RESEARCH

ANTIOXIDANT CAPACITY AND TOTAL PHENOLIC COMPOUNDS OF TWELVE SELECTED POTATO LANDRACE CLONES GROWN IN SOUTHERNCHILE

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Colored potatoes (*Solanum tuberosum* L.) provide a natural source of phytochemicals that help reduce the risk of diseases. However, there is a lack of information on the degree of variation of the antioxidant activity and polyphenolic contents of these native potatoes. Thus, the antioxidant activity (AA) and total phenolic content (TPC) of native Chilean potatoes were determined. Twelve potato landrace clones collected from established cultivations on Chiloe Island and Valdivia were selected. Total phenolic content and AA were compared with two commercial varieties, Shepody and Desirée. Total phenolic content was determined by the Folin-Ciocalteu method, and β-carotene bleaching was used to compare AA. The TPC varied in the peeled potato samples from 191 to 1864 mg 100 g^{-1} DM meanwhile these parameters varied from 345 to 2852 mg 100 g^{-1} DM in unpeeled samples. Antioxidant activity was higher in unpeeled potatoes, and was the highest in the unpeeled NG-6 or 'Bruja' native potato. The commercial var. Shepody showed pro-oxidant activity and had a relatively lower TPC. Results also indicated a higher concentration of total phenolics in the periderm of the colored native Chilean potatoes.

Key words: Chilean potatoes, *Solanum tuberosum*, antioxidant activity, total phenolics, Folin-Ciocalteu, β-carotene.

The most widely cultivated variety of potato tubers, *Solanum tuberosum* Group Tuberosum, is indigenous to southern Chile. The cultivated genotypes on Chiloe Island show a wide variability in tuber shape, flesh and skin color, and flavor, as well as in storage and cooking quality. Published data on the degree of variation of antioxidant activity or phenolic content of these native potatoes is not known. As indicated by various studies, colored potatoes provide a natural source of phytochemicals such as carotenoids, phenolic compounds, flavonoids, and anthocyanins (Lewis *et al*., 1998a; 1998b; Reyes and Cisneros-Zevallos, 2003; Reyes *et al*., 2004) that help reduce the risk of chronic diseases, including cancer, age-related neuronal degeneration, or cardiovascular diseases (Ames *et al*., 1993; Hercberg *et al*., 1998; Velioglu *et al*., 1998; Tamimi *et al*., 2002).

The health-promoting effects of potatoes are also very promising for humans since a recent study showed that the consumption of unpeeled cooked potatoes improves the lipid metabolism and antioxidant status in cholesterol-fed rats (Robert *et al*., 2006). Yellow-orange pigmented potatoes usually have high carotenoid contents, such as lutein, zeaxanthin, violaxanthin, and antheraxanthin (Brown, 2005; Andre *et al*., 2007). They are present in different proportions depending on the genotype and on storage conditions. Phenolic compounds, such as anthocyanins, are found in red-, blue-, or purple-fleshed potatoes (Brown, 2005). These include polyphenol, monohydric phenol, coumarin, flavonoid, tannin, and lignin (Lisinska and Leszczynski, 1989). Phenolic compounds such as chlorogenic, ferulic, caffeic, protocatechuic, and p-coumaric acids have been identified in red- or purple-fleshed potatoes (Lewis *et al*., 1998a). There are also small amounts o flavonoids such as rutin, quercetin, myricetin, naringenin, and kaempferol (Lewis *et al*., 1998b; Rodriguez-Saona *et al*., 1998; Reyes *et al*., 2005). The presence of these metabolites suggests that purple- and red-fleshed potatoes can be natural colorants or antioxidant sources for the food industry; however, a rigorous selection of genotypes with high antioxidant levels is needed. Phenolic acids, mainly chlorogenic acids, can consist of up to 90% of the total polyphenol content

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in potatoes (Andre *et al*., 2007). Phenolic compounds are mostly distributed between the potato cortex and skin (peel) tissues (Friedman, 1997). About 50% of the phenolic compounds are located in the potato peel and adjoining tissues, while the rest decrease in concentration from the outside toward the center of potato tubers (Hasegawa *et al*., 1966).

In order to assess the condition of native Chilean potatoes, the main objective of this study was to examine some native colored potatoes from Chiloe Island for their total phenolic contents. Moreover, their antioxidant activity was also compared. The acquired information would serve as a criterion for selecting germplasm among native Chilean potatoes. For purposes of comparison, two commercial potato varieties commonly sold in local Chilean markets were selected as references.

MATERIALS AND METHODS

Plant materials and sample preparation

Twelve native Chilean potato genotypes were collected from established cultivations on Chiloe Island and at the Faculty of Agricultural Sciences, Universidad Austral de Chile, Valdivia, Chile. Shepody and Desirée, two commercial varieties, were purchased in local markets in Valdivia, to be used as references for purposes of comparison. The selected native potatoes are tetraploid and maintained as part of a germplasm collection of Chilean potatoes at the Universidad Austral de Chile (Contreras, 1987; Contreras and Castro, 2008). Identifier codes of the potato samples are given beside the traditional names in Table 1. Potato samples were all fresh and free of mechanical or physiological damage, and kept in the dark at 4 °C for a maximum period of 48 h until analyzed. Samples were then divided into two groups, peeled or unpeeled. For the peeled samples, about 1 to 2 mm layer of skin was carefully removed with a knife as it is usually done in any household. Samples were cut into small pieces and washed thoroughly with distilled water and wiped with tissue paper to remove any adhering moisture. Samples were then kept frozen in labeled polyethylene bags and freeze-dried at -55 °C in a vacuum (5 mm Hg) for 36 h. All operations during sample preparation were performed very quickly by freeze-drying so as to avoid sample degradation. After freeze-drying and stabilization in a dessicator, samples were pulverized in a laboratory grinder. The cutting of samples was performed in a laboratory in an area especially adapted to give extra protection from sunlight with lightproof curtains. Frozen samples were kept at -20 °C until analyzed. Care was taken to follow the same procedure for all samples, especially exposure time and elapsed time until analysis. Moisture content of all the samples was determined by a gravimetric standard method with a vacuum oven (Memmert UL 80, Büchenbach, Germany) and an analytical balance with an accuracy of ± 0.0001 g (Sartorius A200-CP224 S, Göttingen, Germany). All methodologies followed the recommendations of the Official Method of Analysis (AOAC, 1990) and all analyses were triplicated.

Table 1. Total phenolic (TPC) and dry matter content in peeled native Chilean potatoes.

Potato samples Identifier code (traditional name)	TPC content		Dry matter content
	mg 100 g^{-1} DM	mg kg^{-1} sample	%
Shepody	192 ± 26a	565 ± 80a	29.39 ± 0.98fg
Desirée	302 ± 31b	665 ± 63a	22.06 ± 1.52ab
457-CON-1157 (-)	191 ± 25a	630 ± 72a	33.06 ± 0.70h
254-CON-902 (Corazón de buey)	409 ± 41c	1248 ± 134bc	30.50 ± 0.55g
302-UA-1634A (-)	465 ± 56cd	1221 ± 161bc	26.26 ± 0.53cde
304-UA-1135 (-)	487 ± 34d	1177 ± 103b	24.15 ± 0.63bc
267-UA-1550 (Boyo de chancho)	506 ± 40de	1241 ± 112bc	24.53 ± 0.51cd
NG-85 (Michuñeroja)	529 ± 36de	1365 ± 104c	25.81 ± 0.83cde
NG-71 (Meca de gato)	563 ± 61ef	1564 ± 178d	27.71 ± 0.65def
283-UA-1108 (Cacho azul)	629 ± 65fg	1304 ± 108bc	20.81 ± 1.19a
301-UA-1500 (Corazón azul)	668 ± 64gh	1708 ± 144d	25.59 ± 0.78cd
239-UA-1388 (-)	733 ± 85h	2045 ± 186e	27.99 ± 1.28ef
NG-5 (Chona negra)	945 ± 88i	2560 ± 270f	27.07 ± 1.16f
NG-6 (Bruja)	1864 ± 129j	4757 ± 273g	25.55 ± 0.83g

Means in a column with similar letters are not significantly different (P < 0.05).

Determining total phenolic content

Total phenolic compounds were determined by the Folin-Ciocalteu photo-colorimetric method (Velioglu *et al*., 1998). A freeze-dried sample (200 mg), weighed accurately to 0.1 mg on an analytical balance (Sartorius A200-CP224 S, Göttingen, Germany), was mixed with 2 mL of an aqueous solvent of 80% methanol acidified with 1% HCl to extract the phenolic compounds. Protected from sunlight, the mixture was homogenized in a horizontal shaker (Shaker ZHWY 334 Zhicheng, Shanghai, China) at 200 rpm for 2 h at room temperature. The liquid phase was separated with a Büchner funnel, a vacuum pump, and Whatman N° 5 filter paper. The filtrate was then centrifuged (Mini centrifuge, model 14, Denver Instrument Company, Denver, USA) in 2.5 mL Eppendorf tubes for 15 min at 7000 rpm. The supernatant was kept in dark glass vials from which an aliquot of 100 µL was taken and mixed in a test tube with 750 µL Folin-Ciocalteu reagent and left to stand for 5 min. Next, 750 µL of aqueous sodium bicarbonate solution (60 g L^{-1}) was added and the mixture was allowed to stand for 90 min in the dark at a controlled temperature of 22°C. Absorbance was measured at 725 nm with a UV-visible spectrophotometer (Spectrophotometer 300 Array, UV-Vis, single beam, Milton Roy, Ivyland, USA) and compared to a standard curve of ferulic acid (0, 50, 100, 150, 200, and 250 mg L^{-1}) to calculate total phenolics based on ferulic acid equivalents. All samples were assayed in quadruplicate.

Determination of antioxidant activity

Antioxidant activity of the potato extracts was evaluated by the β-carotene bleaching method as modified by Marco (1968) and described by Velioglu *et al*. (1998). A freeze-dried sample (250 mg), weighed accurately to 0.1

mg, was extracted eight times with 6.25 mL of an aqueous solvent of 80% methanol (with 0.01 g HCl 100 g^{-1} to prevent degradation) in a dark glass vial and homogenized in a horizontal shaker (Shaker ZHWY 334 Zhicheng, Shanghai, China) at 200 rpm at room temperature (15 min). The liquid phase was separated with a Büchner funnel, a vacuum pump, and Whatman N° 5 filter paper. All supernatants were combined. Antioxidant activity was immediately determined with aliquots of the filtrate (0.2 mL). In round-bottomed flasks, 1 mL of β-carotene solution (Sigma Chemical Co., St. Louis, Missouri, USA) and 0.2 mg mL^{-1} chloroform were mixed with 0.02 mL linoleic acid (J. T. Baker Chemical Co., Phillipsburg, New Jersey, USA) and 0.2 mL of Tween 20 (BDH Chemicals, Toronto, Canada). The mixture was then dosed with 0.2 mL of 80% methanol as a control or 0.2 mL of the potato extracts. After evaporation in a vacuum in a dark room, 50 mL of oxygenated deionized water was added and the mixture was shaken before being exposed to thermal oxidation at 50 °C. Absorbance was then measured at 470 nm at 10-min intervals for 2 h.

Antioxidant activity (AA) of phenolic compounds was expressed as percent inhibition with regard to a control with Equation [1], similar to the one Al-Saikhan *et al*. (1995) used, but with a modified bleaching rate R_t, which was calculated in accordance with first order kinetics as described in Equation [2]:

$$AA = \frac{R_c - R_s}{R_c} \cdot 100 \qquad [1]$$

where R_c and R_s are the β-carotene bleaching rate for the control and sample, respectively;

$$(A_t - A_{120}) = (A_0 - A_{120}) \exp(-R_t t) \qquad [2]$$

where A_0, A_{120}, and A_t are absorbance at time 0, 120, and t min, respectively. Calculation of R_t for the control or sample considered absorbance at 120 min to be an equilibrium value so that the modified bleaching rate is related to an absorbance ratio based on the difference between initial and equilibrium absorbance.

Statistical analysis

Total phenolics were analyzed in quadruplicate on 15 tubers of each genotype. Values are expressed as means ± standard deviation. Statistical analysis was performed with Stat Graphics Plus 5.1 (Statistical Graphics Corp., Herndon, Virginia, USA). Tukey's Honestly Significant Difference test was applied and the relevant minimum significant difference at a 95% confidence interval ($P < 0.05$) to compare the significance of differences in means among potato samples. The coefficient of determination (R^2) showed the correlations between total phenolics and antioxidant activity.

RESULTS AND DISCUSSION

Total phenolic content

Typical phenolics with antioxidant activity are mainly phenolic acids and flavonoids, which are the major classes of phenolic compounds widely found in fruits and vegetables (Wojdylo *et al*., 2007). Total phenolic content (TPC) of the potato samples is shown in Tables 1 and 2. Dry matter content of the peeled and unpeeled samples is also given as a percentage of the fresh product since water content of the potato samples showed significant differences at $P < 0.05$. Total phenolic content in the peeled potato sample varied from 565 ± 80 mg kg^{-1} in the commercial var. Shepody to 4757 ± 273 mg kg^{-1} in the genotype NG-6 sample (traditionally known as 'Bruja'). In unpeeled potato samples, var. Shepody also had the lowest TPC and genotype 'Bruja' had the highest with 763 ± 91 and 7486 ± 411 mg kg^{-1}, respectively. Genotype 457-CON-1157 (from the Guaitecas Archipelago) had a TPC that was not significantly different at $P < 0.05$ than the two commercial varieties. It has red skin, similar to 'Desirée', but pale red pulp of the vascular ring. As a peeled sample, its TPC did not differ from 'Shepody'. Significant differences in TPC at $P < 0.05$ can be observed among the native potatoes; the 'Bruja' genotype showed an outstanding TPC at almost tenfold the commercial var. Shepody. Second on the list was genotype NG-5 (traditionally known as 'Chona negra') with about five times more TPC than 'Shepody'. In all cases, TPC in unpeeled potato samples are higher than in peeled samples, showing clearly that TPC is accumulated in the skin tissue. Similar results were also obtained by Al-Saikhan *et al*. (1995), Reyes *et al*. (2005), and Nara *et al*. (2006). According to Nara *et al*. (2006), TPC in the flesh and skin have different compositions. They can be in a free or bound form. Chlorogenic acid and caffeic acid are the phenolic free forms reported in potatoes (Friedman, 1997; Kanatt *et al*., 2005), while ferulic acid and p-coumaric acid are the bound forms that are ester-linked to the cell wall polysaccharides of several plants (Fry, 1986). Nara *et al*. (2006) found that the free form of phenolics predominates over the bound form in both skin tissue and flesh (Table 3). The native Chilean potato

Table 2. Total phenolic (TPC) and dry matter content in unpeeled native Chilean potatoes.

Potato samples	TPC content		Dry matter content
	mg 100 g^{-1} DM	mg kg^{-1} sample	%
Shepody	260 ± 30a	763 ± 91a	29.34 ± 0.76gh
Desirée	352 ± 19a	821 ± 67a	23.30 ± 1.04ab
457-CON-1157	345 ± 19a	1141 ± 81g	33.08 ± 0.87i
267-UA-1550	560 ± 52b	1432 ± 129f	25.55 ± 0.29cd
302-UA-1634A	571 ± 55b	1491 ± 159f	26.10 ± 0.55cde
254-CON-902	601 ± 48b	1855 ± 145f	30.86 ± 0.61h
304-UA-1135	726 ± 66c	1755 ± 153e	24.20 ± 0.27bc
NG-71	745 ± 41c	2061 ± 108e	27.55 ± 0.51efg
301-UA-1500	780 ± 84cd	2011 ± 212de	25.78 ± 0.55cde
NG-85	844 ± 74de	2305 ± 188cd	27.33 ± 0.83defg
239-UA-1388	850 ± 60de	2428 ± 196cd	28.57 ± 1.09g
283-UA-1108	879 ± 74e	1865 ± 189c	21.19 ± 1.19a
NG-5	1304 ± 82f	3684 ± 315b	28.24 ± 1.65fg
NG-6	2852 ± 202g	7486 ± 411a	26.29 ± 1.08cdef

Tukey's HSD test: Means in a column with similar letters are not significantly different ($P < 0.05$).

Table 3. Comparison of total phenolic content (TPC) in some varieties of potatoes as found in the literature.

Potato genotype or variety	Equivalent acid to calculate TPC	TPC		References
		mg kg^{-1} fresh product	mg 100 g^{-1} DM	
Yukon gold	Chlorogenic	237.7	82[1]	Al-Saikhan *et al*. (1995)
Granola	Chlorogenic	407.0	140[1]	Al-Saikhan *et al*. (1995)
Russet Norkotah	Chlorogenic	527.2	182[1]	Al-Saikhan *et al*. (1995)
Viking	Chlorogenic	369.1	127[1]	Al-Saikhan *et al*. (1995)
Purple potato	Ferulic	-	781	Velioglu *et al*. (1998)
Russet Burbank	Ferulic	-	437	Velioglu *et al*. (1998)
All Blue	Chlorogenic	Flesh: 125 ± 11	Flesh: 43 ± 38[1]	
		Peel: 256 ± 18	Peel: 88 ± 62[1]	Reyes *et al*. (2005)
NDC4069-4	Chlorogenic	Flesh: 116 ± 14	Flesh: 40 ± 48[1]	
		Peel: 225 ± 11	Peel: 78 ± 381	Reyes *et al*. (2005)
Toyoshiro	Ferulic	-	Flesh: 168 (free)	
			Peel: 366 (free)	Nara *et al*. (2006)
			Flesh: 2 (bound)	
			Peel:126 (bound)	Nara *et al*. (2006)
Valfi	Gallic	-	481	Lachman *et al*. (2008)
Violette	Gallic	-	455	Lachman *et al*. (2008)
Shetland Black, location Valečov	Chlorogenic	-	99.0	Hejtmánková *et al*. (2009)
Vitelotte, location Stachy	Chlorogenic	-	762.4	Hejtmánková *et al*. (2009)

[1]Value calculated based on a dry matter content mean of 29% in fresh product.

genotypes have an above average TPC compared with other potatoes found in the literature (Table 3). Al-Saikhan *et al*. (1995) mentioned that potatoes are high in phenolic compounds ranging from 530 to 1770 mg kg^{-1}: however, they did not specify if it is based on fresh weight or DM. In many cases, TPC is expressed as chlorogenic acid equivalents. This is common in research since the free soluble phenols are determined using methanol, ethanol, and acetone either separately or mixed (Kahkonen *et al*., 1999; Bonoli *et al*., 2004). Since ferulic acid was used to quantify TPC in this study, only a relative comparison with literature data can be drawn. However, compared with Purple and Russet Burbank potatoes (Table 3) analyzed by Velioglu *et al*. (1998), a similar TPC level is found in 10 of the unpeeled native Chilean potatoes (Table 2). Purple potato TPC amounted to 781 mg 100 g^{-1} DM, while its content varied between 345 and 879 mg 100 g^{-1} DM in unpeeled Chilean potatoes; this indicates that two native Chilean potato genotypes have a remarkably high TPC. Values of 1304 ± 82 mg 100 g^{-1} DM and 2852 ± 202 mg 100 g^{-1} DM were obtained for the native genotypes 'Chona negra' and 'Bruja', respectively. In the unpeeled state, the commercial var. Desirée, red skin and pale yellow flesh, has a TPC of 352 mg 100 g^{-1} DM compared with 260 mg 100 g^{-1} DM in the commercial var. Shepody, which has a smooth to lightly netted white skin and white flesh. In peeled state, 'Desirée' had a TPC of 302 ± 31 mg 100 g^{-1} DM and 'Shepody' only 192 ± 26 mg 100 g^{-1} DM. The other native Chilean potatoes also had a lower TPC in the peeled state, which is consistent with the results obtained by Nara *et al*. (2006). Most of the total phenolics are found in the peel in a free or bound form (Table 3). The potato var. Vitelotte analyzed by Hejtmánková *et al*. (2009) showed high TPC in this respect and was similar to the Purple potato of Velioglu *et al*. (1998) along with three of the Chilean potato genotypes shown in Table 2. Moreover, Onyeneho and Hettiaachchy (1993) evaluated the ability to prevent soybean oil oxidation of freeze-dried extracts taken from the peels of six potato varieties. They found that the peels from red potatoes contained greater amounts of polyphenols than those from brown-skinned varieties. Rodriguez de Sotillo *et al*. (1994a; 1994b) also found high amounts of phenolic compounds in potato peels and confirmed the strong antioxidant activity of freeze-dried extracts of potato peel waste in sunflower oil. These findings therefore suggest the possible value of the potato peel in the prevention of oxidative rancidity of food oils.

Antioxidant capacity

Antioxidant activity was determined in four of the native Chilean potato genotypes and in the two commercial varieties. Selection of the four samples was based on previous field studies as well as for the intense red, dark purple, and pink color. The 'Bruja' sample is a round-shaped potato with deep eye buds, dark purple periderm, and dark purple medulla with small yellow spots or flecks. The 301-UA-1500 ('Corazón azul') sample is also round-shaped potato with deep eye buds, red purplish skin, and predominantly red purplish medulla with a white and red purplish cortex. The 267-UA-1550 ('Boyo de chancho') sample is a curved oblong shaped potato with shallow to deep yellow eye buds, dark purple skin color, and yellow medulla with an irregular distribution of purple pigmentation that becomes more intense towards the stem end. The 239-UA-1388 sample has no traditional name, is round-shaped potato with very deep eye buds, a mainly pink periderm with a secondary creamy yellow color, and pink medulla with some creamy yellow flecks.

The β-carotene bleaching method was used whereby the antioxidant activity is measured by a compound's ability to minimize β-carotene loss during the simultaneous oxidation of linoleic acid and β-carotene in

an emulsified aqueous system. This method is rapid and simple and can be used to compare the antioxidant activity of compounds with different structures (Fukumoto and Mazza, 2000). The reaction is initiated with heat at 50 °C. Figure 1 shows the decrease in β-carotene absorbance in the different methanolic potato extracts caused by β-carotene and linoleic acid oxidation. The curves show a logarithmical tendency that is confirmed by the straight line graph in Figure 2 where the natural logarithm of modified bleaching rate (R_t) is plotted against reaction or incubation time. The gradient of the curve in Figure 1 indicates the β-carotene oxidation rate and shows that after any reaction time t (0 to 120 min), sample 'Bruja'

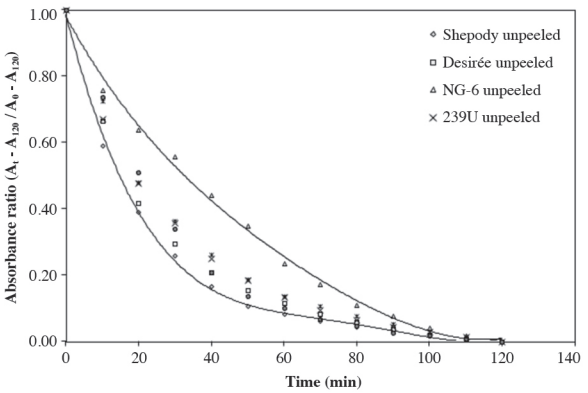

Figure 1. Antioxidant activity of two commercial potato varieties and unpeeled native Chilean potatoes genotypes assayed by the β-carotene bleaching method.

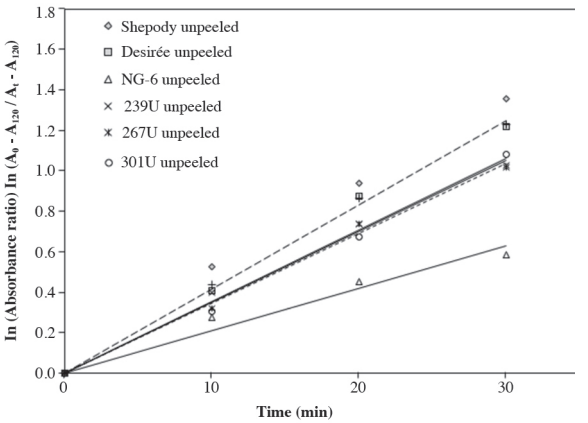

Figure 2. β-Carotene bleaching rate at 50 °C on native Chilean potato extracts.

or NG-6 have a stronger retarding effect on β-carotene oxidation than the 'Shepody' sample. High coefficients of determination R^2 were obtained in all cases for variation of absorbance with reaction time (Table 4). The unpeeled 'Bruja' genotype showed the highest antioxidant activity. The peeled commercial var. Shepody exhibited the lowest antioxidant activity. With regard to the control, it even showed a pro-oxidant activity, which may be due to the antagonist effect of phenolic compounds. According to Peyrat-Maillard *et al*. (2003) and Samotyja and Malecka (2007), antagonism has been observed between α-tocopherol and caffeic acid, between catechin and caffeic acid, or between caffeic acid and quercetin. These phenolics are known to occur in potatoes (Friedman, 1997; Kanatt *et al*., 2005). It is also known that compounds with antioxidant activity can exhibit pro-oxidant behavior under certain conditions (Fukumoto and Mazza, 2000). Ascorbic acid, a potato component, showed pro-oxidant activity at a concentration of 0.320 mg mL^{-1} during a β-carotene bleaching assay (Al-Saikhan *et al*., 1995).

A maximum difference is observed in β-carotene bleaching after a reaction time of 30 min (Figure 2) so that antioxidant activity (Equation [1]) was computed for the control based on a modified bleaching rate for that reaction time (Equation [2]). Table 4 shows the antioxidant activity of the four native Chilean potato genotypes and the two commercial varieties obtained from local markets. On the average, the two commercial varieties showed pro-oxidant activity. The peeled 267-UA-1550 genotype (traditionally known as 'Boyo de chancho') exhibited the lowest antioxidant activity, indicating that antagonistic phenolics probably predominate in the flesh of that sample. Nevertheless, a higher antioxidant capacity is observed in whole potatoes in all the samples. This clearly demonstrates a high nutritional value of the potato peel that is generally discarded during meal preparation. However, compared with antioxidant standards such as BHT or β-tocopherol that minimize β-carotene loss with an antioxidant activity of 97.2% and 97.3%, respectively (Velioglu *et al*., 1998), three of the selected Chilean potato genotypes performed poorly. Genotype NG-6 differed remarkably with the highest antioxidant activity among the native Chilean potatoes.

Finally, antioxidant activity was correlated with TPC. The best positive correlation was found when considering only the native samples (Figure 3). A commonly

Table 4. Antioxidant activity (AA) and modified bleaching rate (R_t) for selected native Chilean potato samples.

	Unpeeled samples			Peeled samples		
Potato variety/genotype	AA %	R_t min^{-1}	R^2	AA %	R_t min^{-1}	R^2
Shepody	-11 ± 6	0.0462 ± 0.0027	0.9945	-29 ± 12	0.0538 ± 0.0049	0.9560
Desirée	0 ± 6	0.0416 ± 0.0026	0.9969	3 ± 7	0.0407 ± 0.0029	0.9901
NG-6 (Bruja)	50 ± 4	0.0210 ± 0.0018	0.9606	11 ± 2	0.0372 ± 0.0008	0.9953
239-UA-1388	15 ± 12	0.0354 ± 0.0052	0.9926	10 ± 1	0.0377 ± 0.0006	0.9812
267-UA-1550 (Boyo de chancho)	17 ± 5	0.0346 ± 0.0021	0.9950	4 ± 2	0.0403 ± 0.0007	0.9977
301-UA-1500 (Corazón azul)	16 ± 2	0.0351 ± 0.0009	0.9943	13 ± 5	0.0365 ± 0.0020	0.9877
Control	0	0.0418 ± 0.0027	0.9977	0	0.0418 ± 0.0027	0.9977

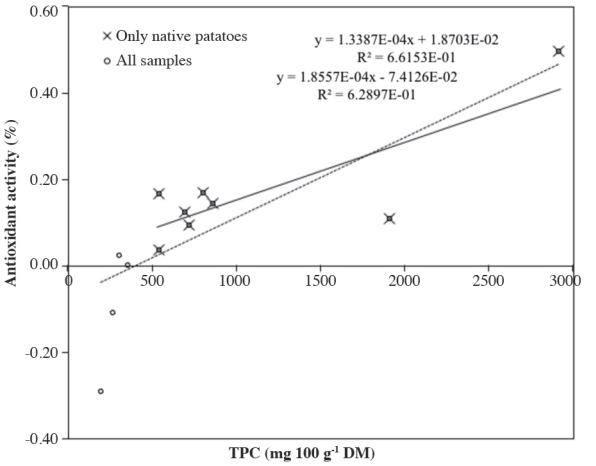

Figure 3. Relationship between total phenolic content (TPC) and antioxidant activity.

observed coefficient of determination (0.66 at $P < 0.05$) was obtained for this relationship. Hejtmánková *et al*. (2009) obtained R^2 values of 0.64 and 0.55 correlating percentage inhibition of ABTS [2,2'-azinobis(3-ethyl-benzothiazoline-6-sulfonic acid)] with total anthocyanins and chlorogenic acid, respectively. Velioglu *et al*. (1998) found that anthocyanin-rich material will interfere in this relationship. High positive correlations between AA and TPC suggest that these compounds are mostly responsible for antioxidant activity.

CONCLUSIONS

Native Chilean potato genotypes have great potential as a source of total phenolics. The assays for TPC and antioxidant activity determined with the β-carotene bleaching method gave consistent results and these methods would be useful in a rapid selection of germplasm for a breeding program initiated in southern Chile. The identification of potato cultivars with high phenolic content adds value to potato consumption and might open new market niches for cultivated native species. In addition, these results support investment in new breeding programs to improve health-promoting nutrients in modern potato cultivars using native Chilean genotypes.

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Capacidad antioxidante y compuestos fenólicos totales de una selección de doce variedades tradicionales de papa cultivadas en la Región Sur de Chile. Las papas (*Solanum tuberosum* L.) coloreadas son una fuente natural de fitoquímicos que ayudan a reducir el riesgo de enfermedades. Sin embargo, existe una falta de información sobre el grado de variación de la actividad antioxidante y el contenido de polifenoles en estas papas nativas. Es así como la actividad antioxidante (AA) y contenido de fenoles totales (TPC) se determinaron en papas nativas chilenas. Doce genotipos de papa recogidos de cultivos establecidos en la Isla de Chiloé y en Valdivia fueron seleccionados, y se compararon TPC y AA con dos variedades comerciales, Shepody y Desirée. El TPC se determinó por el método de Folin-Ciocalteu, y el blanqueamiento de β-caroteno se utilizó para comparar la AA. El TPC varió en las muestras de papas sin piel desde 191 hasta 1864 mg 100 g^{-1} MS mientras que en las muestras con piel estos valores varían entre 345 y 2852 mg 100 g^{-1} MS. La AA fue mayor en las papas con piel, con el mayor valor para la papa nativa 'NG-6' o 'Bruja'. La variedad comercial Shepody mostró actividad prooxidante y tuvo un TPC relativamente más bajo. Los resultados también indicaron una mayor concentración de fenoles totales en la epidermis de las papas nativas chilenas.

Palabras clave: papas chilenas, *Solanum tuberosum*, actividad antioxidante, fenoles totales, Folin-Ciocalteu, β -caroteno.

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