Antioxidant action over extracts of the potato peel (*Solanum tuberosum*)

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Abstract
This work has evaluated the effectiveness of the obtained raw extracts in the potato peel as in vitro antioxidants. Two raw extracts aqueous and purified were developed. The antioxidant activity discovered was highly significant for the two raw extracts, when values between 84 and 94% were found for inhibition of the accelerated oxidation test in the pork fat, even though, it has not been correlated to the reducing power. The purified extract displayed greater yield in the total phenolics content when compared to the aqueous extract. Taking into consideration that potato peels are discarded as by-product and not effectively utilized, these in vitro results suggest the possibility that potato peel waste could be effectively employed as a healthy ingredient or functional food.

Introduction
Food phenolic antioxidants, such as butylated hydroxyanisole, tert-butylated hydroquinone and propyl gallate, are use in foodstuffs against oxidative rancidity. However, in the last decade, the demand for natural antioxidants has increased because of questions about the long-term safety, restriction in many countries of the use as well as negative consumer perception of synthetic antioxidants (Bannawart & Toledo, 1999).

In this context, the potato peel (*Solanum tuberosum*), may be considered as a new source of natural antioxidants, similar in effectiveness to synthetic antioxidants, considering that it is rich in phenolic compounds, some in free form and some bound, directly related to the antioxidant activity of its extracts, and that actuate over the minimization of non-desired effects from the products of the food lipid oxidation (Mansour & Khalil, 2000; Rehman, Habib, & Shah, 2004).

This by-product, which represents one of the main effluents resulting from the potato processing, is usually discarded and used in animal feeding or as raw material of organic fertilizers (Randuz, Lard, Bauer, Marchello & Berg, 2003). Thus, because of the necessity of finding new options for the rational use of the residues, considering the unquestionable benefits to the environment, this work aimed to evaluate the antioxidant action of *in vitro* potato peel extracts.

Materials and methods
Extracts preparation: The potatoes (*Solanum tuberosum*) were washed, manually removing its peels and then dried in a hot air oven at 60° C for the period of 48 hours. For the aqueous extract, 80 g of previously grounded potato peels were used in 400 mL of the hidroethanolic solution (1:5). The mixture was shaken for 40 minutes using a magnetic shaker and afterwards left at rest for the period of 20 minutes. The supernatant was filtered and it was applied on two more successive extractions, using 400 ml of ethanol as solvent. The combined filtrates were put together and the ethanol removed in rotaevaporator, using thermostatic water bath at 40ºC.The purified extract has been obtained through sequence separation, using increasing polarity solvents, according to Simões *et al* (1999). The purified extract as well as the aqueous extract were kept refrigerated and protected from light until its use.

The antioxidant activity of the aqueous and purified extracts was determined through accelerated oxidation test in pork fat.100 grams of pork fat was weighed and 0.5 and 1.0 mL of aqueous or purified extract were added. The control did not contain any extract. The mixture was heated and kept at 100-110ºC for 1 hour and 30 minutes under a shaker. After, the TBA rate in the samples was analyzed and the absorbance was read spectrophotometrically at 531 nm. The antioxidant activity of the extracts was calculated in relation to the percentage of pork fat oxidation inhibition, according to Chang,Yen, Huang & Duh (2002), through the following equation: (%) inhibition = [1- (sample absorbance at 531nm)/ (control absorbance at 531 nm)] x 100. The total phenolics determination in the aqueous and purified

extract was obtained through Folin-Ciocalteau colorimetric method, according to Gavilan *et al* (1986). The reducing power measurement of the aqueous and purified extracts was determined following Yildirim, Mari, Oktay, Kara, Algur & Bilaloglu (2000).

The antioxidant activity, total phenolics and reducing power data were evaluated through ANOVA variance and the averages were compared through Duncan's test (α=5%; $p<0.05$). Statistical analysis were made using the software *Statistical Analysis System*, version 8.02.

Results and discussion

Figure 1 refers to the antioxidant activity of potato peel aqueous and purified extracts, determined in the pork fat accelerated oxidation test. It was observed that the aqueous extract oxidation inhibition percentage was high, but coincident (84.31%), for the different amounts. The purified extract also presented a high antioxidant activity, statistically different ($p<0.05$) compared to the aqueous extract. Therefore, the two extracts were effective in the pork fat oxidation inhibition.

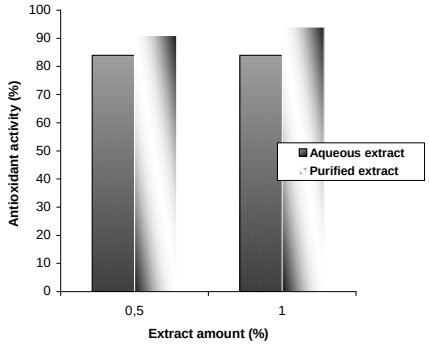

Figure 1. Antioxidant activity of aqueous and purified extracts from potato peel in the accelerated oxidation test on pork fat.

Sotillo, Hadley & Holm (1994), found a sharp antioxidant action in comparison to synthetic antioxidant mixtures when evaluated the potato peel lyophilized aqueous extract on sunflower oil oxidation. Sing & Rajini (2004), investigated the antioxidant activity of potato peel lyophilized aqueous extract against the lipid peroxidation in homogenized of rat liver, and found a potent inhibitory activity mainly in higher concentrations.

On the other hand, the antioxidant activity in natural phytochemicals, according to, Jitoe, Masuda, Tengah, Suprapta, Gara & Nakatani (1992) and Moller, Madsen, Aaltonen & Skibsted (1999) may be influenced by the applied solvent during the active compounds extraction process. The extraction through solvent varies considerably, according to the solvent used, due to the antioxidant potential of compounds with different polarities. This way, the highest percentage of oxidation inhibition of the purified extract compared to the aqueous extract, displays the superior efficiency of n-buthanol in the extraction of the potato peel active compounds comparing to ethanol and water. These compounds are probably phenolic acids, (chlorogenic, gallic, caffeic), ascorbic acid and quercetin, commonly found in potato peel and that act as free-radical acceptors (Sotillo, Hadley & Holm, 1994). Even though the functional constituents of the potato peel have low solubility in non-polar environment, this characteristic did not harm its antioxidant action. It is believed that these compounds probably interact synergistically, which increases the antioxidant potential of the extracts.

Table 1 shows the total phenolics content in (mg catequin/g of dry extract), of the aqueous and purified extract in the potato peel. It was observed a statistical difference ($p<0.05$) on phenolics content among the extracts, where the purified extract showed a higher effectiveness on the extraction of active compounds. Onyeneho & Hettiarachchy (1993), evaluating the total phenolics content of six kinds of potato peel, also found relevant values.

Table 1. Total phenolics content in the aqueous and purified extract of the potato peel

Treatments	Phenolics (mg catequin/g of dry extract)
Aqueous extract	9.516[a]
Purified extract (n-buthanol fraction)	12.016[b]

[a]Averages with the same letter to the vertical are not different (p>0.05) according to Duncan's test.

The reducing power of the aqueous and purified extract of the potato peel (Figure 2) showed that there was no direct correlation between the increase in the amount and the reducing power in both extracts. According to some authors (Tanaka *et al*, 1988; Duh, Du & Yen, 1999) in some extracts from vegetable substrates there is a direct relation between the concentration increase and the reducing power. However, the results in this study suggest that the reducing power did not contribute for the antioxidant effect of the extracts of potato peel.

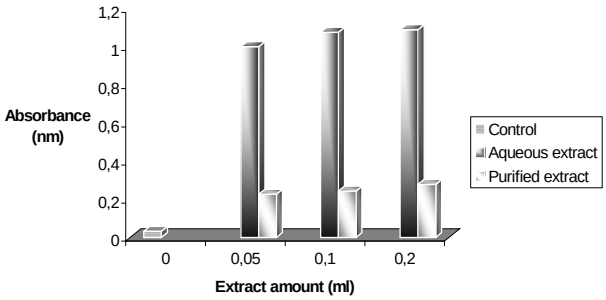

Figure 2. Reducing power of aqueous and purified extracts from potato peel.

Conclusions

The results obtained throughout the study showed that the potato peel extracts have compounds with antioxidant activity, which is not related to reducing power. These compounds are able to inhibit the *in vitro* oxidation process and may be isolated more efficiently through sequence extraction. The intensification of *in vivo* studies in relation to the safeness of the peel is necessary for its possible use as an antioxidant on food.

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