and onion peels powder (OPP). Wheat flour had the highest values in protein (11.51%), fats (1.00%) and total carbohydrates (86.50%) which in the same line with Abd El-Salam *et al.,* (2016). On the other hand, OPP had high contents in ash (6.63%) and crude fiber (29.99%). The obtained results are partially close to Bello *et al.,* (2013) and Prokopov *et al.,* (2018b) who estimated the chemical composition of onion waste powder.

OPP and wheat flour contain 37% and 2.80% of total dietary fiber, respectively. Benítez *et al.,* (2011) mentioned that industrial onion wastes could be used as a potential source of dietary fibers in human diet.

OPP had higher content of total phenols, flavonoids and antioxidant activity (932.12, 747.34 mg/100 g, 79.98% as DPPH and 82% as ABTS, respectively) compared with wheat flour. Cheng *et al.,* (2013) found that total phenols, flavonoids content and antioxidant activity in yellow onion varied from 606 to 2232 mg/100g, from 225 to 1773 mg/100g and from 53.32 to 72.25% (as DPPH) on dry weight, basis respectively. Sidhu *et al.,* (2020) reported that the total phenol values ranged from 816 to 2263 mg/100g for onion outer scales. Presence of flavonoids is an important factor that affects the level of antioxidant activity, where quercetin plays a main role in it (Sagar *et al.,* 2020). Kandoliya *et al.,* (2015) found that antioxidant activity in onion varieties varied from 58.14 to 77.67% (as DPPH).

OPP was higher in WHC and OHC (463.43 and 238.64%, respectively) comparing with wheat flour (72% extraction rate). OPP has a lower L* value and higher a* and b values compared with wheat flour and this may be due the pigments content in OPP.

**Table 1:** Physico-chemical analysis, phytochemicals and antioxidant activity of wheat flour and onion peels powder.

| Constituents | Wheat flour (72% extraction) | Onion peels powder (OPP) |
|---|---|---|
| Moisture content (%) | 10.20±0.22[a] | 7.95±0.08[b] |
| Protein (% dwt) | 11.51±0.31[a] | 3.09±0.06[b] |
| Fat (% dwt) | 1.00±0.17[a] | 0.60±0.02[b] |
| Ash (% dwt) | 0.55±0.03[b] | 6.63±0.87[a] |
| Crude fiber (% dwt) | 0.44±0.02[b] | 29.99±0.44[a] |
| Total carbohydrate (% dwt) | 86.50±0.13[a] | 59.70±1.39[b] |
| Total dietary fiber (% dwt) | 2.80±0.00[b] | 37.00±0.00[a] |
| Total phenols (mg/100g dwt) | 127.54±0.43[b] | 932.12±6.77[a] |
| Flavonoids (mg/100g dwt) | 27.44±0.46[b] | 747.34±2.65[a] |
| AO $_{as\ DPPH}$ (% dwt)* | 9.73±0.48[b] | 79.98±1.71[a] |
| AO $_{as\ ABTS}$ (% dwt)* | 10.08±0.58[b] | 82.00±0.62[a] |
| WHC (%)** | 80.26±1.41[b] | 463.43±3.01[a] |
| OHC(%)** | 66.82±2.48[b] | 238.64±1.22[a] |
| Color | | |
| L*** | 97.60±0.70[a] | 57.42±0.31[b] |
| a*** | -0.42±0.04[b] | 13.23±0.07[a] |
| b*** | 9.90±0.11[b] | 14.58±0.29[a] |

*AO= Antioxidant activity (radical scavenging activity) as DPPH or ABTS. dwt= Dry weight.

** WHC= Water Holding Capacity and OHC= Oil Holding Capacity.

***L (lightness with L = 100 for lightness, and L = zero for darkness), a [(chromaticity on a green (-) to red (+)], b [(chromaticity on a blue (-) to yellow (+)].

Values are mean of three replicates ±SD, number in the same row followed by the same letter are not significantly different at 0.05 level.

## Phenolic acids and flavonoids fractions of onion peels powder

Table 2 presents the phenolic and flavonoid compounds in onion yellow peels powder using HPLC. The results indicated that pyrogallol (49.88 mg/100g) was the highest compound among all phenolic acid compounds, followed by benzoic acid and salicylic acid (41.63 and 24.81mg/100g, respectively). Kwak *et al.,* (2017) separated quercetin in yellow onion using HPLC method.

Likewise, for flavonoid compounds, naringin (61.77 mg/100g) was the highest compound among all flavonoid compounds, followed by quercitrin, rutin and quercetin (25.51 and 21.54 mg/100g, respectively). Flavonoids were the major group of phenolic compounds, which was in agreement with the data for different parts of onion processing wastes (Benítez *et al.,* 2011). Ko *et al.,* (2016) stated that the content of quercetin in different

**Table 2:** Phenolic acid and flavonoid fractions of onion peels powder using HPLC.

| Compounds | mg/ 100g | Compounds | mg/ 100g |
|---|---|---|---|
| Pyrogallol | 49.88 | Naringin | 61.77 |
| Gallic acid | 2.12 | Rutin | 21.54 |
| Protocatechuic acid | 3.94 | Quercitrin | 25.51 |
| *p*-Coumaric acid | 1.44 | Naringenin | 21.90 |
| Chlorogenic | 2.88 | Quercetin | 16.26 |
| *p*-Hydroxybenzoic acid | 16.52 | Hespertin | 3.81 |
| Caffeic acid | 17.89 | Catechin | 13.25 |
| Vanillic | 5.19 | $\alpha$-Coumaric acid | 1.71 |
| Caffeine | 6.01 | 4-Aminobenzoic acid | 0.003 |
| Ferulic acid | 2.97 | Isoferulic acid | 0.98 |
| Benzoic acid | 41.63 | Rosmarinic | 12.94 |
| Salycilic acid | 24.81 | Cinnamic acid | 33.31 |
| Ellagic | 6.73 | Coumarin | 7.00 |

colored onion varieties ranged from 11 to 4109 mg/100 g on dry weight basis and the outer layer has the maximum quercetin content.

## Physical properties

Physical properties (loaf weight, loaf volume, specific volume and specific gravity), moisture, water activity ($a_w$) and color of pan bread with OPP are presented in table 3. From the results, it could be observed that there was a significant increase ($p<0.05$) in loaf weight values between control and other samples with increasing OPP and it was ranged from 141.45 to 145.85 g. Loaf volume and specific volume values were decreased in all pan bread samples containing OPP and the decreased was increase with increasing level of substitution. On the other hand, specific gravity of pan bread samples increased compared with control. These findings are close to Ragaee *et al.*, (2011) who found that the loaf volume and specific volume of fiber and cellulose enriched breads were lower than the control bread and it is primarily due to destruction of gluten in the flour blends.

With regard to the pan bread moisture content (on fresh weight) the results show that the moisture content significantly increased ($p<0.05$) with increasing OPP level compared with control pan bread (100% wheat flour), this may be due to the high fiber content in those samples. Ayub *et al.*, (2003) found that bread samples moisture content ranged from 36.05 to 45.49% on the first day of baking.

Results regarding $a_w$ of pan bread samples showed that substitution of wheat flour with OPP insignificantly ($p>0.05$) affected $a_w$ values of pan bread samples. Ayub *et al.*, (2003) reported that $a_w$ of different bread samples were varied from 0.9425 to 0.9725 after baking.

Color is one of the most important factor that first observed by consumer, thus, the change of food color has a high concern, Table 3 displays color parameters (L*, a* and b*) of pan bread crumb samples prepared from onion peels. From the results, it could be noticed that substitution of wheat flour with onion peels in the formulation of pan bread affected the pan bread color. Data in table 3 indicated that substituting of wheat flour with onion peels significantly decreased the lightness (L*) values of pan bread crumb with increasing level of substitution, where control pan bread recorded the highest value and the pan bread crumb become darker. Regarding to a* and b* values of pan bread with onion peels had a higher a* and lower b*, due to the pigments content of these OPP. Our results are in agreement with Prokopov *et al.*, (2018a) who found that the bread crumb color of onion waste powder tended to be darker with increasing onion waste powder levels than those of the control bread.

## Chemical composition of pan bread

Chemical composition of the pan bread samples containing different levels of onion peels powder (OPP) are showed in table 4. The results showed that there were no significant changes in protein and fats of pan bread samples. Ash content significantly increased ($p<0.05$) in all samples compared with control. Regarding to fiber content, results indicated that pan bread samples were significantly increased ($p<0.05$) in fiber content compared with control and ranged from 0.60 to 1.28%. Crude fiber content may be increased due to the high content of crude fiber in onion peels powder.

Bedrníèek *et al.*, (2020) and Piechowiak *et al.*, (2020) mentioned that onion peel has increasingly attracted more attention recently as a functional food ingredient which has been incorporated, for example, into

**Table 3:** Physical properties, moisture content, water activity ($a_w$) and color of pan bread samples with different onion peels powder levels*.

| Pan bread Samples | Loaf weight (g) | Loaf volume ($cm^3$) | Specific volume ($cm^3/g$) | Specific gravity ($g/cm^3$) | Moisture content (%) | $a_\omega$ | L** | a** | b** |
|---|---|---|---|---|---|---|---|---|---|
| Control | 139.73±0.45[e] | 473.00±2.65[a] | 3.38±0.04[a] | 0.30±0.03[f] | 37.22±0.06[d] | 0.915± 0.01[a] | 72.86±0.69[a] | -1.72±0.12[e] | 19.98±0.53[a] |
| 1% OPP | 141.45±0.55[d] | 415.00±5.02[b] | 2.93±0.03[b] | 0.34±0.03[e] | 37.41±0.20[d] | 0.900±0.01[a] | 66.40±0.15[b] | 3.89±0.71[d] | 18.06±0.83[b] |
| 2% OPP | 142.61±0.26[c] | 395.25±3.01[c] | 2.77±0.03[c] | 0.36±0.04[d] | 37.66±0.16[c] | 0.900±0.02[a] | 63.83±0.32[c] | 5.86±0.12[c] | 17.85±0.44[b] |
| 3% OPP | 143.84±0.54[b] | 383.33±2.89[d] | 2.67±0.06[d] | 0.38±0.01[c] | 38.17±0.15[b] | 0.904±0.001[a] | 60.94±0.18[d] | 6.68±0.08[b] | 17.39±0.35[bc] |
| 4% OPP | 145.51±0.40[a] | 375.00±4.55[e] | 2.58±0.04[e] | 0.39±0.01[b] | 38.57±0.05[a] | 0.905±0.004[a] | 56.72±0.18[e] | 7.64±0.39[a] | 17.18±0.24[bc] |
| 5% OPP | 145.85±0.64[a] | 355.10±3.40[f] | 2.44±0.03[f] | 0.41±0.02[a] | 38.73±0.06[a] | 0.907±0.001[a] | 53.98±0.54[f] | 8.30±0.63[a] | 16.77±0.58[c] |

*Control= Wheat control. OPP= Onion peels powder.

** Color of bread was evaluated using pan bread crumb. L (lightness with L = 100 for lightness, and L = zero for darkness), a [(chromaticity on a green (-) to red (+)], b [(chromaticity on a blue (-) to yellow (+)].

Values are mean of three replicates ±SD, number in the same column followed by the same letter are not significantly different at 0.05 level.

wheat bread, gluten-free bread to promote health benefits or prolong product shelf life.

## Pan bread content of total phenol, flavonoid compounds and antioxidant activity

The content of total phenol, flavonoid compounds and antioxidants activity in pan bread presented in table 5. The highest concentrations of total phenols, flavonoids and antioxidant activity in bread were generally obtained with high substitution of OPP comparing with control bread and these results may be due to the higher phytochemical content of OPP. Prokopov *et al.*, (2018b) mentioned that the onion processing wastes powder could be used as a rich source of flavonoids for improvement of antioxidant activity of food. Therefore, the replacement of wheat flour with 2 to 3% dried onion caused significant improvement of antioxidant abilities of bread (Gawlik-Dziki *et al.*, 2013). Industrial onion wastes contain significant amounts of phenolic compounds and flavonoids, mainly quercetin, resulting in high antioxidant activity (Benítez *et al.*, 2011). Œwieca *et al.*, (2013) and Prokopov *et al.*, (2018a) reported that the higher total phenolic and flavonoid content and antioxidant activity (as DPPH) of bread with onion waste powder in comparison with the control bread may increase health-enhancement. Besides, the antioxidant potential of bread with dried onion was significantly higher than the activity noted in the control.

## Sensory evaluation

One of the limiting factors for consumer acceptability is the organoleptic properties. Crust color, crumb color, odor, texture, taste and overall acceptability of pan bread prepared by substitution of wheat flour (72% extraction rate) with 1, 2, 3, 4 and 5% onion peels powder (OPP) are presented in table 6. The results indicated that control pan bread sample recorded the highest score for all attributes relative to the other pan bread samples. Pan bread samples containing onion peels up to 2% had the highest score for all parameters and were non-significantly difference ($p>0.05$) compared with control bread. The substitution with onion peels reduced crust and crumb color values due to the dark color of yellow onion peels. The color of both bread crust and crumb with more than 3% OPP was much darker than those of the control bread. In addition, it could be observed that substitution with onion peels to pan bread decreased odor scores compared with control and this may be due to the content of volatile compounds in onion peels. The same trend was noticed for bread texture and this may be due to the content of dietary fiber. The higher levels of OPP caused significant ($p<0.05$) changes in taste and odor. The sensory evaluation results showed that substitution of wheat flour in bread making up to 2% OPP led overall to satisfactory acceptability to consumers. Our results were in the same line with those obtained by Prokopov *et al.*, (2018a) who found that samples supplemented with 4% and 5% onion wastes powder indicated significant ($p<0.05$) decreases of overall acceptability compared to the control bread. Gawlik-Dziki *et al.*, (2013) reported that replacement of wheat flour with up to 3% onion powder in bread gave satisfactory consumer acceptability. Addition of higher levels of dried onion caused a sharp aroma and taste and no statistically significant difference was observed for all samples in texture.

**Table 4:** Chemical composition of pan bread samples (% on dry weight basis)*.

| Samples | Protein | Fat | Ash | Crude fiber | Total carbohydrates |
|---|---|---|---|---|---|
| Control | 12.22±0.21[a] | 2.43±0.07[a] | 2.71±0.10[c] | 0.41±0.03[e] | 82.23±0.17[a] |
| 1% OPP | 12.19±0.16[a] | 2.43±0.08[a] | 2.73±0.04[c] | 0.60±0.10[d] | 82.05±0.21[a] |
| 2% OPP | 12.16±0.18[a] | 2.43±0.05[a] | 2.76±0.07[c] | 0.82±0.01[c] | 81.83±0.22[ab] |
| 3% OPP | 12.14±0.11[a] | 2.44±0.03[a] | 2.84±0.06[bc] | 1.05±0.17[b] | 81.53±0.23[bc] |
| 4% OPP | 12.09±0.32[a] | 2.45±0.06[a] | 2.91±0.12[ab] | 1.15±0.05[ab] | 81.40±0.30[bc] |
| 5% OPP | 12.08±0.05[a] | 2.46±0.11[a] | 3.00±0.05[a] | 1.28±0.03[a] | 81.18±0.16[c] |

*Control= Wheat control. OPP= Onion peels powder.
Values are mean of three replicates ±SD, number in the same column followed by the same letter are not significantly different at 0.05 level.

**Table 5:** Total phenol, flavonoid compounds and antioxidant activity of pan bread samples at different levels of onion peels (on dry weight basis)*.

| Pan bread samples | Total phenols (mg/100g) | Flavonoids (mg/100g) | $AO_{as}$ DPPH (%)** | $AO_{as}$ ABTS (%)** |
|---|---|---|---|---|
| Control | 96.55±0.68[f] | 32.56±1.55[f] | 10.39±1.76[e] | 13.50±3.99[d] |
| 1% OPP | 106.59±0.32[e] | 38.69±0.90[e] | 20.89±0.26[d] | 23.23±2.91[cd] |
| 2% OPP | 110.93±4.76[d] | 50.84±0.45[d] | 28.61±1.33[c] | 32.82±7.48[bc] |
| 3% OPP | 115.96±1.37[c] | 59.35±3.12[c] | 35.70±1.69[b] | 40.82±8.88[ab] |
| 4% OPP | 120.36±0.43[b] | 68.20±3.58[b] | 42.33±2.78[b] | 45.61±4.16[ab] |
| 5% OPP | 125.30±2.26[a] | 75.10±2.48[a] | 49.69±6.37[a] | 54.14±10.92[a] |

*Control= Wheat control. OPP= Onion peels powder.
**AO= Antioxidant activity (radical scavenging activity) as DPPH or ABTS.
Values are mean of three replicates ±SD, number in the same column followed by the same letter are not significantly different at 0.05 level.

## Freshness of pan bread during Storage

Alkaline water retention capacity (AWRC) of pan bread loaves could be considered as an indication for staling and freshness. AWRC was evaluated in pan bread with different onion peels level at zero time and different storage periods (24, 48 and 72 h) as displayed in table 7. Results indicate that AWRC was significantly increased as onion peels level increased compared with control sample. On the other hand, there is a significant decrease in AWRC with increasing the storage period of pan bread in all OPP levels as well as control sample. There were significant differences (5% level) between pan bread samples substituted with onion peels (1, 2, 3, 4 and 5%) as well as control at zero time and during storage for 72h. Reduction of AWRC showed an increase by increasing the storage periods for all samples.

Slowing the dehydration rather than increasing the initial moisture content prevented staling and there is a strong correlation between the staling rate of bread and moisture content. Moreover, bread with higher moisture content was significantly fresher than bread with a lower content (Piazza and Masi, 1995). Dietary fiber, such as vegetable peels, has the excellent water absorption. The use of different fibers sources reduced water loss during storage, as well as the probable interaction between fiber and starch, resulting in the delay of starch retrogradation (Gomez *et al.*, 2003 and O'Shea *et al.*, 2012).

**Table 6:** Sensory evaluation of pan bread samples at different levels of onion peels*.

| Pan bread Samples | Crust color | Crumb color | Odor | Texture | Taste | Over all acceptability |
|---|---|---|---|---|---|---|
| Control | 8.85±0.34$^{a}$ | 8.90±0.32$^{a}$ | 8.80±0.42$^{a}$ | 8.90±0.31$^{a}$ | 8.70±0.67$^{a}$ | 8.90±0.31$^{a}$ |
| 1% OPP | 8.10±0.83$^{ab}$ | 7.95±0.72$^{ab}$ | 8.25±0.43$^{ab}$ | 8.55±0.50$^{a}$ | 8.60±0.46$^{a}$ | 8.40±0.42$^{a}$ |
| 2% OPP | 8.05±1.08$^{ab}$ | 7.80±1.03$^{abc}$ | 7.90±0.91$^{abc}$ | 8.40±0.46$^{a}$ | 8.20±0.58$^{ab}$ | 8.30±0.52$^{a}$ |
| 3% OPP | 7.45±1.52$^{b}$ | 7.35±1.47$^{bc}$ | 7.55±1.23$^{bcd}$ | 7.75±0.72$^{b}$ | 7.55±1.21$^{bc}$ | 7.60±0.91$^{b}$ |
| 4% OPP | 7.35±1.47$^{b}$ | 7.05±1.62$^{bc}$ | 7.20±1.03$^{cd}$ | 7.60±0.94$^{b}$ | 7.25±1.06$^{c}$ | 6.90±0.97$^{c}$ |
| 5% OPP | 7.00±1.56$^{b}$ | 6.70±1.64$^{c}$ | 6.85±1.36$^{d}$ | 7.35±0.84$^{b}$ | 6.80±0.89$^{c}$ | 6.65±0.88$^{c}$ |

*Control= Wheat control. OPP= Onion peels powder.

Values are mean of ten replicates ±SD, number in the same column followed by the same letter are not significantly different at 0.05 level.

**Table 7:** Alkaline water retention capacity (AWRC) of pan bread produced by different levels of onion peels*.

| Pan bread samples | Storage period (h) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Zero time | 24 | RD (%)** | 48 | RD (%)** | 72 | RD (%)** |
| Control | 180.08±0.14$^{f}_{a}$ | 167.71±0.23$^{f}_{b}$ | 6.78 | 159.53±0.27$^{f}_{c}$ | 11.41 | 155.81±0.13$^{f}_{d}$ | 15.58 |
| 1% OPP | 183.00±0.10$^{e}_{a}$ | 170.59±0.30$^{e}_{b}$ | 6.78 | 163.00±0.18$^{e}_{c}$ | 10.93 | 159.32±0.15$^{e}_{d}$ | 12.94 |
| 2% OPP | 185.57±0.38$^{d}_{a}$ | 174.09±0.33$^{d}_{b}$ | 6.19 | 165.54±0.21$^{d}_{c}$ | 10.79 | 161.84±0.42$^{d}_{d}$ | 12.79 |
| 3% OPP | 193.20±0.35$^{c}_{a}$ | 181.78±0.29$^{c}_{b}$ | 5.91 | 172.81±0.48$^{c}_{c}$ | 10.57 | 170.54±0.67$^{c}_{d}$ | 11.73 |
| 4% OPP | 205.91±0.59$^{b}_{a}$ | 195.06±0.64$^{b}_{b}$ | 5.27 | 185.13±0.59$^{b}_{c}$ | 10.09 | 182.18 ±0.36$^{b}_{d}$ | 11.52 |
| 5% OPP | 213.51±0.35$^{a}_{a}$ | 203.25±0.35$^{a}_{b}$ | 4.81 | 192.22±0.52$^{a}_{c}$ | 9.97 | 189.62±0.17$^{a}_{d}$ | 11.19 |

*Control= Wheat control. OPP= Onion peels powder.

**RD (%) = Reduction of freshness.

Values are mean of three replicates ±SD, number in the same column (superscript letter) or row (subscript letter) followed by the same letter are not significantly different at 0.05 level.

**Table 8:** Total fungal count (log cfu/g) of pan bread at different levels of onion peels during storage*.

| Pan bread | Storage period (days) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Samples | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Control | 0.00±0.00$^{a}_{h}$ | 0.67±0.03$^{a}_{g}$ | 1.38±0.01$^{a}_{f}$ | 4.17±0.02$^{a}_{e}$ | 5.75±0.03$^{a}_{d}$ | 6.95±0.00$^{a}_{c}$ | 7.72±0.01$^{a}_{b}$ | 8.78±0.00$^{a}_{a}$ |
| 1% OPP | 0.00±0.00$^{a}_{h}$ | 0.60±0.01$^{b}_{g}$ | 1.15±0.01$^{b}_{f}$ | 3.40±0.01$^{b}_{e}$ | 4.33±0.01$^{b}_{d}$ | 5.50±0.01$^{b}_{c}$ | 6.87±0.00$^{b}_{b}$ | 8.33±0.00$^{b}_{a}$ |
| 2% OPP | 0.00±0.00$^{a}_{h}$ | 0.56±0.01$^{c}_{g}$ | 1.05±0.01$^{c}_{f}$ | 2.85±0.02$^{c}_{e}$ | 3.29±0.01$^{c}_{d}$ | 4.88±0.00$^{c}_{c}$ | 6.59±0.00$^{c}_{b}$ | 7.78±0.01$^{c}_{a}$ |
| 3% OPP | 0.00±0.00$^{a}_{h}$ | 0.48±0.01$^{d}_{g}$ | 0.96±0.01$^{d}_{f}$ | 1.93±0.00$^{d}_{e}$ | 3.23±0.00$^{d}_{d}$ | 4.31±0.01$^{d}_{c}$ | 5.33±0.01$^{d}_{b}$ | 7.27±0.00$^{d}_{a}$ |
| 4% OPP | 0.00±0.00$^{a}_{h}$ | 0.45±0.00$^{e}_{g}$ | 0.86±0.02$^{e}_{f}$ | 1.80±0.01$^{e}_{e}$ | 2.85±0.02$^{e}_{d}$ | 3.40±0.01$^{e}_{c}$ | 5.02±0.00$^{e}_{b}$ | 6.86±0.04$^{e}_{a}$ |
| 5% OPP | 0.00±0.00$^{a}_{h}$ | 0.35±0.00$^{f}_{g}$ | 0.70±0.00$^{f}_{f}$ | 0.90±0.02$^{f}_{e}$ | 2.66±0.00$^{f}_{d}$ | 3.20±0.01$^{f}_{c}$ | 4.72±0.03$^{f}_{b}$ | 5.69±0.02$^{f}_{a}$ |

*Control= Wheat control. OPP= Onion peels powder.

Values are mean of three replicates ±SD, number in the same column (superscript letter) or row (subscript letter) followed by the same letter are not significantly different at 0.05 level.

**Total fungal count of pan bread**

Table 8 displays the effect of substitution of onion peels at 1-5% levels of on log fungal total count (yeast and moulds) in pan bread during storage for seven days at room temperature. Data revealed a gradual increase in log fungi count by increasing storage period (7 days) of all onion peel samples and control. There is a significant difference in total fungi count between control and samples substituted with different concentration of onion peels during storage periods except for the fourth day. Decreasing in log fungi count in pan bread was showed by increasing the concentration of onion peels during storage and this may be due to the content of compounds such as salicyilic acid and quercetin which has an anti-fungal effect. The shelf life of control sample recorded 3 days only, while pan bread samples substituted with 1, 2, 3 and 4% onion peels recorded 4, 5, 5 and 5 days, respectively. Moreover, the shelf life was extended to 6 days in samples substituted with 5% onion peels, caused more inhibition to fungal growth and recorded log 4.72 cfu/g. Bread spoilage was indicated by *Aspergillus flavus*, Penicillium sp., *Rhizopus stolonifer* and *Mucor mucedo* which led to its spoilage after 6-8 days and form a black, yellow and green color on the bread (Ijah *et al.*, 2014). Fungi are the most important forma of microbial spoilage of bakery products and generally, foods are spoilage when they contain more than $10^5$ cfu/g of molds (Mossel *et al.*, 1995). The phenolic compounds in onion peels waste are a good source that can be used as antimicrobial agent (Škerget *et al.*, 2009). Furthermore, onion peels waste has an antifungal activity and presents efficiency in the inhibition of the mycelial growth of *Fusarium moniliforme* (Franco *et al.*, 2018).

## Conclusion

The utilization of onion peels powder (OPP) could contribute to the solution of some environmental problems and it could be an interesting source of phenols, antioxidants and dietary fibers. The substitution with OPP increased the total phenols, flavonoids content and antioxidant activity of pan bread which may enhance the health benefits. Onion peels powder could be added efficaciously up to 2% level to produce acceptable pan bread. Enriched pan bread with OPP delayed pan bread staling. Shelf-life of the produced pan bread extended to five days. In general, onion peels powder could be successfully utilized in improving the freshness and increasing antioxidant activity as well as prolonging the shelf life of pan bread.

## Acknowledgements

The authors would like to express gratitude to the Food Technology Research Institute, Agricultural Research Center for continuing cooperation to support research by intramural funding and provided facilities required to carry out the most wanted objectives of the research work.

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