An Investigation of Antioxidant and Antimicrobial Activity of *Opuntia Stricta* Fruit Peels

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**ABSTRACT**

The aim of this study was to look into the benefit of using prickly pear (*Opuntia stricta*) fruit peels as a source of dietary fibre, minerals, unsaturated fatty acids, phenols, flavonoids, total phenols, total flavonoids, antioxidant activity, and the impact of adding them to baked goods. In addition to investigate the antimicrobial effect, sensorial evaluation characteristics of these peels at different levels, which are considered plant excrement, plus storage time of the cupcake at room temperature. On the contrary, it is worth noting that increasing the percentage of peels powder enhanced the sensorial properties of the cupcakes. Results also showed that peels of prickly pear fruits had an inhibitory effect on microbial growth and on it; findings suggest the importance of using prickly pear peels to improve and raise the nutritional, microbial, and sensory consistency of bakery products.

**Keywords:** prickly pear peel, antioxidant, antimicrobial, cupcakes

**1. Introduction**

Wastes from the production and processing of many fruits result in vast quantities. By properly using these by-products, waste management concerns can be alleviated, as well as a possible new source of fats and proteins for use in food. Kamel and Kakuda, (2002). The red prickly pear peel found all over the world and is a significant source of nutrition and food. The genus *Opuntia stricta* comprises around 1500 species of red prickly pear peel, many of which produce edible and highly favored products. In Egypt, the total area cultivated with red prickly pear fruits peels annually was about 6268.5 ha, producing about 28.431.000 Kg of fruits, which measured approximately 6268.5 hectares and yielded approximately 28.431.000 kilograms of fruit, with 13.420.000 kilograms of peels (Anonymous, 2008).

Peels represent about 45–50 percent of total fruit weight in *Opuntia stricta* fruits (*Opuntia ficus-indica* L.), the most widely distributed genus of the Cactaceae family. Stintzing *et al.*, (2001). Peels commonly used as antioxidant compounds, which used in the food industry, where they are incorporated as active ingredients in edible films. Betalains and phenolic compounds are the major antioxidants found in red prickly pear peel. Betalains had been linked to a range of health benefits, including antioxidant, antiviral, anti-inflammatory, and anti-carcinogenic effects. Reddy *et al.*, (2005)

Villanueva *et al.*, (2003) stated that the peels of prickly pear fruits are used in the preparation of high-fiber foods. Dietary fibres are important for human health. Foods rich in dietary fibre have been related to the prevention, mitigation, and treatment of certain diseases, such as diverticular and coronary heart disease. Peels are a novel desert source of dietary fibre, with a higher content of galacturonic acid than commercial cladode cactus racquet. Furthermore, the fibres of prickly pear peels have a good fragrance and taste.
2. Material and Methods

Material:
Prickly pear fruits were obtained from the local market at Kafrelsheikh city, Egypt.

2.1. Source of material

2.1.1. Prickly Pear Fruits Peels Powder:
Prickly pear fruits were washed, soaked and hand peeled. The peels were dried in electric air oven at 50°C until occurred completely dried, followed by grinding (60 mesh) to obtain the final powder of prickly pear fruits peels.

2.2. Chemical composition:
Moisture, crude protein, ether extract, ash and minerals content were determined according to the methods of the AOAC (2010), while total carbohydrates were calculated by difference as follows: Total carbohydrates % = 100 - (% crude fiber + % crude protein + % ether extract + % ash). Available carbohydrates were calculated by subtracting crude fibre from total carbohydrates.

2.2.1 Identification of phenolic and flavonoids compounds:
Phenolic compounds were fractionated and identified by High Performance Liquid Chromatography (HPLC), Hewllet Packard, series 1050 according to the method of Goupy et al. (1999). Flavonoids compounds were determined according to Mattila et al. (2000).

2.2.2 Determination of total phenolic content (TPC):
Total phenolic content of Prickly pear fruits peels was assayed as outlined by Meda et al. (2005).

2.2.3 Determination of total flavonoids content (TFC):
Total flavonoids content of Prickly pear fruits peels was determined by a spectrophotometric method outlined by Boateng et al. (2008).

2.2.4 Determination of DPPH radical-scavenging activity:
Radical-scavenging activity (DPPH) was determined according to the procedure outlined by Moure et al. (2001).

2.2.5 Fatty acids composition:
Fatty acids analysis Fatty acids composition in Prickly pear fruits peels was determined according to the procedure described by ISO (2015).

2.2.6 Preparation of cupcakes.
Control cupcakes recipes were prepared of ingredient, (250.0g) wheat flour (72% extraction), (125.0g) sugar, (3.50 g) salt, (25.0g) skimmed milk powder, (53.50g) Shortening, (110.0g) fresh whole egg, (12.50 g) baking powder, (2.01g) vanillia according to the method described by Khalifa et al. (2015).

2.3 Determination of microbiological count:
Microbial count were determined according to Marshall, (1992). All the microbiological count were carried out in duplicates and expressed as colony forming units per gram samples (cfu/g).

2.3.1 Total plate count: Using plate count agar medium, the total number of bacteria colonies was calculated. The plates were incubated for 48 hours at 37°C.

2.3.2 Moulds and Yeasts: The mould and yeast counts were calculated using the American Public Health Association's (APHA) methods for microbiological analysis of foods on malt extract agar medium.
2.5 Sensorial evaluation:
Sensory evaluation of cupcake recipes was evaluated by twenty-five panelists according to Hoojjat and Zabik, (1984).

2.6. Statistical analysis:
Results were expressed as the mean ± SD. Data for multiple variable comparisons were analyzed by one-way analysis of variance (ANOVA). For the comparison of significance between blends, Duncan’s test was used as a post hoc test.

3. Results and Discussion

3.1. Chemical composition of Prickly pear fruits peels (on a dry weight).
Table 1 shows the chemical composition of prickly pear fruit peels which revealed that the peels of prickly pear fruits are good sources of crude protein, ether extract, crude fibre, and ash.

Table 1: chemical composition of prickly pear fruits peels (on a dry weight).

| Constituents (%)                  | Peels          | Prickly pear fruits peels |
|-----------------------------------|----------------|---------------------------|
| Moisture                          | 77.85±1.23     | 77.85±1.23                |
| Crude protein                     | 5.78±0.21      | 5.78±0.21                 |
| Ether extract                     | 4.21 ±0.15     | 4.21 ±0.15                |
| Ash                               | 8.79± 0.04     | 8.79± 0.04                |
| Crude fibers                      | 8.45± 0.30     | 8.45± 0.30                |
| Available carbohydrates           | 72.77± 0.54    | 72.77± 0.54               |
| Total carbohydrates               | 81.22±0.44     | 81.22±0.44                |

Prickly pear fruits peels had 77.85 % percent moisture, 5.78% percent crude protein, 4.21% percent ether extract, 8.79% percent ash, 8.45% percent crude fibre, and 81.22% percent total carbohydrates, according to Table 1. These results are in near to those reported by (Anwar and Sallam, 2016) who found that Prickly pear fruits peels contained 4.56% crude protein, 3.66% crude fat, 7.72% crude fibre and 8.66% ash.

3.2. Minerals content of Prickly pear fruits peels:
Minerals can be found in abundance in fruits and vegetables. The findings in Table 2 show that the peels of prickly pear fruits are abundant in most minerals, including K, Ca, Na, Mg, P, Zn, Cu, Fe, and Mn, suggesting that a diet rich in fruits and vegetables is correlated with a lower risk of illnesses such as diabetes and cancer. These results are in a harmony with Nesreen et al., (2011).

Table 2: Minerals content of Prickly pear fruits peel (as a dry weight).

| Minerals (mg/100g)       | Opuntia stricta fruit peels |
|--------------------------|-----------------------------|
| Potassium (K)            | 353.17                      |
| Calcium(Ca)              | 978.54                      |
| Sodium(Na)               | 977.76                      |
| Magnesium(Mg)            | 987.57                      |
| Phosphorus(P)            | 235.50                      |
| Zinc(Zn)                 | 25.79                       |
| Copper(Cu)               | 11.10                       |
| Iron(Fe)                 | 34.70                       |
| Manganese(Mn)            | 19.44                       |

3.3. Fractionation of phenolic compounds of Prickly pear fruits peel:
High Performance Liquid Chromatography (HPLC) was used to isolate and classify phenolic and flavonoid compounds in prickly fruit peel powder (HPLC). Table 3 summarises the findings. Seventeen
phenolic compounds were found in the prickly peel powder, with protocatechuic, catechin, pyrogallo, P-OH-benzoic, catechol and ellagic acid being the most common. The results are in similar with Anwar and Sallam, (2016). Flavonoids are a type of plant pigment that is found in abundance in nature. As a result, the flavonoid compounds in prickly peel powder were isolated, and the findings can be found in. Table three: Prickly peel powder contains nine flavonoids, according to the findings. The most abundant compounds in the powdered prickly fruit peels were hesperidin, naringin, and quercetin. These results are consistent with those reported by Anwar and Salam (2016).

### Table 3: phenols and flavonoids content of prickly fruits peels powder.

| Phenols       | ppm    | flavonoids  | ppm    |
|---------------|--------|-------------|--------|
| Pyrogallol    | 118.86 | Naringin    | 125.96 |
| Gallic        | 14.45  | Rosmarinic  | 21.75  |
| Protocatechoic| 938.12 | hesperidin  | 443.07 |
| Catechol      | 55.83  | Rutin       | 19.82  |
| 4-Aminobenzoic| 6.40   | Quercetin   | 21.36  |
| Catechein     | 138.72 | Naringenin  | 33.32  |
| chlorogenic   | 46.92  | Quercetin   | 42.51  |
| P-OH- benzoic | 98.12  | Hespirtin   | 7.33   |
| benzoic       | 102.67 | Kampferol   | 3.21   |
| caffeic       | 3.92   | Apigenin    | 2.84   |
| P-Coumaric    | 5.46   |             |        |
| Ferulic       | 4.77   |             |        |
| Iso-Ferulic   | 5.13   |             |        |
| α Coumaric    | 2.59   |             |        |
| coumarin      | 3.48   |             |        |
| Ellagic       | 84.26  |             |        |
| 3, 4, 5 cinnamic | 8.98  |             |        |

3.4. Total Phenol, Flavonoids compound and antioxidant activity in Prickly pear fruits peels

The results in Table 4 explained that contents of Prickly pear fruits peels of total phenolic was 471.51 mg/100g, also contents of Prickly pear peel of flavonoids 36.54 mg/100g and the antioxidant activity of Prickly pear fruits peels is 65.47%. The antioxidant activity of phenolic compounds result from the neutralization of free radicals initiating oxidation processes or from the termination of radical chain reactions. Also the antioxidant activity of phenolic compounds is due to their high tendency to chelate metals. Phenols are very vital plant constituents because of their scavenging ability on free radicals due to their hydroxyl groups these results are in a harmony with Heim et al., (2002).

### Table 4: Total Phenol, Flavonoids compound and antioxidant activity in Prickly pear fruits peels.

| Sample                      | As a dry sample (mg/100 g) | % |
|-----------------------------|-----------------------------|---|
| Total Phenolics as gallic acid | 471.51                     |   |
| Flavonoids as catechin      | 36.54                      |   |
| DPPH                        | 65.47%                      |   |

3.5. Fatty acids composition of Prickly pear fruits peels:

Results in Table 5 shown that, Prickly pear fruits peels is rich in fatty acids. In addition demonstrated that Prickly pear fruits peels contained higher amounts of unsaturated fatty. Unsaturated fatty acids which play an important role in human health. The predominant unsaturated fatty acids were (28.33%) linoleic acid, (17.83%) oleic acid, and (14.85%) linolenic acid and the main saturated fatty acid were (22.56%) palmitic acid, (6.46%) stearic acid and (4.35%) arachidic acid. These results are in a harmony with those reported by Ramadan and Mörsel, (2003).
Table 5: Fatty acids composition of Prickly pear fruits peels.

| Fatty acids (%) of total F.A. | Symbol | Prickly pear fruits peels |
|-------------------------------|--------|---------------------------|
| Caprylic acid                 | C10:0  | ND                        |
| Undecylic acid                | C11:0  | ND                        |
| Lauric acid                   | C12:0  | ND                        |
| Tridecylic acid               | C13:0  | ND                        |
| Myristic acid                 | C14:0  | ND                        |
| Pentadecanoic acid            | C15:0  | ND                        |
| Palmitic acid                 | C16:0  | 22.56                     |
| Margaric acid                 | C17:0  | ND                        |
| Stearic acid                  | C18:0  | 6.46                      |
| Arachidic acid                | C18:2  | 4.35                      |
| Heneicosylic acid             | C20:0  | ND                        |
| Total Saturated F.A.          |        | 33.37                     |
| Myristoleic acid              | C14:1  | ND                        |
| Palmitoleic acid              | C16:1  | 3.54                      |
| Heptadecenoic acid            | C17:1  | ND                        |
| Oleic acid                    | C18:1  | 17.83                     |
| Linoleic acid                 | C18:2  | 28.33                     |
| Linolenic                     | C18:3  | 14.85                     |
| Eicosa pentanoic acid         | C20:5  | ND                        |
| Docosadienoic acid            | C22:2  | ND                        |
| Total Unsaturated F.A.        |        | 64.55                     |

Table 6: Sensorial properties of cupcakes containing different extents of Prickly pear fruits peels.

| Recipes | Appearance (20) | Crust Color (10) | Crumb Color (20) | Texture (10) | Odor (20) | Taste (20) |
|---------|-----------------|-----------------|-----------------|--------------|-----------|------------|
| Control | 17.83±0.28      | 8.25±0.28       | 17.84±0.35      | 8.00±0.38    | 18.41±0.25| 19.18±0.25 |
| T1      | 18.33±0.25      | 8.75±0.28       | 18.35±0.45      | 8.83±0.28    | 18.51±0.30| 19.26±0.28 |
| T2      | 18.69±0.27      | 9.25±0.27       | 18.96±0.25      | 9.30±0.25    | 19.08±0.27| 19.40±0.35 |
| T3      | 19.40±0.25      | 9.33±0.25       | 19.06±0.45      | 9.41±0.22    | 19.33±0.25| 19.38±0.37 |

Values followed by the same letter in columns are not significantly different at LSD at (p ≤ 0.05).
Each value was an average of three determinations ± standard deviation.
Control (wheat flour 100%), T1, wheat flour + 5% Prickly pear fruit Peels, T2, wheat flour + 10% Prickly pear fruit Peels, T3, wheat flour + 15% Prickly pear fruit Peels

3.6. Sensorial properties of cupcakes containing different extents of Prickly pear fruits peels.

Table 6 showed the organoleptic properties of cupcakes supplemented with 5, 10, and 15% Prickly pear fruits peels. The obtained data indicated that adding Prickly pear fruits peels to the cupcakes improves the sensory properties compared to the control. Also revealed that, the produced cupcakes by supplemented 15% Prickly pear fruits peels emplacement had sensorial properties better than those of extents (0, 5 and 10 %). On the contrary, it should be noted that an increase in the percentage of the peels of the replaced prickly pear fruits caused an enhancement in the sensorial properties of the cupcakes. So, it can be concluded that, the best level extents of enriched with Prickly pear fruits peels was 15% followed by 10 and 5% for making cupcakes with a very good acceptability.

3.7. Effect of addition different levels extents of prickly pear fruits peels to cupcakes on the total count of bacterial and mould at room temperature.

The total count of bacterial and mould of cupcakes were investigated to assess one of the most important factors in evaluation of cupcakes quality. The total count of bacterial and mould of cupcakes supplemented with 0,5,10 and 15% red prickly pear fruits peels in stored at room temperature for (0,5,10 and 15 days) are presented in Table 7. From the results observed that control sample (wheat flour)
showed higher total count of bacterial and mould than cupcakes supplemented with prickly pear fruits peels during storage at room temperature periods, the total count of bacterial and mould were reduced in all cupcakes treatments. Generally, the total count of bacterial and mould reduced with increasing prickly pear peels level. The inhibition influence of prickly pear fruits peel's on microbial growth.

Table 7: Effect of addition different levels extents of Prickly pear fruits peels to cupcakes on the total count of bacterial and mould (log cfu/g) at room temperature for different periods

| Sample | 0 | 5 | 10 | 15 |
|--------|---|---|----|----|
|         | Bacteria | Fungi | Bacteria | Fungi | Bacteria | Fungi | Bacteria | Fungi |
| Control | ND | ND | 3.00<sup>a</sup> | 2.90<sup>a</sup> | 3.11<sup>a</sup> | 3.00<sup>a</sup> | 3.20<sup>a</sup> | 3.15<sup>a</sup> |
| T<sub>1</sub> | ND | ND | ±0.1 | ±0.02 | ±0.03 | ±0.18 | ±0.28 | ±0.14 |
| T<sub>2</sub> | ND | ND | 2.94<sup>ab</sup> | 2.90<sup>a</sup> | 3.09<sup>a</sup> | 2.90<sup>b</sup> | 3.15<sup>a</sup> | 3.08<sup>b</sup> |
| T<sub>3</sub> | ND | ND | ±0.02 | ±0.01 | ±0.12 | ±0.23 | ±0.28 | ±0.18 |
|         | 2.85<sup>b</sup> | 2.78<sup>b</sup> | 2.90<sup>b</sup> | 2.85<sup>c</sup> | 3.08<sup>b</sup> | 3.00<sup>c</sup> |
| T<sub>3</sub> | 2.69<sup>c</sup> | 2.60<sup>c</sup> | 2.78<sup>b</sup> | 2.70<sup>d</sup> | 2.90<sup>c</sup> | 2.85<sup>d</sup> |

Values followed by the same letter in columns are not significantly different at LSD at (p ≤ 0.05). Each value was an average of three determinations ± standard deviation.

Control (wheat flour 100%), T<sub>1</sub>, wheat flour + 5% Prickly pear fruit Peels, T<sub>2</sub>, wheat flour + 10% Prickly pear fruit Peels, T<sub>3</sub>, wheat flour + 15% Prickly pear fruit Peels

4. Conclusion

The obtained results in this study revealed that cupcakes were prepared using wheat flour supplemented with prickly pear fruits peels at different levels. The final products were rich of antioxidant and antimicrobial. The applied technological procedure using well-blended combination of supplements resulted in production of biscuits its excellent sensory properties of Appearance, Crust Color, Crumb Color, Texture, Odor and Taste. Finally, it could prepare some bakery products using materials such as prickly pear fruits peels with high quality that are suitable for consumers. prickly pear fruits peels waste can be utilize for production of high economic value products.

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