



Article Comparative Study of Potato (Solanum tuberosum L.) and Sweet Potato (Ipomoea batatas L.): Evaluation of Proximate Composition, Polyphenol Content, Mineral and Antioxidant Activities

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Abstract: The objective of the present study was to differentiate and compare the proximate composition, minerals, flesh colour, phenolic composition, and antioxidant activities of varieties of white-fleshed sweet potato (WFSP) and potato (WFP) locally grown in Pakistan. The results showed that WFP presented higher moisture and crude fat content, while WFSP offered better ash, crude protein, and crude fibre contents. Colour analysis revealed that WFSP and WFP showed the highest L* (lightness) values and exhibited the maximum total phenolic content and total flavonoids content of 9.27 ± 0.88 mg GAE/g and 19.01 ± 0.66 mg QE/g. *In vitro*, results demonstrated that WFSP possessed better antioxidant activity with the highest ferric reducing antioxidant power of 58.67 ± 0.22 mM Fe²⁺/g and DPPH scavenging activity of $39.12 \pm 0.33\%$ compared to WFP. It is concluded that WFSP possesses a better proximate and mineral profile followed by higher antioxidant activity.

Keywords: white-fleshed sweet potato; white-fleshed potato; proximate composition; antioxidant; DPPH; phenolic composition

1. Introduction

Human health is linked to nutrition, such as caloric intake and dietary components, which are available naturally [1]. During the past few decades, research has established the remarkable therapeutic potential of various natural products. Synthetic drugs possess undesirable toxicity, either acute or chronic, and are used based on benefit vs. adverse effects. It has been known that a vast majority of synthetic drugs cause various health and dietary issues if ingested chronically, such as ulcers, cancer, gastrointestinal disorders,



Citation: Arshad, A.; Iqbal, H.; Siddiqa, A.; Zulfiqar, T.; Tareen, M.B.K.; Amna, D.; Shakir, M.; Hazafa, A.; Naeem, M.; Lorenzo, J.M.; et al. Comparative Study of Potato (*Solanum tuberosum* L.) and Sweet Potato (*Ipomoea batatas* L.): Evaluation of Proximate Composition, Polyphenol Content, Mineral and Antioxidant Activities. *Appl. Sci.* 2021, *11*, 11844. https://doi.org/ 10.3390/app112411844 5

Academic Editor: Monica Gallo

Received: 28 September 2021 Accepted: 8 December 2021 Published: 13 December 2021

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Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/). cardiovascular toxicity, and renal damage [2]. Health-conscious people are concerned about the quality of their diet and additives, which may impact their quality of life. This concept brought a revolution in the field of conventional medical therapy, and the term "nutrition therapy" gained special attention over modern drug therapy [3]. The term "functional food" is characterised as naturally occurring foodstuffs that provide nutritional and physiological benefits for health. It focuses mainly on improving health and minimizing the risk of diet-related chronic illnesses [4].

Aerobic respiration and drug metabolism are linked to reactive oxygen species (ROS) production. Reactive oxygen species are a series of metabolic by-products of oxygen that are involved in pathogenic and degenerative diseases [5]. It was found that ROS overproduction could disrupt cellular redox status, thus leaving the cells susceptible to apoptosis or necrosis [6]. ROS can activate the process of inflammation, which is linked to many diseases. Oxidative damage is linked to the progression of various diseases, including cardiovascular disease, atherosclerosis, cancer, chronic inflammatory disease, and diabetes [6,7]. Protection against excessive ROS is achieved by endogenous antioxidants, such as reduced glutathione and peroxiredoxins, but often their levels may be insufficient in conditions such as excessive chemical exposure, diabetes, Alzheimer's disease, and older age. If ROS are not efficiently removed, cells are prone to cell damage or transformed cells [8]. Among the naturally occurring antioxidants are vitamins C and E. Raising the levels of vitamin E within cells is difficult, if not impossible. Over the past few decades, synthetic antioxidants (tert-butyl hydroquinone, butylated hydroxy anisole, propyl gallate, and butylated hydroxy toluene) as scavengers of ROS to treat ROS associated diseases were widely used as therapeutic agents. These synthetic antioxidants may be linked to other diseases such as cancer. Replacing synthetic antioxidants with naturally occurring antioxidants is an excellent priority for humans to reduce toxicity. One of the natural antioxidants capable of free radical scavenging are polyphenols, commonly present in fruits and vegetables. Polyphenols possess numerous biological activities, including anti-ageing, antioxidant, chemoprevention, anti-inflammatory, antibacterial and anti-viral effects [9,10]. The emerging evidence suggests that natural antioxidants not only reduce free radicals but also increase intracellular antioxidant defences [11]. Different vegetables, tubers, fruits, leaves, oilseeds, cereal crops, and herbs serve as potential sources of antioxidants and/or other bioactive ingredients [12].

Sweet potato (Ipomoea batatas L.) and potato (Solanum tuberosum L.) tubers are known as one of the world's most essential and commonly used edibles that are not only limited to energy but also contain several biologically important components [13,14]. A tuber is considered the critical part that is harvested and mostly used to reproduce and regenerate nutrients. Many sweet potatoes and potato cultivars worldwide have skin colour variations (yellow, cream, white, and pink), size, and flesh colours such as purple, white, yellow, and orange [15,16]. According to an estimation, globally, total potato production has increased to 370,436,581 tonnes, with a total harvested area of 17,340,986 ha in 2019. Pakistan accounts for a total potato production of 4,869,312 tonnes in 2019, while sweet potato remained at around 0.01 million tonnes [17]. Sweet potatoes are a rich source of phytochemicals, carbohydrates, minerals, dietary fibres, and β -carotenoids, but their quantity and type of sugars, such as glucose, fructose, and sucrose, vary from variety to variety [18]. These phytochemicals showed various activities, including antioxidants, anti-diabetic, anti-inflammatory, antimicrobial, anticancer, antiulcer, and immune-modulatory. Anthocyanins and choline in sweet potatoes are the best remedies against chronic inflammation. Research studies established that sweet potatoes also improved haematological parameters in animal models [19,20]. Anthocyanins are the phenolic compounds that impart purple and blue colours to many vegetables and fruits. Evidence has revealed that polyphenols (anthocyanins) are helpful in rheumatoid arthritis and osteoarthritis because they reduce inflammation [21,22].

Sweet potatoes contain a high level of β -carotene ranging from 0.2 to 226 μ g/g FW (fresh weight) in 19 different varieties of sweet potato [23]. Rumbaoa et al. [24] showed

a total phenolic content of approximately 192.7–1159.0 mg GAE/100 g DW (dry weight) among five different Philippine sweet potato varieties and observed a negative correlation between EC50 of antioxidant DPPH assay and total phenolic content, suggesting that phenolic content is a leading contributor to their free radical scavenging activity. Similarly, Wang et al. [25] demonstrated that five cultivars of sweet potatoes showed 213 different metabolites, including 27 phenolic acids and 29 flavonoids. They also observed that quinic acids, anthocyanins, and ferulic acids were the primarily phenolic acids in OFSP (orange flesh sweet potato) and WESP (white flesh sweet potato). Yong and co-workers [18] showed that purple-fleshed sweet potato extract (PSPE) exhibited the total pelargonidin-3-O-(6malonyl-glucoside), petunidin-3-O-(6-malonyl-glucoside), and peonidin-3-O-glucoside levels of 30.77%, 16.86%, and 12.56%. They also revealed that chitosan-PSPE I and chitosan-PSPE II showed the maximum antioxidant DPPH scavenging activity of 50% and 60% after 60 min. Sun et al. [26] reported that twelve different types of anthocyanins were observed in Chinese purple-fleshed sweet potatoes and stated that peonidin-based extract of purple sweet potatoes showed better antioxidant scavenger free radicle properties followed by good Fe²⁺ chelating power and reducing ability. The data of biological activities of different varieties of sweet potatoes in different parts of the world are known, but there are very limited data regarding the biological activities of WFSP and WFP in Pakistan. The present study evaluated the antioxidant activity of a locally grown variety of WFSP and WFP in Pakistan. In addition, it defines the total phenolic and total flavonoid contents, proximate analysis, minerals, and powder colour properties of WFSP and WFP.

2. Materials and Methods

2.1. Chemicals

2,2 Diphenyl-1-picrylhydrazyl (DPPH; D4313, \geq 97.0%), Folin–Ciocalteu phenol reagents (OF1181, \geq 95%) and tripyridyltriazine (TPTZ; FHL01, \geq 98%) were obtained from Tokyo Chemical Industry Co., Ltd. (Tokyo, Japan). Methanol (CH₃OH; \geq 99.85%), sodium hydroxide (NaOH; \geq 50% w/v), boric acid (H₃BO₃; \geq 99.95%), sulphuric acid (H₂SO₄; \geq 97%), sodium carbonate (Na₂CO₃; \geq 99.8%), gallic acid (C₇H₆O₅; \geq 97.5%), sodium nitrite (NaNO₂; \geq 98.0%), aluminium chloride (AlCl₃; \geq 99.99%) and quercetin (C₁₅H₁₀O₇; \geq 95.0%) were purchased from Sigma–Aldrich (St. Louis, MO, USA).

2.2. Plant Materials

Sweet potato (red peeled with white flesh) and potato (red peeled with white flesh) were purchased from the local market of Faisalabad, Pakistan. The white-fleshed sweet potato (WFSP) and white-fleshed potato (WFP) were washed with distilled H_2O to remove dust, trashes, stones, and damaged seeds. Both WFSP and WFP tubers were cut into 2 cm slices by a stainless-steel slicer and then steamed for 15 min at 100 °C to control the browning of flesh. Samples were cut into cubes (each of 2 cm³) and cooled before subjecting to a lyophiliser. Lyophilised (St. Louis, MO, USA) samples were ground into a fine powder, placed in a polyethylene resealable bag, and stored below 4 °C until further analysis.

2.3. Physiochemical Parameters Analysis

2.3.1. Proximate, Colour and Mineral Analysis

Proximate analysis consisting of moisture, ash, crude protein, crude fat, and crude fibre evaluation of tuber powder extracts of WFSP, and WFP was carried out by following the method of Horwitz and Latimer [27] with slight modifications. The refined powder of sweet potato was taken into three separate China dishes, weighed, and placed in an air-forced draft oven (Model: DO-1-30/02, PCSIR, Pakistan) at 105 ± 5 °C till constant weight. Equation (1) was used to calculate the percentage of moisture. For ash content analysis (Method No. 942-05) [27], the sample was taken in pre-weighed crucibles, charred on a burner till the end of the fume's appearance. Then, the sample was subjected to direct incineration in a muffle furnace (MF-1/02, PCSIR, Pakistan) at 550–600 °C after charring until a white greyish residue. Equation (2) was used to calculate the percentage of ash

content. Similarly, for crude protein content (Method No. 984-13) [2], 2 g extracts were firstly digested with 30 mL concentrated sulphuric acid (H_2SO_4) in the presence of digestion mixture for 4–5 h and then diluted to 250 mL with distilled water (d. H_2O). Distillation of 10 mL diluted sample and 10 mL of 40% sodium hydroxide solution was conducted by distillation apparatus. Ammonia (NH₃) was liberated and collected in 2% boric acid solution (4 g boric acid and 100 mL solution) containing methyl red as an indicator. Then samples containing ammonium borate were titrated against a 0.1 N sulphuric acid solution till a golden-brown endpoint.

$$Moisture (\%) = \frac{Weight of original sample (g) - weight of dried sample (g)}{Weight of original sample (g)} \times 100$$
(1)

$$Ash (\%) = \frac{Weight of residue (g)}{Weight of original sample (g)} \times 100$$
(2)

The crude fibre content of the sample was determined by Labconco Fibertech (Labconco Corporation, Kansas City, MO, USA) as described in AOAC (2005) Method No. 978-10 [27]. Briefly, 1 g of moisture and the fat-free sample was taken in a 1000 mL beaker, and 200 mL of diluted (1.25%) sulphuric acid was added. Samples were digested by boiling for 30 min. It was filtered (via suction apparatus), and residues were washed with hot water at least three times until they became acid-free. This method was repeated thrice until samples became alkali-free. Residues were transferred into a pre-weighed crucible and dried in an oven at 70–80 °C until a constant weight was attained. Finally, residues were charred on a burner and ignited in a muffle furnace at 550 °C for 5–6 h and cooled in a desiccator and weighed. The loss in weight during incineration represented the weight of crude fibre in the sample from which the percentage present in sample was calculated by using Equation (3). Similarly, crude fat (Method No. 920.39) and nitrogen-free extract (NFE) of WFSP and WFP were determined by Equations (4) and (5), respectively. The total energy was measured using Atwater conversion factors by following Equation (6). [28]:

$$Crude \ fiber \ (\%) = \frac{Loss \ of \ weight \ of \ sample \ during \ ashing \ (g)}{Weight \ of \ original \ sample \ (g)} \times 100$$
(3)

$$Crude fat (\%) = \frac{Weight of petroleum ether extract (g)}{Weight of original sample (g)} \times 100$$
(4)

$$NFE (\%) = (Crude \ protein + Crude \ fat + Ash + Moisture + Crude \ fiber) \times 100$$
(5)

$$Total \ energy \left(\frac{\text{kcal}}{100}\text{g}\right) = (4 \times protein) + (9 \times fat) + (4 \times carbohydrate) \tag{6}$$

Similarly, the colour analysis of WFSP and WFP was performed using a CIELab Colour Meter. Lightness (L*), "a*" (–a redness; +a greenness), and "b*" (–b yellowness; +b blueness) under constant lighting conditions using a white tile control. The mineral profiling of the samples was performed by following the Alam et al. [29] method on atomic absorption spectrophotometer and flame photometer.

2.3.2. Phytochemical Analysis

Total phenolic content (TPC) was determined by following the Folin–Ciocalteu method with slight modifications [8]. To determine the total phenolic content (TPC) of WFSP and WFP, 50 μ L of methanolic extract of samples (WFSP and WFP) were taken in a test tube. Two hundred and fifty microliters of Folin reagent, 750 μ L 20% sodium carbonate (Na₂CO₃), and 30 mL of distilled water were added into it and kept at room temperature for 2 h. Absorbance was measured through a UV–Vis spectrophotometer (CECIL CE7200) at 765 nm. Gallic acid was used as standard (10–400 μ g/mL). Outcomes were indicated as mg GAE/g

extract of the dry weight of sweet potato/potato. TPC of extract in gallic acid equivalents (GAE) was calculated by following Equation (7).

$$C\left(\mathrm{mg}\frac{\mathrm{GAE}}{\mathrm{g}}\right) = \frac{V\left(\mathrm{mL}\right)}{M\left(\mathrm{g}\right)} \times c\left(\frac{\mathrm{mg}}{\mathrm{mL}}\right) \tag{7}$$

where *C* is total phenolic content (mg GAE/g), *c* is the concentration of gallic acid (mg/mL), *V* is a volume of extract (mL), and *M* is the weight of sample extract (g).

Flavonoids from samples (WFSP and WFP) were analysed using a modified colourimetric assay. Briefly, 250 μ L of each sample extract was taken into a test tube containing 750 μ L of d.H₂O. One hundred and fifty microliters of 5% sodium nitrite solution were added, and the resulting mixture was kept at room temperature for 5 min. Then, 300 μ L of 10% aluminium chloride was added and kept at room temperature for 5 min. After that, 1 mL of 1 M sodium hydroxide was mixed, and absorbance was measured through a UV– Vis spectrophotometer at 510 nm. A standard calibration curve was plotted using quercetin at concentrations of 0.1, 0.2, 0.3, 0.4 and 0.5 mg/g. Total flavonoid content was expressed as the mg quercetin equivalents per gram of sweet potato/potato tuber extract [30].

2.4. In Vitro Antioxidant Analysis

2.4.1. 2,2-Diphenyl-1-picrylhydrazyl (DPPH) Assay

Free radical scavenging capacity, supporting its antioxidant potential, was evaluated by DPPH assay. Two millilitres of DPPH reagent (0.004 g DPPH powder in 100 mL methanol) were added into 50 μ L methanolic extract of samples (WFSP and WFP) and allowed to stand in the dark for 30 min. Afterward, the absorbance of the solution was measured with a spectrophotometer at 515 nm. Vitamin C and BHT were used as the standard to calculate the antioxidant activities of plant extract, and only methanolic DPPH solution as a blank was used. The following formula was used to calculate the percent DPPH inhibition after triplicate measurements of each selected medicinal plant.

The scavenging capacity was determined by the following Equation (8) [31]:

$$DPPH Inhibition (\%) = \frac{Blank Abs. (A0) - Sample Abs. (A1)}{Blank Abs. (A0)} \times 100$$
(8)

where A0 represents the absorbance of 70% methanol, and A1 represents the reaction solution's absorbance.

2.4.2. Ferric Reducing Antioxidant Power (FRAP) Assay

Ferric reducing antioxidant power (FRAP) of (WFSP and WFP) was assessed by following Liu et al. [32] method with slight modifications. Briefly, 20 mM FeCl₃ solution (dissolved in 0.3 M acetate buffer at pH 3.6), 10 mm TPTZ solution (dissolved in 40 mM HCl) and 0.3 M acetate buffer at a ratio of 1:1:10 (v:v:v) were mixed in a beaker and incubated at 37 °C for 30 min. After, 0.15 mL of sample solution was thoroughly mixed with 2.85 mL of FRAP reagent and remained at room temperature for 30 min, and absorbance was measured at 593 nm using a UV–Vis spectrophotometer to assess the FRAP assay. Methanol was used as the blank [31], after which Equation (9) was used to determine the FRAP of the samples.

Sample FRAP or mM Ferrous Equivalents =
$$B \times (D/V)$$
 (9)

where *B* represents the amount of ferrous ammonium sulfate (nmol), *V* represents sample volume added in the sample wells (μ L), and *D* represents sample dilution factor.

2.5. Statistical Analysis

Data for each parameter were taken in three replicates and are shown as the mean \pm standard deviation (mean \pm SD). The significance of variables was assessed by analysis of variance (ANOVA), and means were ranked on Tukey's HSD (honestly significant difference) test ($p \le 0.05$) for antioxidant activities [33].

3. Results and Discussion

3.1. Proximate Composition Analysis

Figure 1a,b summarise the proximate composition of both WFSP and WFS. The results of Figure 1a show that WFSP presented the maximum moisture of 5.57 \pm 0.22, ash of 1.79 ± 0.28 , crude fat of 0.86 ± 0.41 , crude protein of 5.56 ± 0.99 , and crude fibre of 2.06 ± 0.17 and nitrogen-free extract (NFE) of 83.17 ± 0.98 g/100 g DW, while WFP exhibited the highest moisture of 8.50 \pm 1.01, ash of 1.53 \pm 0.04, crude fat of 1.62 \pm 0.02, crude protein of 2.06 \pm 0.06, and crude fibre of 1.49 \pm 0.02 and nitrogen-free extract (NFE) of 80.71 \pm 0.91 g/100 g DW. Figure 1b reveals that WFSP and WFP exhibited the total energy of 362.73 ± 2.49 and 337.21 ± 2.15 kcal/100 g DW, respectively. Overall, it was observed that moisture and crude fat content were higher in WFP, while ash, crude protein, crude fibre, NFE, and total energy were higher in WFSP. The results were significant (p < 0.05) based on the Tukey HSD test. Our results are in co-relation with the findings of previously published data. Alam et al. [34] stated that the BARI SP4 Bangladesh variety of orange-fleshed sweet potato (OFSP) showed the highest moisture, protein, fat, crude fibre, ash, and carbohydrate content of about 70.95 \pm 0.70, 5.83 \pm 0.30, 0.30 \pm 0.25, 0.54 \pm 0.14, 1.29 ± 0.06 and 21.10 ± 0.93 g/100 g of FW, respectively. Similarly, Omoba et al. [28] demonstrated that UMUSPO1 and UMUSPO2 varieties of Nigerian, orange-fleshed sweet potato showed the maximum moisture content of 85.12 \pm 0.08 and 84.71 \pm 0.05 g/ 100 g DW, ash content of 15.49 \pm 0.06 and 12.71 \pm 0.01 g/100 g DW, the crude fibre content of 4.50 \pm 0.02 and 4.90 \pm 0.03 g/100 g DW, the protein content of 30.07 \pm 0.09 and 25.00 ± 0.08 g/100 g DW, fat content of 1.44 ± 0.06 and 1.74 ± 0.04 g/100 g DW, and total energy value of 327.24 ± 0.05 and 338.26 ± 0.07 kcal/100 g, respectively. Kumari and co-workers [35] reported that Lady Rosetta and Lady Claire cultivars of potato peel powder showed the highest crude fat content of 2.09 ± 0.01 and $1.27 \pm 0.38\%$, crude protein content of 11.17 \pm 0.03 and 12.44 \pm 0.09%, ash content of 7.24 \pm 0.02 and 4.83 \pm 0.13%, moisture of 6.98 \pm 0.05 and 77.38 \pm 0.65%, and total carbohydrate of 72.53 \pm 0.08 and 77.38 \pm 0.65%, respectively.



Figure 1. The representation of (**a**) proximate composition and (**b**) total energy of white-fleshed sweet potato (WFSP) and white-fleshed potato (WFP). NFE: Nitrogen-free extract.

3.2. Colour Analysis

Figure 2 shows the results of colour analysis of WFSP and WFP. It was observed that WFSP and WFP showed the maximum L* (lightness) value of 81.29 ± 0.41 and 76.85 ± 0.08 , respectively. Similarly, the b* (yellowness) value of 12.48 ± 0.08 and 17.84 ± 0.05 was noted for WFSP and WFP, followed by an a* (redness) value of 1.47 ± 0.08 and 1.66 ± 0.38 ,

respectively. The results showed that the lightness (L*) value was prominent in both samples (i.e., WFSP and WFP), while WFSP presented the best results compared to WFP regarding lightness. In contrast, WFP showed the highest yellowness colour compared to WFSP. Our results are in agreement with the findings of Kourouma et al. [36]. They experimented on twenty-five different varieties of Chinese-cultivated sweet potatoes and revealed that Xinxiang, Mixuan No.1, Nongdabai, Zheshu 75 and Jishu No. 7 varieties showed a flesh colour of yellow-white, while Qinshu No. 7, XS 15-11-15, Yanshu 25, Sushu 16, Xiangshu 2, Yizi 138, Longshu 515 and Zheshu 13 varieties showed a yellow-orange colour, respectively.



Figure 2. Colour analysis of the powder of WFSP and WFP. L* (lightness), b* (yellowness), and a* (redness).

3.3. Mineral's Analysis

Figure 3 presents the results of the mineral analysis of WFSP and WFP. The results show that WFSP obtained the highest Fe content of 0.32 \pm 0.02, Ca content of 0.74 \pm 0.04, P content of 0.57 \pm 0.04, K content of 8.11 \pm 0.09, Mg content of 1.12 \pm 0.03, Na content of 0.46 ± 0.03 , Cu content of 0.01 ± 0.00 and Zn content of 0.03 ± 0.00 mg/g DW. Similarly, WFP exhibited the highest Fe, Ca, P, K, Mg, Na, Cu and Zn value of 0.34 \pm 0.03, 0.81 \pm 0.09, 0.42 ± 0.06 , 7.99 ± 0.05 , 1.22 ± 0.05 , 0.51 ± 0.04 , 0.01 ± 0.00 and 0.03 ± 0.00 mg/g DW, respectively. WFSP showed better K and P content than WFP, while Fe, Ca, Mg and Na were higher in WFP than WFSP. It was also noted that K was the predominant mineral in both varieties, while Cu and Zn were trace elements. Alam et al. [29] showed comparative results, experimenting on nine different varieties of orange-fleshed sweet potato (OFSP), reporting that BARI SP4 possessed the highest iron, copper, zinc, calcium, potassium, and magnesium amounts of 1.40 ± 0.10 , 0.67 ± 0.07 , 4.17 ± 0.21 , 22.04 ± 1.08 , 336.10 ± 3.64 and 23.37 ± 0.78 mg/100 g DW, respectively. Moura and co-workers [37] demonstrated that Brazilian-cultivated purple-fleshed sweet potato (PFSP) and WFSP showed the highest Ca content of 0.35 \pm 0.0058% and 0.62 \pm 0.0058%, K content of $3.47 \pm 0.06\%$ and $3.84 \pm 0.11\%$, Mg content of $0.37 \pm 0.0058\%$ and $0.41 \pm 0.0058\%$, Na



content of 0.0168 \pm 0.0058% and 0.0167 \pm 0.002% and P content of 0.31 \pm 0.01% and 0.23 \pm 0.0057% of total content, respectively.

Figure 3. Mineral analysis of (a) WFSP and (b) WFP extracts.

3.4. Phytochemical Analysis

3.4.1. Total Phenolic Content in WFSP and WFP

Figure 4 represents the results of total phenolic content (TPC) of both varieties (WFSP and WFP) of potatoes. Results showed that WFP and WFSP presented the TPC of about 2.91 \pm 0.42 and 9.27 \pm 0.88 mg GAE/g DW, respectively. It is observed that WFSP showed a higher TPC compared to WFP. Our results are in agreement with the findings of Alam et al. [34], who reported that BARI SP7 variety of Bangladesh cultivated orange-fleshed sweet potato (OFSP) presented the highest total polyphenol content (TPC) and total carotenoids content (TCC) of 136.05 \pm 3.53 mg GAE/100 g FW and mg/100 g FW, respectively. Similarly, Omoba et al. [28] verified that the UMUSPO1 and UMUSPO2 varieties of Nigerian orange-fleshed sweet potato showed the highest total phenolic content of 7.69 \pm 0.08 and 7.33 \pm 0.00 mg GAE/g, respectively. Soltys-Kalina et al. [38] demonstrated that wild species of potato (*S. michoacanum*), potato hybrid (DG 97-952), and cultivated potato (Ari) showed the maximum TPC content of 28.58 \pm 3.66, 40.50 \pm 4.02 and 20.27 \pm 4.37 µg/mL, respectively. Galani and co-workers [39] stated that the K. Surya cultivar of potato peel showed the maximum TPC of approximately 0.27 mg GAE/g FW after 30 days of incubation at room temperature.

3.4.2. Total Flavonoids Content in WFSP and WFP

Figure 4 signified the findings of total flavonoids content (TFC) of both varieties (i.e., WFSP and WFP) of potatoes. It was revealed that WFSP and WFP reported a TFC of approximately 19.01 \pm 0.66 and 2.38 \pm 0.73 mg QE/g DW, respectively. Based on these results, it was concluded that WFSP showed a higher TFC compared to WFP. Overall, the present study's results are in accordance with findings reported by Moura et al. [37], who revealed that Brazilian-cultivated PFSP and WFSP presented the highest TFC of 76.76 \pm 3.19 and 133.10 \pm 4.81 µg CE/mg, while the highest total phenolic content (TPC) was notes as 106.57 \pm 5.46 and 192.49 \pm 11.69 µg GAE/mg, respectively.





Figure 4. The total flavonoids content (TFC) and total phenolic content (TPC) of WFSP and WFP. Different letters in the column represent the significant difference based on the Tukey HSD test (a = $p \le 0.05$, b = $p \le 0.01$).

Kourouma et al. [36] experimented on twenty-five different varieties of Chinese cultivated sweet potato and reported that Huangmeigui showed the highest TFC of $2.54 \pm 0.00 \text{ mg RE/g DW}$, TPC of $8.58 \pm 0.12 \text{ mg GAE/g DW}$ and total anthocyanin content (TAC) of $0.75 \pm 0.02 \text{ mg/g DW}$, respectively. Friedman et al. [40] revealed that organic Russet variety of potato peel presented the maximum TFC of $29.7 \pm 0.4 \text{ µg/mg}$, followed by conventional Russet ($23.0 \pm 5.5 \text{ µg/mg}$) and organic red potato ($12.5 \pm 3.9 \text{ µg/mg}$) varieties. Similarly, Soltys-Kalina et al. [38] confirmed that wild species of potato (*S. michoacanum*), potato hybrid (DG 97-952), and cultivated potato (Dalila) showed the highest TFC of 12.54 ± 2.49 , 13.38 ± 0.44 and $8.10 \pm 1.63 \text{ µg/mL}$, respectively. Overall, it is concluded that Pakistani-cultivated WFSP showed better TFC results.

3.5. Antioxidant Activity

3.5.1. DPPH Assay Analysis

Figure 5 shows the results of the antioxidant DPPH assay for WFP and WFSP. The results demonstrate that methanolic extract of WFSP and WFP showed DPPH inhibition activity of $39.12 \pm 0.33\%$ and $31.67 \pm 0.30\%$, respectively. The present findings confirmed that methanolic extract of WFSP showed better results compared to WFP. Our results lead to a similar conclusion with the findings of Kumari et al. [35], who revealed that 80% methanolic extract of Lady Rosetta and Lady Claire cultivars of potato peel powder presented the maximum antioxidant DPPH activity of 3.51 ± 0.00 and 1.75 ± 0.05 mg TE gdb⁻¹. Kim et al. [41] experimented on different sweet potato varieties and suggested that the JM variety submitted the best DPPH and ABTS radical scavenging activity of 48.15 and 80.0 mg TE/g DW after heat treatment with pre-ethanol (80%).



Figure 5. Ferric reducing antioxidant power (FRAP) and antioxidant (DPPH) activities of WFSP and WFP. Different letters in the column represent a significant difference based on the Tukey HSD test (a = $p \le 0.05$, b = $p \le 0.01$).

3.5.2. FRAP Assay Analysis

Figure 5 indicates the findings of the FRAP of both varieties (i.e., WFSP and WFP) of potatoes. Based on the results, it was demonstrated that WFSP presented a FRAP activity of approximately 58.67 ± 0.22 mM Fe²⁺/g DW, while WFP exhibited FRAP of approximately 47.74 ± 0.49 mM Fe²⁺/g DW. Based on the results, it was concluded that WFSP showed the best FRAP activity compared to WFP. Overall, the present study's results are in accordance with the findings reported by Friedman et al. [40], who revealed that conventional Russet variety of potato showed the highest FRAP activity (0.76 ± 0.17 mM/mg) followed by organic Russet (0.67 ± 0.05 mM/mg), and conventional red varieties (0.40 ± 0.02 mM/mg). Oloniyo and co-workers [42] experimented on different varieties of orange-fleshed sweet potato (OFSP) and indicated that the MDP variety presented the best FRAP activity of 40.36 ± 0.4 mg AEE/g followed by KJP (35.61 ± 0.1 mg AEE/g) and KJC (35.41 ± 0.2 mg AEE/g).

4. Conclusions

The main objection of the present study was to evaluate the antioxidant activity of locally cultivated WFSP and WFP varieties in Pakistan. In addition, the total phenolic and total flavonoids contents, proximate analysis, minerals and powder colour properties of WFSP and WFP were evaluated. The present study summarised that white-fleshed sweet potato showed higher values of crude protein, fibre, total phenolic content (TPC), total flavonoids content (TFC), ferric reducing antioxidant power (FRAP) and DPPH than white-fleshed potato. The potato is widely regarded as one of the most important dietary sources of antioxidants globally, but the white-fleshed sweet potato has the potential to make a substantial addition to the diet. Sweet potato extract can be explored as a functional food ingredient and therapeutic food, as it contains a higher proportion of phytochemicals. However, it is recommended that further studies should be performed to illustrate the nutraceutical characteristic of white-fleshed sweet potato and other varieties of sweet

potato as well that could be used in the future as a potential source of phytochemicals due to the fact of their cost-effectiveness and easy to harvest behaviour.

Author Contributions: Conceptualisation, A.A. and A.H.; methodology, A.A.; software, A.H., H.I., A.S. and D.A.; validation, M.N., A.H., M.B.K.T. and T.Z.; formal analysis, M.S. and H.I.; investigation, A.H. and R.D.; resources, J.M.L., A.A. and R.D.; data curation, A.A. and M.B.K.T.; writing—original draft preparation, A.H., A.S., H.I. and T.Z.; writing—review and editing, A.H., D.A., T.Z., A.S., M.B.K.T. and M.N.; visualisation, R.D. and J.M.L.; supervision, A.H. and R.D. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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