LWT - Food Science and Technology 51 (2013) 553–559

Contents lists available at SciVerse ScienceDirect

LWT - Food Science and Technology

journal homepage: www.elsevier.com/locate/lwt

Effect of sugar addition (torrefacto) during roasting process on antioxidant capacity and phenolics of coffee

Iziar A. Ludwig, Jimena Bravo, M. Paz De Peña*, Concepción Cid

Department of Nutrition, Food Science, and Physiology, School of Pharmacy, University of Navarra, E-31080-Pamplona, Spain

ARTICLE INFO

Article history:
Received 30 March 2011
Received in revised form
14 December 2012
Accepted 18 December 2012

Keywords:
Coffee
Roasting
Antioxidant
Phenolic compounds
Maillard reaction products

ABSTRACT

The addition of sugar during roasting (torrefacto) has been proposed as a technique to increase the antioxidant capacity. However, other factors such as roasting degree and coffee origin also play a key role. Two batches of Colombian green coffee were roasted adding increased amounts of sucrose (0–15 g per 100 g of coffee) to reach the same roasting degree than a commercial Colombian coffee. Moreover, seven conventional roasted coffees from different origins (Colombia, Brazil, Kenya, Guatemala and Vietnam) and roasting degrees (Dark, Medium and Light), and one 100% Torrefacto roasted coffee were analyzed. Although the addition of sugar during roasting increased the DPPH quenching activity, phenolic compounds (5-caffeoylquinic, caffeic and ferulic acids, and 4-vinylguaiacol) were hardly affected by torrefacto roasting process, showing that Maillard and other roasting reactions products, such as browned-colored compounds including melanoidins (Abs 420 nm), have an important role as antioxidants. Principal Component Analysis (PCA) showed that roasting degree also plays a key role on overall antioxidant activity. Moreover, the Absorbance at 420 nm has been proposed as a good marker of torrefacto roasting process, whereas the roasting degree might be better characterized by L^* values.

1. Introduction

During last few years, roasted coffee has been proposed as one of the main source of antioxidants in the diet (Pulido, Hernandez-Garcia, & Saura-Calixto, 2003; Svilaas et al., 2004). The roasting of coffee is a complex process where the loss of antioxidant activity due to natural antioxidants – mainly represented by polyphenols – by progressive thermal degradation has been found to be minimized by the formation of Maillard reaction products (MRPs) (Nicoli, Anese, Manzocco, & Lerici, 1997).

Torrefacto is a roasting process in which sugar is added to coffee, normally Robusta. This roasting technique is used in several countries of Southern Europe and South America where some segments of the population prefer coffees with a dark brown, intense aroma and a strong taste with a tendency to bitterness. This kind of roasting process was initially used to mask negative sensorial attributes in Robusta coffees. Nowadays, Torrefacto roasted coffee is usually blended with conventional roasted coffee (Arabica or Robusta) to be commercialized. The addition of sugar at the end of the torrefacto roasting process might intensify the development of Maillard reactions and, consequently, increase the antioxidant capacity of coffee (Andueza, Cid, & Nicoli, 2004; Lopez-Galilea, Andueza, di Leonardo, de Peña, & Cid, 2006; Lopez-Galilea, de Peña, & Cid, 2008). However, the analyzed samples in these works were commercial coffees in which Arabica and Robusta coffees from different unknown origins, percentages and roasting degrees were blended.

Nicoli et al. (1997) reported that dark-medium roasted coffee had the highest antioxidant capacity showing that roasting degree is a key factor. But, the origin and the variety of coffee (Arabica and Robusta) with different amounts of phenolics in green coffee also can play an important role. Consequently, the different antioxidant capacity of commercial Torrefacto roasted coffee blends previously studied by our research group (Lopez-Galilea et al., 2006, 2008) can not be attributed only to Torrefacto roasting process. Thus, the influence of the sugar addition during torrefacto roasting process on the antioxidant capacity of coffee should be deeper studied controlling the other parameters. So that, the aim of this work was to know whether the addition of increased amounts of sugar to coffee during roasting process (torrefacto) could be a key factor to increase the antioxidant capacity, and to know its influence on the most relevant coffee antioxidant compounds (phenolic compounds and melanoidins). And secondly, whether the addition of sugar during roasting had higher or lower influence than the roasting degree and the origin of coffee.

* Corresponding author. Tel.: +34 948 425600x806580; fax: +34 948 425740.
E-mail address: mpdepena@unav.es (M.P. De Peña).

0023-6438/$ – see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.lwt.2012.12.010

2. Materials and methods

2.1. Chemicals and reagents

The methanol (spectrophotometric grade), Folin–Ciocalteau reagent and sodium carbonate were obtained from Panreac (Barcelona, Spain). Gallic acid, 2,2-Diphenyl-1-picrylhydrazyl (DPPH•), Trolox (6-hydroxy-2,5,7,8-tetramethyl-chroman-2-carboxylic acid) 5-caffeoyl quinic acid (5-CQA), caffeic acid, ferulic acid, 4-vinylguaiacol, were obtained from Sigma–Aldrich (Steinheim, Germany). Acetonitrile, HPLC, grade was provided by Scharlau (Barcelona, Spain).

2.2. Coffee samples

Seven conventional roasted vacuum-packed coffee samples from different origins (5 Arabica coffees from Colombia, Brazil, Kenya and Guatemala and 2 Robusta coffees from Vietnam), and one commercial 100% Torrefacto roasted coffee (T100 Light) were selected. Roasted coffee samples were classified into 3 roasting degrees according to the L^* color parameter results: Dark ($L^* < 23$), Medium (L^*23–26) and Light ($L^* > 26$) following similar criteria of other authors (Nicoli et al., 1997; Vignoli, Bassoli, & Benassi, 2011). Colombia Dark and T100 Light coffee samples of the same brand were purchased in a local market. Colombia Medium, Brazil Medium, Kenya Medium, Guatemala Medium, Vietnam Medium and Vietnam Light roasted coffee samples and green coffee beans (variety *Coffea arabica*, from Colombia) were supplied by two roasting companies.

2.3. Coffee roasting process

Two batches (I and II) of Colombian green coffee beans were roasted adding increased amounts of sucrose (0, 5, 10 and 15 g per 100 g of coffee) to reach the same roasting degree (L^* 19–23, Dark) than the selected commercial Colombian coffee sample (Colombia Dark). The amount of added sugar must not exceed 15g/100 g coffee beans as regulated by law in Spain (Real Decreto 1231/1988). Roasting process was developed following the time and temperature conditions presented in Fig. 1. Sucrose was dissolved in the minimum volume of water and homogenously spread out to the coffee beans at 21 min of roasting. During the roasting process, pan surface and air temperatures were controlled. Each batch of coffee was roasted in duplicate. At the end of the process, coffee samples were controlled by the L^* value (19–23, Dark) and weight loss (18–19 g per 100 g). Weight loss was calculated by the difference between green and roasted coffee weights and expressed as g per 100 g. After 4 h of degassing, 60 g of roasted coffee were packed in plastic bags (type *160*300 PA/PE 90 μm*, Vaessen-Schoemaker Industrial S.A.U., Barcelona, Spain) and sealed under vacuum (Ramon Serie VP Mod.450, Barcelona, Spain). Samples were named with the amount of added sugar followed by the roasting degree and the batch number (0 Dark I, 5 Dark I, 10 Dark I, 15 Dark I, 0 Dark II, 5 Dark II, 10 Dark II and 15 Dark II). All coffee samples were stored in darkness and at 4 °C up to the coffee analysis (<1 month after roasting or purchasing).

2.4. Sample preparation

Coffee packages were opened immediately before the preparation of the coffee extracts in order to avoid oxidative damage. Sixty g of roasted coffee beans were ground in a Moulinex coffee grinder (model Super Junior "s", Paris, France) for 30 s. Coffee extracts were obtained by solid–liquid extraction, using deionized water at 100 °C. The ratio between coffee and water was 10/100 (g/mL). The extraction time was 10 min. The extracts were immediately cooled with cold running water and filtered through Whatman No. 1 filter paper.

2.5. Color analysis

Color analysis was carried out on ground roasted coffees by means of a tristimulus colorimeter (Chromameter-2 CR-200, Minolta, Osaka, Japan) using the D65 illuminant. The instrument was standardized against a white tile before sample measurements. Ground roasted coffee was spread out in an l cm Petri plate, and the color measured was expressed in L^*, a^* and b^* CIELab scale parameters.

2.6. Browned compounds (Abs 420 nm)

Fifty microliters of coffee extract were diluted up to 2 mL with deionized water. Browned compounds were quantified by measuring the absorbance of the sample at 420 nm after exactly 1 min, in a 3 mL capacity cuvette (1 cm length) with a spectrophotometer Lambda 25 UV-VIS (Perkin–Elmer Instruments, Madrid, Spain) connected to a thermostatically controlled chamber (25 °C) and equipped with UV Win-Lab software (Perkin Elmer).

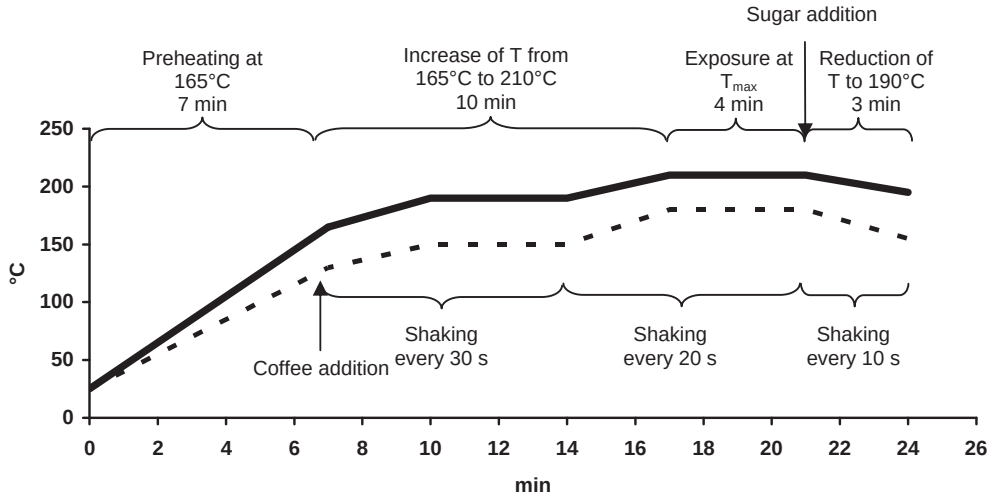

Fig. 1. Time and temperature conditions of coffee roasting process and control of pan surface (bold line) and air (dotted line) temperatures.