Nutritional and antioxidant profile of some selected Pakistani potato cultivars

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ABSTRACT

Present researcher was designed to evaluate the nutritional and antioxidant activity of the some prominent potato cultivars. The mean indicated that potato contained appreciable amount of moisture (77.5 to 82.37%), ash (1.46 to 1.66%), crude protein (2.037 to 3.062%), crude fat (1.16 to 1.89%) and crude fiber (2.12 to 2.66%). However, specific gravity were in the ranged of 1.05 to 1.22. The antioxidant assays indicated that the highest total phenolic content, DPPH inhibition, FARP and ABTS values were observed in FD 8-1, followed by Cardinal whereas the lowest activity was noticed in FD 19-2. Conclusively, the consumption of the potato will provide nutritional worth along with antioxidant potential that might be helpful for proper functioning of the physiological systems of body.

Keywords: Potato, Proximate composition, Antioxidant potential, Potato quality

INTRODUCTION

Consumers have paid immense attention towards the benefits of nutrients and natural antioxidants in food, such as fruits and vegetables (Zhou and Yu, 2004). Nowadays, potato has become high yielding carbohydrate enrich vegetable containing phytochemicals and minerals contents throughout the world (Abbasi et al., 2011; Andre, et al., 2007). Furthermore, it is rich in antioxidants such as vitamin C, polyphenols (phenolcarboxylic acids), carotenoids and selenium (Lachman et al., 2006) and α-tocopherol (Kalt, 2005). It is fourth most important food crop worldwide after maize, wheat and rice, with production of more than 325 million tons (Aziz et al., 2012).

There number of investigations expounded that potato containing phytochemicals with high free radical scavenging activity that may helps to reduce the risk of chronic health diseases and age related neuronal degeneration (Teow et al., 2007). It is well documented that principal components of potato that are responsible for antioxidant activity are phenolics such as chlorogenic acid, gallic acid, protocatechuic acid, caffeic acid and quercetin (Rodriguez de Sotillo et al., 1994; Al-Saikhan et al., 1995; Nara et al., 2006). Other phenolics in potato include ferulic acid, p-coumaric acid as well as small amounts of rutin, quercetin, myricetin, kaempferol, naringenin and other flavonoids (Nara et al., 2006). However, red fleshed potato has contained pelargonidin and peonidin-3-rutinoside-5-glycosides acylated with p-coumaric and ferulic acid (Reyes, 2005).

According to phenolics classification, potato is categorized in medium group among different vegetables. Thus, the utilization of potato in a daily diet provides not only nutritive value but also give antioxidants to the body for proper functioning. Earlier, it is reported that red fleshed potatoes has two to three times higher antioxidant activity as measure by various antioxidant assays than that of white fleshed due to synergistic effect of each anthocyanin pigment (Hayashi et al., 2003; Kosieradzka et al., 2004; Łukaszewicz and Szopa, 2005). Considering the above facts regarding potato nutritive value and antioxidant profile, present research project was designed to evaluate the locally grown potato cultivars for their nutritional and antioxidant profiling.
MATERIALS AND METHODS

Procurement of raw materials

Ten potato varieties were collect from the Horticulture Section of Ayub Agricultural Research Institute (AARI) Faisalabad, Pakistan (2007-08). The tubers were stored in the sacks after harvesting from the field. All the potato were cleaned with water manually to remove dust, field trashes, stones, damaged seeds and other foreign matters.

(i) Specific Gravity of potato

The specific gravity was determined as the weight of 10 cleaned tubers both in air (W₁) and completely immersed in a container of water (W₂) were calculated by the following formula (Elfaki and Abbsher, 2010).

\[
\text{Specific gravity} = \frac{W_1}{W_1 - W_2}
\]

Where

\(W_1=\) Wt. of tubers in the air

\(W_2=\) Wt. of tubers in water

Proximate composition

(i) Moisture Contents of potato

The moisture content of flesh and peels of each variety was determined using air forced draft oven at 70±5 °C temperature till the sample weight becomes constant according to the method of AOAC (2006). The moisture was calculated according to the following formula:

\[
\text{Moisture } \% = \frac{\text{Loss in Weight}}{\text{Wt. of fresh sample (g)}} \times 100
\]

(ii) Ash content of potato

The ash content of each sample was determined by incinerating of dry sample in Muffle furnace at a temperature of 550-600°C for 5 to 6 hours by using protocol as described in AOAC (2006). The following formula was used to calculate the ash content.

\[
\text{Ash content } \% = \frac{\text{Loss in ash}}{\text{Wt. of fresh sample (g)}} \times 100
\]

(iii) Crude Protein of potato

The nitrogen present in each sample was estimated by using Kjeldahl’s method as mentioned in AOAC (2001). Sample (5.0 g) was digested with concentrated H₂SO₄ in the presence of digestion mixture (K₂SO₄, CuSO₄, FeSO₄, with 100:10:5 parts respectively). The digested sample was then filtered and volume was made to 250 mL. The 10 mL of diluted sample was distilled with 40% NaOH. Ammonia gas (NH₃) was liberated and absorbed into 4% boric acid which was then titrated with N/10 H₂SO₄ to light pink color as an end point. A factor of 6.25 was applied for the conversion of percent nitrogen into percent crude protein. Following equation was used to calculate % nitrogen:

Crude fat of potato

 Soxtec System (Model: H-2 1045 Extraction Unit, Hoganas, Sweden) was used to determine the crude fat content in potato samples using hexane as a solvent according to the guidelines illustrated in AOAC (2006).

Crude fiber of potato

Crude fiber content of fat free samples was determined by digesting initially with 1.25% H₂SO₄ for 30 min followed by 1.25% NaOH solution for same time in Labconco Fibertech (Labconco Corporation Kansas, USA) apparatus as per procedure described in AOAC (2006).

Antioxidant assays

Sample preparation

The samples were washed, cut into 2 cm slices and steamed at 100 °C for 15 min to prevent browning of flesh. Samples were cooled, cut into 2 cm³ cubes, lyophilized and ground to fine powder. The flour was stored in a polyethylene resealable bag at 4 °C for further analysis.

(i) Total phenolic content of potato

Extraction of phenolic compounds: Five grams of potato flour were mixed with 40 mL methanol for 24 h in orbital shaker at 250 rpm. The resultant suspension was filtered through Whatman No. 1 filter paper and finally diluted to 210 mL with methanol. Sample solutions were stored at 4 °C in amber color media bottles and used for subsequent analyses.

Determination of total phenolic content: Total phenolics of potato sample were estimated through modified method of Slinkard and Singleton (1997). Briefly, two hundred microliters of the sample was added in 1.4 mL distilled water and subsequently 100 L of Folin-Ciocalteu was added. After gentle mixing of 2 min, 300 L of 20% Na₂CO₃ solution was added and resultant adduct was allowed to react

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for 2 h. The absorbance of color mixture was recorded at 765 nm UV–Vis Spectrophotometer. Calibration curve was prepared by using gallic acid solutions (10–400 µg/mL). Results were expressed as mg gallic acid/100g fresh sample

(ii) DPPH radical scavenging activity of potato

DPPH radical scavenging activity of potato extracts was determined using the method described by by Huang et al. (2005b). Sample (1 mL) was mixed with same volume of methanolic DPPH solution (0.0012M). The mixture was kept for 30 min under dark place for the completion of reaction. Free radical scavenging activity of the potato was measured by recording the absorbance of reaction mixture at 517 nm using UV–Vis Spectrophotometer. Percent inhibition was calculated using the following equation.

Inhibition (%) = \[100 \times \left(\frac{A_{\text{blank}} - A_{\text{sample}}}{A_{\text{blank}}}\right)\]

(iii) ABTS reducing activity assay of potato

For the estimation of ABTS assay, Pennycooke et al., (2005) protocol was used. The weighted quantity (54.2 mg) of ABTS was dissolved in 5mM phosphate buffer (pH 7.0) and activated its radical activity by addition of 1 g of MnO\(_2\) with infrequent stirring and time of activation 30 min. The resulted adduct was centrifuged at 7000g for 5 min and passed through filtrate having pore size 25 μm. Afterwards, solution was diluted with phosphate buffer for adjusting the absorbance at 0.700 ± 0.01. Sample (5 mL) was added and stay for reaction completion for 20 min. Absorbance of the solution was recorded at 734 nm.

(iv) Reducing power of potato

Fe-reducing power of the potato was estimated by following the method described by Singh and Rajini (2004). One milliliter of 0.2 M phosphate buffer having pH 6.6 and 1 mL of 1% (w/v) K\(_3\)Fe(CN)\(_6\) were mixed with 1 mL aliquot of the extract. The resultant mixture was incubated for 20 min at 50 °C. Thereafter, 1 mL trichloroacetic acid (10%, w/v) was added to the mixture. The resulting adduct was centrifuged at 3000 rpm for 10 min at 25°C. One mL of supernatant was mixed with same volume of distilled water and 0.2 mL of 0.1% (w/v) FeCl\(_3\) solution. The absorbance was read at 700 nm using 1 UV–Vis Spectrophotometer. Standard curve was plotted by determining the reducing power of α-tocopherol (20–100 ppm).

Statistical analysis

The data obtained for each parameter were subjected to statistical analysis using Completely Randomized design (CRD) technique and level of significance was determined by using least student according to the methods described by Steel et al. (1997).

RESULTS AND DISCUSSION

Moisture content of potato

The mean values for moisture content in the flesh of different potato varieties in Table 1 showed significant variations. The results showed that FD1-8 (82.37%) had the highest moisture content in the flesh of potato while FD40-10 (77.5%) had lowest moisture content. The SH-5, FD35-36 and FD8-3 had almost the same moisture contents and Diamant, FD 40-10 and FD19-2 exhibited the statistically at par moisture contents. The results of present investigation is in accordance with the earlier findings of Sotelo and Serrano, (2000), they reported that the moisture of various tested potato are in ranged of 82 to 87%. Later, Naz et al. (2011) documented that Pakistani potato contained 73.17 to 81.44% moisture content grown in Abbottabad. One of their peers, Abbasi et al. (2011) evaluated the six verities of potato cultivated in district Okara and reported the moisture content ranged from 74.15 to 77.05%.

Ash content of potato

The results revealed that the ash content varied significantly among different potato varieties. The maximum ash content was observed in SH-5 (1.66%), followed by Diamant (1.62%) and FD 1-8 (1.62%) whilst the lowest content was noticed in FD 19-2 (1.46%) that are statistically equivalent to FD 35-36 (Table 1).

The present study results are in harmony with the earlier findings of Abbasi et al. (2011), they expounded that the ash content of potato grown in district Okara varied from 1.89 to 3.30%. Similarly, Naz et al. (2011) reported ash content of different Pakistani potato cultivars that differed from 3.67 to 5.18% on dry weight basis. Earlier, Javid et al. (1995) investigated the proximate composition of Diamant, Cardinal, Lale-e-Faisal and Desir. They reported that ash content was varied from 1.0 to 2.0% in tested potato cultivars.

The differences in ash content among potato cultivars attributed might be due to their genotype. It has been reported that ash content of potato varieties also influenced by non-genetic factors like soil, climatic conditions and use of fertilizer etc. (Abbasi et al., 2011).

Crude Protein of potato
Specific gravity of a potato is directly proportional to its starch concentration. The perusal of the results inferred that the specific gravity varied significantly among potato cultivars from 1.22 to 1.05 (Table 1). The results showed that maximum specific gravity was found in FD40-10 (1.22) while lowest were exhibited by Diamant (1.05). Earlier, Abbasi et al. (2011) investigated six cultivars of potato for their physic-chemical analysis and reported that specific gravity of tested cultivars were in the range of 1.081 to 1.01.

**Antioxidant activity of potato**

The total phenolic content of selected potato cultivars were expressed as mg gallic acid equivalent (GAE)/100g fresh weight (FW) and presented in Table 2. The tested potato cultivars showed significantly ($P < 0.05$) differences among each other in terms of total phenolic contents. Total phenolic content of potato are in ranged from 17.8±0.81 to 34.0±1.65mg GAE/100g FW. Among the potato cultivars, FD 8-3 (34.0±1.65mg GAE/100g FW) exhibited maximum total phenolic contents followed by Cardinal (31.2±1.34mg GAE/100g FW) whereas, minimum value was observed in FD 19-2 (17.8±0.81mg GAE/100g FW). This variations may be endorsed to genotypes and harvest location that influence the accumulation of phenolic compounds by synthesizing different quantities and/or types of phenolics (Lachman et al., 2008; Sule et al., 2008). Earlier, Karadeniz et al. (2005) reported that the phenolic content of potato are 32.44 ± 6.07 mg GAE/100 g. Previously, Al-Saikhan et al. (1995) also delineated that potato contains 11.41–27.47 mg GAE/100 g total phenolic contents. In contrary, Kaur and Kapoor (2002) and Vinson et al. (1998) documented higher total phenolic contents as 231.46 ± 9.73 mg GAE/100g FW and 100.37 ± 66.35 mg GAE/100g FW, respectively compared to the present study results. Generally, it is consider that edible part of potato accounts 40% of the total phenolic content (Chu et al., 2002), while amount of conjugated phenolics in potato is 57.9±13.4% (Vinson et al., 1998). The tendency of phenolic compounds to accumulate in the peel is cause of low-phenolic content in the flesh of potato (Reyes, 2005; Nara et al., 2006).

**DPPH radical scavenging activity**

The mean pertaining to DPPH radical scavenging activity exhibited the maximum value (37.54±1.67%) for FD 8-3 followed by Cardinal (34.98±1.73%), whereas FD 19-2 showed minimum value 19.86±0.99% inhibition. Previously, it was investigated that the radical scavenging activity of the
Table 1: Proximate composition and specific gravity of some selected potato cultivars

<table>
<thead>
<tr>
<th>Potato Cultivar</th>
<th>Moisture</th>
<th>Ash</th>
<th>Crude protein</th>
<th>Crude fat</th>
<th>Crude fiber</th>
<th>Specific gravity</th>
</tr>
</thead>
<tbody>
<tr>
<td>SH-5</td>
<td>81.64±2.61B</td>
<td>1.66±0.008A</td>
<td>2.477±0.012BC</td>
<td>1.21±0.005</td>
<td>2.33±0.011</td>
<td>1.22±0.005A</td>
</tr>
<tr>
<td>Diamant</td>
<td>77.75±2.01BC</td>
<td>1.62±0.007B</td>
<td>2.477±0.011AB</td>
<td>1.89±0.006</td>
<td>2.47±0.012</td>
<td>1.16±0.004AB</td>
</tr>
<tr>
<td>Cardinal</td>
<td>79.9±2.22B</td>
<td>1.58±0.007C</td>
<td>3.533±0.016A</td>
<td>1.16±0.006</td>
<td>2.45±0.010</td>
<td>1.16±0.004AB</td>
</tr>
<tr>
<td>FD 35-36</td>
<td>81.32±2.76BC</td>
<td>1.49±0.006CI</td>
<td>3.062±0.015AB</td>
<td>1.29±0.004</td>
<td>2.35±0.011</td>
<td>1.15±0.004AB</td>
</tr>
<tr>
<td>FD 8-3</td>
<td>81.51±2.45BC</td>
<td>1.57±0.007CI</td>
<td>3.062±0.014AB</td>
<td>1.45±0.005</td>
<td>2.41±0.010</td>
<td>1.14±0.007BC</td>
</tr>
<tr>
<td>FD 8-1</td>
<td>79.5±2.16D</td>
<td>1.53±0.007CI</td>
<td>2.037±0.012C</td>
<td>1.65±0.005</td>
<td>2.55±0.012</td>
<td>1.13±0.003BC</td>
</tr>
<tr>
<td>FD 40-10</td>
<td>77.5±2.00BC</td>
<td>1.52±0.008B</td>
<td>3.207±0.014AB</td>
<td>1.88±0.006</td>
<td>2.66±0.013</td>
<td>1.13±0.003BC</td>
</tr>
<tr>
<td>FD 1-8</td>
<td>82.37±2.53A</td>
<td>1.62±0.007B</td>
<td>2.185±0.013D</td>
<td>1.34±0.005</td>
<td>2.12±0.010</td>
<td>1.12±0.004BC</td>
</tr>
<tr>
<td>FD 19-2</td>
<td>77.8±2.26C</td>
<td>1.46±0.006C</td>
<td>3.062±0.014AB</td>
<td>1.78±0.006</td>
<td>2.56±0.012</td>
<td>1.08±0.002CD</td>
</tr>
<tr>
<td>FD 3-9</td>
<td>81.14±2.47B</td>
<td>1.55±0.007CD</td>
<td>2.185±0.013C</td>
<td>1.44±0.004</td>
<td>2.15±0.010</td>
<td>1.05±0.002CD</td>
</tr>
</tbody>
</table>

Letter containing different letter in a column varied significantly

Table 2: Antioxidant potential of some selected Pakistani potato cultivars

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Total phenolic content (mg of GAE/100gram of FW)</th>
<th>DPPH (% inhibition)</th>
<th>FARP (mg ascorbic acid/100g FW)</th>
<th>ABTS* (mg ascorbic acid/100 FW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SH-5</td>
<td>24.0±1.10C</td>
<td>26.43±1.32C</td>
<td>46.09±1.99C</td>
<td>57.12±2.77C</td>
</tr>
<tr>
<td>Diamant</td>
<td>21.3±1.07C</td>
<td>22.67±1.12C</td>
<td>42.45±2.01C</td>
<td>51.33±2.45C</td>
</tr>
<tr>
<td>Cardinal</td>
<td>31.2±1.34B</td>
<td>34.98±1.73B</td>
<td>51.23±2.34B</td>
<td>62.25±3.01B</td>
</tr>
<tr>
<td>FD 35-36</td>
<td>26.7±1.30C</td>
<td>29.34±1.40C</td>
<td>47.76±2.12C</td>
<td>59.51±2.78C</td>
</tr>
<tr>
<td>FD 8-3</td>
<td>34.0±1.65A</td>
<td>37.54±1.67A</td>
<td>56.32±2.76A</td>
<td>69.61±3.13A</td>
</tr>
<tr>
<td>FD 8-1</td>
<td>19.9±0.99CD</td>
<td>22.13±1.01CD</td>
<td>41.91±2.10CD</td>
<td>49.21±2.19CD</td>
</tr>
<tr>
<td>FD 40-10</td>
<td>20.1±0.91CD</td>
<td>23.87±1.11CD</td>
<td>45.85±2.09CD</td>
<td>53.73±2.51CD</td>
</tr>
<tr>
<td>FD 1-8</td>
<td>18.5±0.89D</td>
<td>22.03±1.10D</td>
<td>42.37±1.99D</td>
<td>51.03±2.43D</td>
</tr>
<tr>
<td>FD 19-2</td>
<td>17.8±0.81D</td>
<td>19.86±0.99D</td>
<td>37.49±1.78D</td>
<td>45.44±2.07D</td>
</tr>
<tr>
<td>FD 3-9</td>
<td>22.7±1.09C</td>
<td>26.37±1.22C</td>
<td>47.55±2.22C</td>
<td>57.52±2.55C</td>
</tr>
</tbody>
</table>

Letter containing different letter in a column varied significantly

potato sample (on a g phenolic content basis), is higher than that of α-tocopherol (Lee et al., 2004), which accounts for its higher-EC50 value. There is evidence that hydrogen abstraction is only a marginal pathway in the reaction between antioxidant and DPPH (Prior et al., 2005).

**ABTS reducing activity assay**
The mean pertaining to ABTS ranged from 69.61±3.12 to 45.44±2.07 mg ascorbic acid/100 FW in tested potato cultivars. The maximum value for ABTS 69.61±3.12 mg ascorbic acid/100 FW was observed in FD 8-3 followed by Cardinal 62.25±3.01 mg ascorbic acid/100 FW however FD 19-2 showed the minimum value 45.44±2.07 mg ascorbic acid/100 FW.

Earlier, it is proven that color of flesh has significant influence on antioxidant activity of the potato. Moreover, the red potato has higher antioxidant activity which is investigated through ABTS than that of white and yellow-fleshed. The red fleshed potato has more antioxidant activity (359.38 mg ascorbic acid Eq/kg of FW) that is four time higher than yellow or white fleshed cultivars (82.83 mg ascorbic acid Eq/kg FW). The variations among the tubers antioxidant activity was might be due to colored potato flesh that contained varying quantity of anthocyanin (Lachman et al. 2008, 2009).

**Reducing power of potato**
The value of FRAP among all the selected potato cultivars ranged from 56.32±2.76 to 37.49±1.78 mg ascorbic acid/100g FW. The cultivar FD 8-3...
expressed the maximum value of FRAP (56.32±2.76 mg ascorbic acid/100g FW) followed by Cardinal (51.23±2.34 mg ascorbic acid/100g FW). However, the FD 19.2 exhibited minimum value of FRAP (37.49±1.78 mg ascorbic acid/100g FW).

Previously, it was expounded that the activity of ethnicolic and aqueous potato extract has activity 62.3% and 62.5%, respectively (Kaur and Kapoor, 2002). Afterwards, Karadeniz et al. (2005), reported similar activity (70%) of the potato extracts 70% for same sample weight. Numerous investigations reported that potato has applicable amount of antioxidant that possess significant inhibition ability (Al-Saikhan et al. 1995; Karadeniz et al., 2005).

CONCLUSIONS
The proximate composition indicated that potato contained crude protein (2.037 to 3.062%), crude fat (1.16 to 1.89%), crude fiber (2.12 to 2.66%) and ash (1.46 to 1.66%). Nonetheless, specific gravity values were varied from 1.05 to 1.22. The antioxidant assays revealed that the maximum total phenolic contents, DPPH inhibition, FARP and ABTS values of tested ten potato cultivars were noticed in FD 8-3, followed by Cardinal however the minimum values of aforementioned parameters were recorded in FD 19-2.

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