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Original Article

Physicochemical Characteristics, Total Phenolic Content and Free Radical Scavenging Activity of Apple (Malus Domestica) Peel Powder

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ABSTRACT

Apple peel is considered as a waste product in many fruit industries but it is a noteworthy source of nutrients and phytochemicals, particularly polyphenols which have the ability to scavenge free radicals. **Objectives:** To study the physicochemical properties of apple (*Malus domestica*) peel powder, as well as its TPC and free radical scavenging activities. **Methods:** Proximate analysis of the apple peels powder was carried out. Total polyphenol content of apple peel powder was determined. The total content of phenolic compounds was expressed as gallic acid equivalent, i.e. mg GAE/100g of extract dry weight of sample. **Results:** The results of physicochemical characteristics moisture (7.65±0.88%), ash (2.50±0.35%), fat (1.18±0.02%), fiber (15.25±1.03%), protein (2.79±0.05%), carbohydrates (71.0±2.30%) and energy were 312±4.70 Kcal/100g. The total phenolic contents in the methanolic extract of apple peel powder were 320±5.4 mg GAE/100g while in H_2O extract 201±4.20 mg/100g. The findings of the apple peel powder's methanolic extract's capacity to scavenge free radicals varied from 25.40±1.30—69.2±3.80%, while those of the water extract were 14.30±1.05—45.62±1.90% and BHT were 17.8±1.15—51.62±2.15% at concentration 20-100 µg/ml. **Conclusions:** The outcomes showed that both apple peel powder extracts had promising total polyphenols and have strong free radical scavenging activity. These findings suggest that the apple peel powder act as robust naturally occurring antioxidants and may be employed as a preventative therapy for several oxidative stress-related degenerative disorders.

INTRODUCTION

Plants are essentially the basis of life and offer an unrivalled, exceptional source of nutrition for both humans and animals. Due to the many chemical compounds that they contain, many plant species have medical benefit (Ani and Abel, 2018)[1]. The best sources of natural antioxidants are fruits and vegetables. It is reasonable to hypothesise that increasing the purposeful consumption of these fruits would improve the intake of natural antioxidants. Since various fruits have varying antioxidant capacities, they may offer diverse protection against oxidative stress. Antioxidants are chemicals that can stop or postpone oxidative damage to lipids, proteins, and nucleic acids when they are present at low concentrations[2]. The apple (*Malus domestica*) is a member of the rose family (*Rosaceae*) and it is the fourth most produced fruit in the world. In 2020, there were 84.6 million tonnes of apples produced globally [3]. Apple fruit and its products are a great source of natural antioxidants in our diet, contributing up to 22% of all dietary phenolics. Drinks and dietary supplements for the food sector are regularly made with apples which are significant part of the human food chain and a complex of physiologically active phenolic and triterpenic chemicals governs their nutritional qualities. After citrus, mango, and banana, apple is the fourth most popular fruit in Pakistan and is consumed frequently. It is cultivated commercially in Pakistan's Gilgit-Baltistan, Punjab, Khyber Pakhtunkhwa, and Quetta [4]. Apple peel has a variety of biological properties and in earlier research; apple peel extract was found to have an inhibitory impact on obesity related insulin resistance and type II

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diabetes in mice. In those mice, dietary treatment with apple peel extract lowered levels of cytokines during the early stages of pro-inflammation, enhanced insulin sensitivity and decreased levels of oxidation in adipose tissue [5]. According to Raudone *et al.*, 2017 study, hydroxycinnamates, flavanols, anthocyanins, and dihydrochalcones are polyphenolic chemicals in apple peel that contribute to antihypertensive and anti-inflammatory and antioxidant properties [6]. Numerous factors, including as environmental factors, soil composition, the timing of harvest, varied storage conditions, etc., affect the quantity of polyphenolic compounds as well as their antioxidant activity in many apple cultivars and their content fluctuates [7]. Consumers' growing health consciousness has increased demand for functional foods that contain minerals, polyphenols, and antioxidants. Thus, the primary goal of the investigation is to concentrate on the apple peel nutrients, identify its phenolic contents and antioxidant capabilities.

METHODS

All of the chemicals and solvents that used in this study were of the analytical grade and procured from Merk, Sigma Aldrich. Apples were purchased from a local Lahore market. The fruits were carefully rinsed under running water before being peeled with an apple peeler. Fresh peels were dried for 6 to 8 hours in a hot air oven at 50 °C. For further investigation, the dried peel was then ground into a powder using a grinding mill and packaged in a plastic bag. Proximate analysis of the apple peels powder was carried out as follows: Moisture content was determined using the hot air oven by drying at 60-70 °C till constant weight. Ash, protein, fat and crude fiber were determined. Carbohydrate content was determined by difference method. The sum of percentage moisture, ash, protein, fat, and crude fiber was subtracted from 100.

Percentage (%) carbohydrate = 100 – (% moisture + % ash + % protein + % fat + crude fiber).

The energy was calculated using the formula computed by multiplying the percentages of crude protein and carbohydrate by 4.0 and crude fat by 9.0 which was expressed as Kcal/100g [8]. To make the water and methanolic extract. 5 gram of apple peel powder was mixed with 200 ml of methanol and water by using of electronic blender. The mixture was then agitated for four hours in a thermostatic water bath set at 40°C. The residue was removed by filtration using filter paper and the filtrate was used for antioxidant study. Total polyphenol content of apple peel powder was determined according to the method described by Singleton and Rossi (1965) [9]. The total content of phenolic compounds was expressed as gallic acid equivalent, i.e. mg GAE/100g of extract dry weight of sample. The free radical activity was performed according to the DPPH assay described previously by Brand-Williams (1995) method [10] with slight modification. The percentage inhibition of DPPH radicals (%I) was calculated according to the equation:

$$\% \text{ Inhibition } (DPPH^{\cdot}) = A^{(517)}_{control} - A^{(517)}_{sample} / A^{(517)}_{control} \times 100$$

where: A^{517}_{conrol}: absorbance of the control sample, A^{517}_{sample}: absorbance of the tested sample. The concentration of the extracts was plotted against the % inhibition. Version 21 of the Statistical Product for Service Solution (SPSS) was used to statistically evaluate the data that was collected. As means and standard deviation, they were expressed (SD).

RESULTS

Table 1 shows the percentage of moisture, ash, fat, fiber and protein values of apple peel powder sample were 7.65±0.88%, 2.50 ±0.35%, 1.18±0.02%, 15.25±1.03%, 2.79±0.05%, respectively. While the carbohydrates was measured by difference which was 71.0±2.30% and energy 312±4.70 Kcal/100g.

Sr. No.	Parameters	Values (g/100g)
1	Moisture	7.65 ± 0.88
2	Ash	2.50 ± 0.35
3	Crude fat	1.18± 0.02
4	Crude fiber	15.25 ± 1.03
5	Crude protein	2.79 ± 0.05
6	Carbohydrate	71.00 ± 2.30
7	Energy (Kcal/100g)	312 ± 4.70

Table 1. Nutritional facts of fresh Apple peel
Data are represented ± standard deviation

In the current study, it was discovered that apple peel powder extract in methanolic form had greater levels of radical scavenging activity than its water extract, as measured by the DPPH assay. As the concentration increased from 20—100 µg/ml, the % inhibition of the samples increased. Figure 1 shows the range of DPPH radical scavenging activity for methanolic extract of apple peel powder, which was 25.40±1.30—69.2±3.80% while 14.30±1.05—45.62±1.90% with water extract and with BHT was 17.8±1.15—51.62±2.15%.

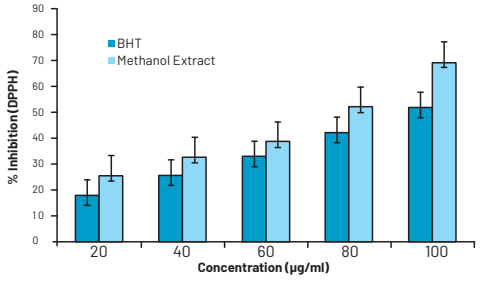

Figure 1: Free radical scavenging activity (% Inhibition DPPH) of

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methanol extract of apple peel powder

Methanol extract had higher free radical scavenging activity than the synthetic standard antioxidant BHT followed by water extract (Figure 2).

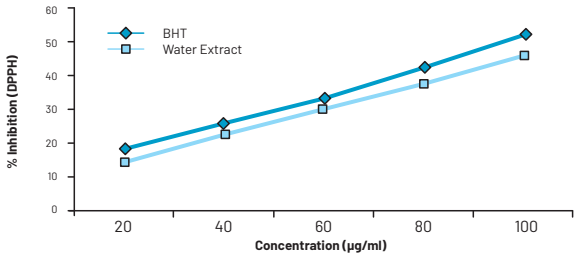

Figure 2: Free radical scavenging activity (% Inhibition DPPH) of water extract of apple peel powder

DISCUSSION

It is now widely acknowledged that apple fruits are a good source of phytochemicals, which are mostly concentrated in the peel. They influence the nutritional content, aesthetics, flavour, colour and texture of meals in addition to improving customers' health (Ou and Gu, 2014) [11]. According to Safdar *et al*. (2017) [12], estimation of proximate composition is important for determining the quality of raw materials. Apple peel powder contains moderate level of carbohydrate, moisture, low level fat and protein, moderate level of crude fiber and ash. According to Henrquez *et al*. (2010) [13], apple peels include ash (2.4%), crude fat (2.7%), crude fiber (19.6%), crude protein (2.7%), and NFE (72.7%) and our findings are in line with this findings. In food processing, moisture content is one of the most significant and often utilized parameters which affects both product's shelf life and the viability of microorganism development [14, 15]. The sample's ash content reveals how much inorganic materials and oxides are present. It is the factor that determines the composition of the sample's minerals [16]. Fat provide great source of energy and also improves the transit of fat-soluble vitamins, insulates, protects interior tissues, and supports essential cellular functions. However, it is firmly held that excessive consumption of saturated fatty acids is to blame for men's propensity for coronary thrombosis and aortic atheroma. High quantity of polyunsaturated fatty acids significantly decrease the blood cholesterol levels [17]. According to scientific data, increasing fibre consumption especially dietary fiber helps prevent, cure, and manage chronic illnesses as well as support physiological processes including blood lipid and glucose regulation [18, 19]. Energy generation is the main metabolic function of carbohydrates in diets. There are several forms of carbohydrates, but only total carbohydrates are taken into account in meals, which is what remains after protein, fat, moisture, and ash have been taken out [20]. The phenolic content of the apple peel was determined as the gallic acid equivalent. According to the findings, the total phenolic content of the powdered apple peel in methanolic extract was 320±5.4 mg GAE/100g and 201±4.20 mg/100g after the extraction in H_2O. El-Messery 2019 [21] said that the overall polyphenolic content in apple peel 1141.92 ppm and this is confirmed by Jakobek *et al*. (2013) [22] who mentioned PC in apple peel ranged from 672 to 3150 mg•kg–1. The TPC reported by Vasile *et al*. (2021) [23] varied from 2056 to 2723 mg GAE/kg among red skinned varieties, which was greater than the TPC found in yellow skinned apples. Moreover Khalid *et al*. (2021) [24] obtained grater TPC in apple peel than our results and he determined the amount of phenolic compounds in the apple peel as chlorogenic acid equivalents and demonstrated that it was 832.05±0.05 mg GAE/100g. The antioxidant action of apples is established by phenolic compounds, which operate as reducing agents by donating hydrogen, quenching singlet oxygen, serving as chelators and trapping free radicals. This inhibits free radicals from harming DNA, proteins, lipids, and other biomolecules structures [25, 26]. The DPPH radical scavenging experiment shows a positive correlation between TPC and % inhibition. According to Ahmad *et al*., (2020) the overall free radical scavenging capacity of apple peels was 2.5 times larger than that of the pulp [27].

CONCLUSIONS

This study provides evidence that apple peel powder is a superior source of nutrients, especially fiber. They have the high free radical activity (% DPPH scavenging activity) and a high quantity of phenols. The polyphenolic rudiments found in apple peel powder may be linked to the antioxidant action.

Conflicts of Interest

The authors declare no conflict of interest

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REFERENCES

[1] Ani PN and Abel HC. Nutrient, phytochemical, and antinutrient composition of Citrus maxima fruit juice and peel extract. Food Science & Nutrition. 2018 May; 6(3): 653-8. doi: 10.1002/fsn3.604

[2] Saeed MK, Zahra N, Ahmad I, Syed Q. Quality assessment, sensory evaluation, and radical scavenging activity (RSA) of orange (Citrus auranthium) pulp. Bangladesh Journal of Scientific and Industrial Research. 2022 Jun; 57(2): 123-30. doi: 10.3329/bjsir.v57i2.60409

DOI: https://doi.org/10.54393/pbmj.v6i02.847

[3] FAO F. Food and agriculture organization of the United Nations. Rome. 2018 Jul.
[4] Akhtar S, Khan FA, Ali J, Javid B. Nutritional composition, sensory evaluation and quality assessment of different brands of commercial tetra pack apple juices available in local market of Peshawar Pakistan. Global Journal of Biotechnology and Biochemistry. 2013; 8(11): 69-73.
[5] Qiang J, Khamis OA, Jiang HJ, Cao ZM, He J, Tao YF, *et al*. Effects of dietary supplementation with apple peel powder on the growth, blood and liver parameters, and transcriptome of genetically improved farmed tilapia (GIFT, Oreochromis niloticus). PLoS One. 2019 Nov; 14(11). doi: 10.1371/journal.pone.0224995
[6] Raudone L, Raudonis R, Liaudanskas M, Janulis V, Viskelis P. Phenolic antioxidant profiles in the whole fruit, flesh and peel of apple cultivars grown in Lithuania. Scientia horticulturae. 2017 Feb; 216: 186-92. doi: 10.1016/j.scienta.2017.01.005
[7] Kschonsek J, Wolfram T, Stöckl A, Böhm V. Polyphenolic compounds analysis of old and new apple cultivars and contribution of polyphenolic profile to the in vitro antioxidant capacity. Antioxidants. 2018 Jan; 7(1): 20. doi: 10.3390/antiox7010020
[8] Akinyeye RO, Oluwadunsin A, Omoyeni A. Proximate, mineral, anti-nutrients, phyto-chemical screening and amino acid compositions of the leaves of Pterocarpus mildbraedi harms. Electronic Journal of Environmental, Agricultural & Food Chemistry. 2010 Sep; 9(8).
[9] Singleton VL and Rossi JA. Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. American journal of Enology and Viticulture. 1965 Jan; 16(3): 144-58.
[10] Brand-Williams W, Cuvelier ME, Berset CL. Use of a free radical method to evaluate antioxidant activity. LWT-Food science and Technology. 1995 Jan; 28(1): 25-30. doi: 10.1016/S0023-6438(95)80008-5
[11] Ou K and Gu L. Absorption and metabolism of proanthocyanidins. Journal of Functional Foods. 2014 Mar; 7: 43-53. doi: 10.1016/j.jff.2013.08.004
[12] Safdar MN, Kausar T, Nadeem M. Comparison of ultrasound and maceration techniques for the extraction of polyphenols from the mango peel. Journal of Food Processing and Preservation. 2017 Aug; 41(4): e13028. doi: 10.1111/jfpp.13028
[13] Henríquez C, Speisky H, Chiffelle I, Valenzuela T, Araya M, Simpson R, *et al*. Development of an ingredient containing apple peel, as a source of polyphenols and dietary fiber. Journal of Food Science. 2010 Aug; 75(6): H172-81. doi: 10.1111/j.1750-3841.2010.01700.x
[14] Nasir M, Akhtar S, Sharif MK. Effect of moisture and packaging on the shelf life of wheat flour. Internet Journal of Food Safety V. 2004; 4: 1-6.
[15] Nwofia GE, Victoria NN, Blessing KN. Nutritional variation in fruits and seeds of pumpkins (Cucurbita Spp) accessions from Nigeria. Pakistan Journal of Nutrition. 2012 Oct; 11(10): 848-858. doi: 10.3923/pjn.2012.946.956
[16] Preti R and Tarola AM. Study of polyphenols, antioxidant capacity and minerals for the valorisation of ancient apple cultivars from Northeast Italy. European Food Research and Technology. 2021 Jan; 247: 273-83. doi: 10.1007/s00217-020-03624-7
[17] Akpabio UD, Akpakpan AE, Enin GN. Evaluation of proximate compositions and mineral elements in the star apple peel, pulp and seed. Magnesium (Mg). 2012; 6(3.52): 29-49.
[18] Figuerola F, Hurtado ML, Estévez AM, Chiffelle I, Asenjo F. Fibre concentrates from apple pomace and citrus peel as potential fibre sources for food enrichment. Food chemistry. 2005 Jul; 91(3): 395-401. doi: 10.1016/j.foodchem.2004.04.036
[19] Romelle FD, Rani A, Manohar RS. Chemical composition of some selected fruit peels. European Journal of Food Science and Technology. 2016 Sep; 4(4): 12-21.
[20] Hussain M, Maqbool M, Ishtiaq M. Nutritional Evaluation of Some Selected Fruits (Pyrus Malus, Psidium Guajava, Musa Paradisiaca, Citrus Maxima) Available in Local Market of Sargodha City of Pakistan. Transactions in Physical and Biochemical Sciences. 2021; 1(1): 47-56.
[21] El-Messery TM, El-Said MM, Demircan E, Ozçelik B. Microencapsulation of natural polyphenolic compounds extracted from apple peel and its application in yoghurt. Acta Scientiarum Polonorum Technologia Alimentaria. 2019 Mar; 18(1): 25-34. doi: 10.17306/J.AFS.2019.0597
[22] Jakobek L, García-Villalba R, Tomás-Barberán FA. Polyphenolic characterisation of old local apple varieties from Southeastern European region. Journal of food composition and analysis. 2013 Sep; 31(2): 199-211. doi: 10.1016/j.jfca.2013.05.012
[23] Vasile M, Bunea A, Ioan CR, Ioan BC, Socaci S, Viorel M. Phytochemical content and antioxidant activity of Malus domestica Borkh peel extracts. Molecules. 2021 Dec; 26(24). doi: 10.3390/molecules26247636
[24] Khalid MU, Shabbir MA, Mustafa S, Hina S, Quddoos MY, Mahmood S, *et al*. Effect of Apple peel as an antioxidant on the quality characteristics and

DOI: https://doi.org/10.54393/pbmj.v6i02.847

oxidative stability of mayonnaise. Applied Food Research. 2021 Dec; 1(2). doi: 10.1016/j.afres.2021.100023

[25] Li H, Subbiah V, Barrow CJ, Dunshea FR, Suleria HA. Phenolic profiling of five different Australian grown apples. Applied Sciences. 2021 Mar; 11(5): 2421. doi: 10.3390/app11052421

[26] Butkeviciute A, Abukauskas V, Janulis V, Kviklys D. Phenolic content and antioxidant activity in apples of the 'Galaval'cultivar grown on 17 different rootstocks. Antioxidants. 2022 Jan; 11(2): 266. doi: 10.3390/antiox11020266

[27] Ahmad I, Khalique A, Shahid MQ, Ahid Rashid A, Faiz F, Ikram MA, *et al*. Studying the influence of apple peel polyphenol extract fortification on the characteristics of probiotic yoghurt. Plants. 2020 Jan; 9(1). doi: 10.3390/plants9010077