Antioxidant and Pro-Oxidant Activity of Coffee as Affected by Torrefacto Roast

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Abstract: The addition of sugar at the end of the torrefacto roasting process could influence on the antioxidant and pro-oxidant properties of coffee because sugar is one of the main precursors of Maillard reaction. The aim of the work was to study and compare the antioxidant and pro-oxidant properties of some commercial roasted coffees which are selected to represent conventional roasted coffee and torrefacto roasted blends. When the percentage of torrefacto coffee was increased, the antioxidant activity increase and a slight tendency to decrease the pro-oxidant activity were observed. Moreover, a principal component analysis allowed to separate (a) brands by PC1 (46.9%) characterised by colour parameters defined by roast degree, and (b) torrefacto roast blends by PC2 (33.7%) characterised by antioxidant/pro-oxidant activity.

Keywords: coffee; antioxidant capacity; pro-oxidant activity; torrefacto roast; colour; Maillard reaction

INTRODUCTION

Although compounds with antioxidant properties are lost during roasting of coffee beans, the overall antioxidant properties of coffee can be maintained, or even enhanced, by the development of compounds possessing antioxidant activity, including Maillard reaction products [1–3]. Moreover, pro-oxidant molecules formation has been observed during the early phases of Maillard browning [1, 4], but in the advanced stages, antioxidant products seem to prevail. The addition of sugar at the end of the torrefacto roasting process could influence on the antioxidant and pro-oxidant properties of coffee because sugar is one of the main precursors in the Maillard reaction. Therefore, the aim of the present work was to study and to compare the antioxidant and pro-oxidant properties of some commercial roasted coffees which are selected to represent conventional roasted coffee and torrefacto roasted blends.

EXPERIMENTAL

Coffee samples and preparation. Nine commercial roasted coffee samples were purchased in a local market: three conventional roasted coffees (0), two blends with 30% Torrefacto roasted coffee (30), two blends with 50% Torrefacto roasted coffee (50) and two 100% Torrefacto roasted coffees (100). Four brands (A, B, C, D) were chosen among the most consumed. Two batches of each coffee sample were analysed by triplicate.

Coffee extract was obtained by solid-liquid extraction (10 g/100 ml) using deionised water at 100°C, under nitrogen atmosphere, during 10 min. Extract was immediately cooled and filtered through Whatman n. 4 filter paper.

Colour analysis. Colour analysis was carried out on ground roasted coffees using a tristimulus colorimeter (Chromameter-2 CR-200, Minolta, Osaka, Japan), and was expressed in $L^*a^*b^*$ Cielab scale.

Antioxidant, pro-oxidant activity and rRedox potential. The antioxidant activity was measured by using the $DPPH^{\cdot}$ (2,2-diphenyl-1-picrylhydrazyl) decolorisation assay [5]. Reaction rates were calculated using the equation proposed by Manzocco *et al*. [6] and was expressed as slope (Abs^{-3}/min) per ml of sample.

The pro-oxidant activity was determined using crocin as a radical quencher, according to the method described by Manzocco *et al*. [7] and was

expressed as the decrease in crocin absorbance at 443 nm after 5 min of reaction per ml of sample (ΔOD_{5min}/ml).

Redox potential was measure with a platinum indicating electrode connected to a voltmeter (mod. 2002, Crison, Spain). Milivolt values were recorded for at least 15 min at room temperature, until a stable potential (change of less than 1 mV in a 3 min period) was reached.

Statistical analysis. One-way ANOVA and *T*-Tukey *a posteriori* test were applied. Principal components analysis (PCA) was applied to the analytical data, selecting principal components (PC) with eigenvalues greater than 1. SPSS v.9.0 software package was used.

RESULT AND DISCUSSION

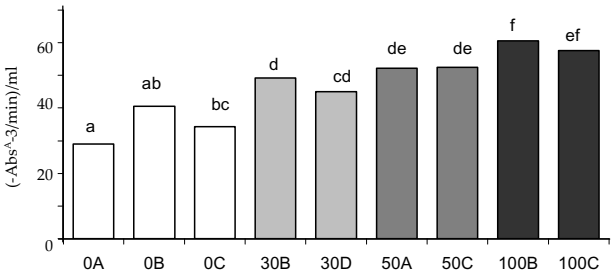
A tendency to increase in *L** (lightness) and *b** (yellow) parameters with torrefacto percentage was found (Table 1), maybe due to a lower roasting degree to avoid an excess of burnt caramel in torrefacto.

Antioxidant activity (Figure 1) was increased with the percentage of torrefacto coffee. This could be due to the addition of sugar –one of the main precursors of Maillard reaction – to the roasting process. On the other hand, highly reactive radicals are formed in the early phases of the Maillard reaction, whereas strong antiradical properties are attributable to the high molecular weight brown compounds formed in the advanced phases of the reaction [7]. Therefore, when roasting process had been completed, pro-oxidant radicals could be quenched by MRPs reducing pro-oxidant activity with torrefacto roast (Figure 2). A tendency to decrease the redox potential – which evaluates the oxidation/reduction efficiency – with the percentage of torrefacto coffee was observed (Figure 3), suggesting an increase of the overall antioxidant activity.

Table 1. Colour data of ground roasted coffees

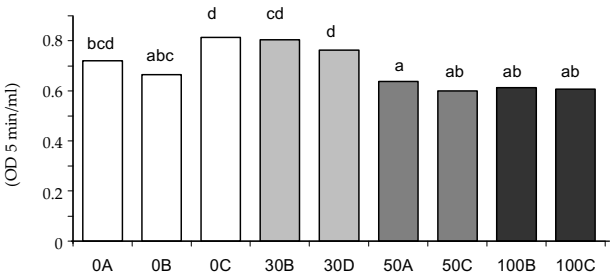
	*L**	*a**	*b**
0A	24.50 ± 0.50c	11.19 ± 0.16b	13.36 ± 0.33d
0B	26.16 ± 0.33d	12.54 ± 0.27cd	15.68 ± 0.43f
0C	22.92 ± 0.45b	10.05 ± 0.17a	11.15 ± 0.36b
30B	26.58 ± 0.86d	12.78 ± 0.39d	16.37 ± 0.56g
30D	24.88 ± 0.27c	11.40 ± 0.23b	14.15 ± 0.30e
50A	24.83 ± 0.52c	11.29 ± 0.13b	13.77 ± 0.21de
50C	21.90 ± 0.62a	9.78 ± 0.53a	10.39 ± 0.36a
100B	30.86 ± 0.55e	12.64 ± 0.09d	20.42 ± 0.26h
100C	22.45 ± 0.24ab	11.28 ± 0.07b	12.63 ± 0.09c

In each column, different superscripts indicate significant differences ($P < 0.05$) among coffee samples. Results are shown as mean ± standard deviation ($n = 6$)



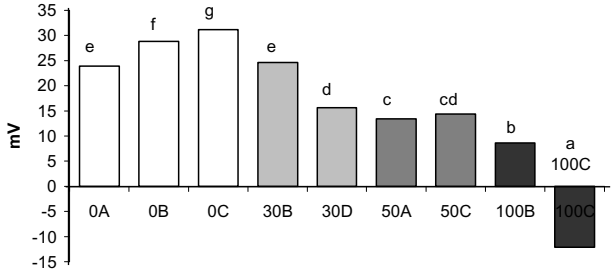
Different letters indicate significant differences ($P < 0.05$) among coffee samples

Figure 1. Antioxidant activity of ground roasted coffee



Different letters indicate significant differences ($P < 0.05$) among coffee samples

Figure 2. Pro-oxidant activity of ground roasted coffee



Different letters indicate significant differences ($P < 0.05$) among coffee samples

Figure 3. Redox potential values of ground roasted coffee

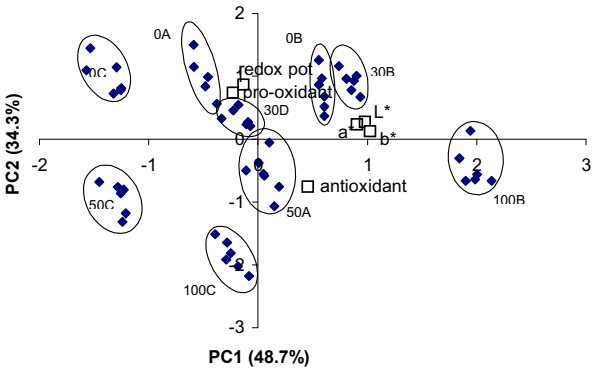


Figure 4. Principal Component Analysis of the ground roasted coffee

Two principal components (PC) were selected by PCA (Figure 4). PC1 (48.7% total variance), mainly characterised by colour parameters of ground roasted coffees, suggested that brand C samples might have higher roasting degree, and brand B coffees lower. PC2 (34.3% total variance), characterised by antioxidant/pro-oxidant activity, showed blends with more than 50% of torrefacto roast at the bottom because of their highest antioxidant activity.

CONCLUSIONS

Coffees with higher percentage of torrefacto roast had stronger antioxidant activity, maybe because sugar addition could contribute to the formation of MRPs during roasting. At the same time, roast degree and, consequently, colour parameters could also influence in the antioxidant/pro-oxidant activity of coffee, but linear correlations were not observed and both groups of parameters were represented in different principal components.

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