Green and Roasted Coffee Antiradical Activity Stability in Chemical Systems

*M. DAGLIA, A. PAPETTI and G. GAZZANI**

*Department of Pharmaceutical Chemistry, Faculty of Pharmacy, University of Pavia, Pavia, Italy, *E-mail: gabriella.gazzani@unipv.it*

Abstract: The stability to storage at different temperature and oxygen exposure of green and roasted coffee either as coffee beans or as ground coffee antiradical activity, was evaluated. The results showed that the coffee solution antihydroxyl radical activity was constant, independently from the coffee species, from the roasting process, and moreover from the type of storage conditions, suggesting that temperature and oxygen exposure did not affect this antiradical activity. With regard to antiperoxyl radical activity, all green coffee solutions showed remarkable and stable activity. Conversely, the roasted coffee beans and roasted and ground coffee antiperoxyl radical activity started to increase after three month of storage, suggesting that Maillard reaction products affect the stability of such antiradical property.

Keywords: green and roasted coffee beans; ground coffee; *in vitro* antiradical activity; storage conditions; antioxidant property stability

INTRODUCTION

In recent years the antioxidant activity of coffee has been extensively studied, to explain the implications of coffee consumption on human health, concerning chronic diseases such as cancer, cardiovascular, inflammatory and neurodegenerative pathologies, all being phenomena in which oxidative stress has been demonstrated as the major cause [1, 2]. Numerous reports have shown that coffee can suppress the *in vitro* mutagenicity of oxidants such as tert-butyl-hydroperoxide, and can also inhibit lipid peroxidation and malondialdehyde formation [3]. Additionally, in our previous researches, coffee (mainly roasted coffee) was found to possess strong antihydroxyl and antiperoxyl radical activity, both in chemical and in biological systems [4, 5]. The responsible of the antioxidant activity of green coffee were found to be the naturally occurring polyphenolic compounds, such as chlorogenic acids. In roasted coffee, where most polyphenolic compounds are destroyed, the antioxidant activity was also ascribed to Maillard reaction products (MRPs) that are generated during the roasting process.

Coffee is a dry food with low activity water and may be stored for a long period before its use. Coffee shelf life is affected by $\%O_2$, and temperature applied during normal storage and distribution [6]. Storage conditions must guarantee the good preservation of the product not only regarding its sensory properties (flavour, taste, and colour) but also as regards its biological properties. As far we know, little information is available about the fate of antiradical properties of green and roasted coffee beans and of roasted and ground coffee during storage. The aim of this investigation was to determine the stability of coffee antiradical activities to storage at different temperatures and oxygen exposure. The *in vitro* antihydroxyl and antiperoxyl radical activities were evaluated by deoxyribose assay and linoleic acid-β-carotene micellar system, respectively. The antiradical properties were evaluated on coffee solutions prepared from green, and medium roasted coffee obtained from the two most commonly consumed species, *Coffea arabica* and *Coffea robusta*. Different storage conditions were applied to determine the stability of coffee antiradical activity.

EXPERIMENTAL

Coffee samples. One sample of *C. arabica* from Costa Rica (Santos) and one sample of *C. robusta* from Java (Parkment) coffee beans were roasted in a pilot roaster apparatus for 7 min at 190°C (medium roasted). The green and roasted coffees were subdivided into nine batches. The first batch was ground in a laboratory scale mill, sieved through a no. 30 sieve. The obtained coffee powder was use to prepared coffee solution as described in a previous paper [4] and immediately analysed to determine the antiradical activities. Four coffee bean batches were stored in different conditions: two batches were stored in nitrogen atmosphere at 25°C or 4°C while the other two batches were stored in the presence of ordinary atmosphere at the same temperatures (25°C and 4°C) for 1, 3, 6, and 12 months. The last four batches were ground and sieved before the storage and then were stored as the above four coffee beans batches for the same periods. After the storage period, green and roasted coffee beans or green and roasted ground coffees were used to prepared the coffee solutions that were analysed to determine their antiradical properties.

Deoxyribose assay. The scavenger activity of the coffee solutions, based on the inhibition of the deoxyribose degradation caused by the attack of hydroxyl radicals, was evaluated using the Aruoma [7] method and included some modifications as reported in a previous paper [5].

Linoleic acid-β-carotene micellar system assay. The antioxidant activity of the coffee solutions, based on coupled oxidation of linoleic acid and β-carotene, were evaluated following the method of Taga *et al*. [8] with some particular modifications [4].

Statistical analysis. The values represent the mean values of at least 6 replications for the deoxyribose assay and linoleic acid-β-carotene assay. Data were analysed by analysis of variance (ANOVA) with the statistical package Statgraphic Plus (1998). Means were separated with the LSD method at a confidence level of 95%.

RESULTS AND DISCUSSION

The antihydroxyl and antiperoxyl radical activity were determined using deoxyrybose assay and the linoleic acid-β-carotene assay, respectively. The percentage of inhibitory activity (IA%) of deoxyribose degradation in the presence of the water soluble components occurring in *C. arabica* and *C. robusta* green and medium roasted freshly prepared coffee solutions, were reported in Figure 1A. All coffee solutions showed remarkable antihydroxyl radical activity ranging from 48.8 and 31.9%. The data concerning the percentage of antiperoxyl radical activity (AA%) calculated after 10, 20, and 30 min of reaction at 50°C for each fresh prepared coffee solution, are reported in Figure 1B. The green coffee solutions showed an immediate, strong activity which increased with time of reaction. The roasted

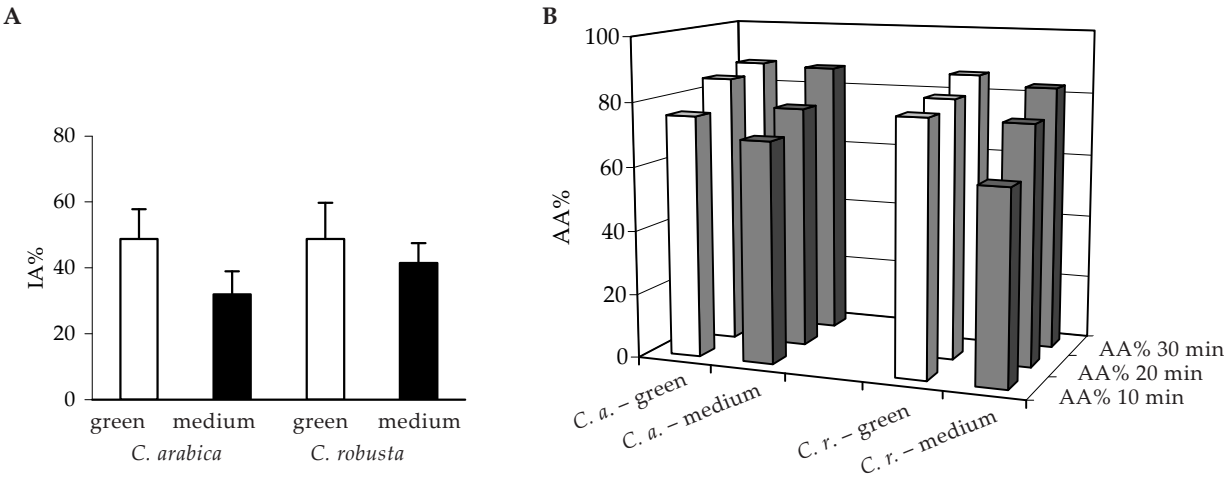

Figure 1. A: inhibitory activity percentage (IA%) and B: antiperoxyl radical activity percentage (AA%) of fresh prepared green and medium roasted coffee solutions

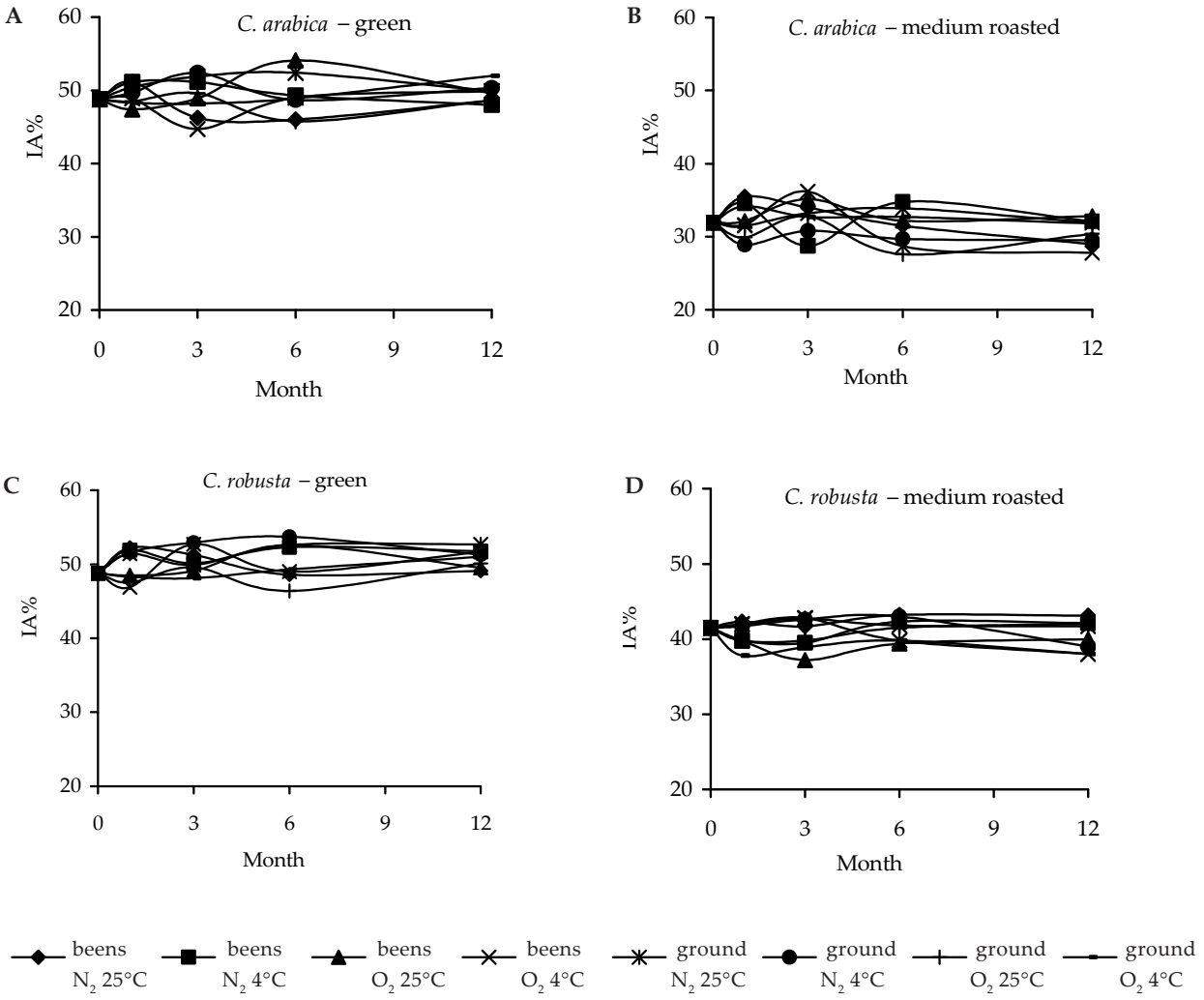

Figure 2. IA% of: A green *C. arabica*; B roasted *C. arabica*; C green *C. robusta*; D roasted *C. robusta*

coffee AA values initially (after 10 min of reaction) were lower than the corresponding green coffee values, then they slightly increased with the time of reaction, although they never exceed the AA values of green coffee.

The eight stored batches were analysed after four different periods of storage (i.e. 1, 3, 6, and 12 months) and the obtained results are reported in Figures 3 and 4. The coffee solution antihydroxyl radical activity shows no significant changes independently from the coffee species, from the roasting process and moreover from the type of storage conditions, suggesting that grinding, temperature and oxygen exposure did not affect this antiradical activity and the coffee components that are responsible for this biological property are stable to storage. With regard to linoleic acid-β-carotene assay, all green coffee solutions showed no remarkable activity changes. Conversely, the roasted coffee beans and roasted and ground coffee antiperoxyl radical activity started to increase after three month of storage either in nitrogen or in ordinary atmosphere, mainly when the storage temperature was 25°C. Significant differences were found when the one year stored roasted coffee sample were compared to the corresponding fresh prepared coffee sample data ($P < 0.05$).

CONCLUSIONS

This study showed that the antihydroxy radical property of coffee were substantially stable to storage independently from grinding, temperature, and oxygen exposure. The same trend in the behaviour

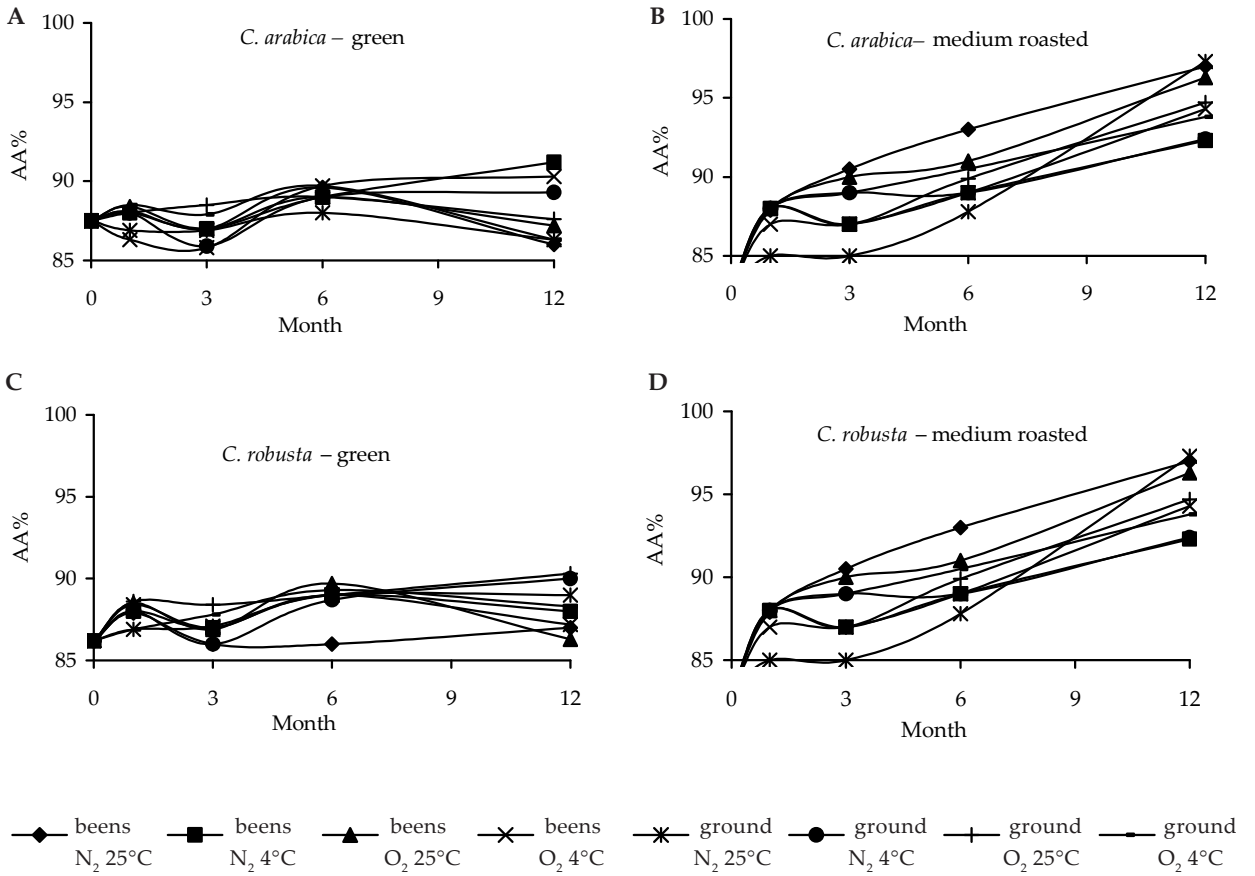

Figure 3. AA% of: A green *C. arabica*; B roasted *C. arabica*; C green *C. robusta*; D roasted *C. robusta*

of the two green coffee samples was observed in linoleic acid-β-carotene assay. Conversely, the antiperoxyl radical activity of both roasted coffee samples shows significant increases durind a year period of storage. This seem to indicate that the storage induced MRPs formations with antiradical activity that positive affects this property. Overall, these results suggest that green and roasted coffee maintain or even increase their high antiradical activity. Investigations are currently under way to evaluate the stability of coffee antiradical activities in biological systems.

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