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Impact of crema on expected and actual espresso coffee experience

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ABSTRACT

The formation and stabilization of crema on espresso coffee are areas that have been well studied during the last 2 decades. In contrast, the contribution of the sensory perception of crema in the coffee consumption experience has not received a lot of attention. Crema being a key visual differentiator between espresso coffees, it may influence the overall sensory and hedonic experiences through the process of assimilation or contrast of visually induced expectations. The objective of this research was therefore to investigate the role of the expectation generated by crema visual cues on actual sensory and hedonic espresso coffee consumption experience. The study was designed to measure the impact of absence, presence and amount of crema on expectation for espresso coffee in liking, quality, overall taste intensity, bitterness and smoothness. Four espresso coffees with different amounts of crema were rated on each characteristic by espresso coffee consumers in three evaluation conditions: *visual condition* (expectation induced by crema visual cues), *in-mouth condition* (espresso coffee tasting while participants were blindfolded), *full condition* (standard tasting). The aim of this procedure was to quantify the respective contribution of crema visual cues and in-mouth espresso coffee tasting to the overall espresso coffee experience. Results showed that espresso coffee without crema was expected to be moderately liked, low in quality and weakly smooth as compared to espresso coffee with crema. Such expectations negatively impacted hedonic and sensory in-mouth experience through assimilation effect. Change in crema amount also impacted consumers' expectation which in turn modulated hedonic and sensory experience for espresso coffee. For the first time, this study highlighted the key role of crema visual cues on espresso coffee consumption experience.

1. Introduction

Espresso is a highly popular form of coffee preparation where the roast and ground coffee is extracted under high pressure to a volume of around 25–40 mL depending on culture and habits. The resulting typical beverage is strong in taste and aroma intensity and covered with a crema varying from light to dark brown, the hallmark of espresso coffee. The National Coffee Association reports almost 40% of Americans having consumed espresso coffee beverages in the past week (National Coffee Drinking Trends 2015, NCA). This explains why extensive research has been conducted in the past to understand the impact of coffee processing and preparation parameters on chemical composition and related sensory properties (Albanese, Di Matteo, Poiana, & Spagnamusso, 2009; Andueza, Vila, Paz de Peña, & Cid, 2007; Charles et al., 2015; Lindinger et al., 2008; Navarini & Rivetti, 2010) as well as consumer preference (Cristovam, Russell, Paterson, & Reid, 2000).

Espresso coffee crema has also been extensively studied in terms of formation, physical properties, chemical composition (Illy & Navarini, 2011; Nunes, Coimbra, Duarte, & Delgadillo, 1997) and sensory properties (Maeztu et al., 2001; Navarini, Cappuccio, Suggi-Liverani, & Illy, 2004). Espresso coffee crema has been shown to enhance aroma release in the first moments of extraction and to influence the dynamics of sensory perceptions over sips (Barron et al., 2012). This effect has been explained by the impact of foam structure on the kinetics of volatile aroma compounds through physicochemical interactions (Dold et al., 2011). However, the contribution of espresso crema on liking has never been reported to our knowledge. Yet its visual characteristics may impact the sensory and hedonic expectations of espresso consumption, which could modulate actual perception.

It has been widely reported that food or beverage visual cues available to the consumers prior to eating or drinking generate expectations impacting the consumption experience. For instance, two orange juice drinks with the same sucrose concentration but varying in orange color hue are differently perceived in terms of sweetness (Hoegg & Alba, 2007). The amount of foam and presence of lacing in beer influence consumer expectations and actual beer experience in terms of liking, sweetness, bitterness and fruitiness (Donadini, Fumi, & Faveri, 2011). For instance, for a group of consumers, beers with high and medium levels of foam were expected to be fruitier and preferred to beers

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with a low level of foam expected to be richer in off-flavors. Vegetable meal appearance can change its acceptance since cooked carrots are preferred by children when presented with a slice shape rather than a stick shape because they are perceived as more familiar (Morizet et al., 2011).

Crema is the characteristic that differentiates espresso coffee preparation from other coffee brewing methods. Furthermore, in the context of espresso coffee, crema is the main intrinsic source of visual cues varying across different coffee blends and extraction machines (e.g. amount of crema, color and finesse (i.e. bubble size). Consequently, understanding the impact of visual cues generated by crema on expected and actual espresso perception is of interest since a mismatch between expected and actual sensory properties can modulate the product perception. This discrepancy is generally explained by the assimilation–contrast theory (Sherif & Hovland, 1961). According to this theory, the initial judgment raised from expectations acts as an anchor to a more informed perception, which drives the final judgment or attitude in one of two possible ways: if the informed perception falls in the person's latitude of discrepancy acceptance, the initial judgment is assimilated; if the discrepancy is higher than the person's latitude of acceptance, it produces a contrast effect, meaning that the final judgment changes in the opposite direction in a greater magnitude than the actual discrepancy. For a review of the role of visual cues on expectation and its impact on actual perceptual and hedonic responses according to *assimilation* and *contrast* models, see Deliza and MacFie (1996).

The first objective of the present study was to investigate if the absence or presence of crema on top of an espresso, as well as its quantity, generated different expectations about the actual espresso coffee perception and hedonic value. If confirmed, the second objective was to measure the impact of these expectations on the actual espresso coffee experience using the assimilation and contrast model.

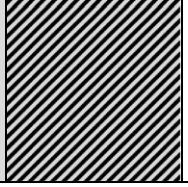
2. Materials and methods

2.1. Espresso coffees

A range of five espresso coffees with different levels of crema and a liquid phase with similar aroma and taste properties was prepared using a dark roasted commercial Nespresso blend composed of 100% Arabica coffee. All capsules came from the same production batch. The espresso coffee range included one espresso coffee without crema named “Ref” and four espresso coffees with crema varying in amount named “A”, “B”, “C” and “D” (Table 1).To suppress crema or to modify the amount, espresso coffees were extracted using a protocol combining two extraction pressures and two different filters. To modify the pressure 2 different coffee machines were used. One was a commercial Nespresso machine where extraction pressure varied between 12 and 16 bar, the default pressure for the specific coffee blend. The other one was an adapted machine where extraction pressure was set at 20 bar. This pressure was chosen based on preliminary trials and tasting to significantly increase crema quantity without impacting the olfactory and taste profile of the extract. In order to remove crema, filtration of the extracted coffee was applied. A Fluortex 02-70/22-based filter (polyvinylidene fluoride, 70 mm pore size, 22% open area) was used to reduce crema quantity and a Petex 07-33/21-based filter (polyethylene terephthalate, 33 mM pore size, 21% open area) was used for totally removing the crema (reference sample).

Coffee sample preparation was done by filling the machine with Acqua Panna mineral water (Sanpellegrino S.p.A., Milan, Italy), placing the capsule inside and setting the operating pressure. A transparent coffee cup which allowed visualization of the crema was used, either with or without filter according to the sample requested, placed below the coffee nozzle exit. Coffee was extracted until an approximate volume of 40 mL (i.e. exactly 40 g, as measured with a Mettler type PM6 balance (Mettler Instrument AG, Zurich, Switzerland)) which is the recommended volume of the selected blend and the common mode of preparation for French consumers. Each espresso coffee cup was served at 75 °C. In-cup coffee temperature was controlled using a probe thermometer. The preparation protocol and the five resulting coffee samples are summarized in Table 1.

Table 1
Conditions of preparation in terms of filter and pressure for each espresso coffee with the related photographs and codes.

Filter / Pressure	Petex	Fluortek	No filter
12–16 bar	 Ref (no crema)	 A	 C
20 bar		 B	 D

2.2. Sensory validation of the range of espresso coffees

Eleven trained female panelists routinely involved in sensory profiling of espresso coffee through Quantitative Descriptive Analysis (QDA®) took part in the sensory profiling with a replication of the range of espresso coffees. They used a glossary with attributes covering foam quantity, in-mouth aroma (carbony, fruity, cereal, roasty notes), taste (sweet, bitter and acid) and texture (body). Participants rated each attribute using 10 cm-unstructured scales anchored at the left and right extremity with “Not at all” and “Extremely”, respectively. Data acquisition was realized on a computer screen with FIZZ software (Biosystemes, Couternon, France). The order of coffee presentation was balanced across participants and replicates. Each coffee was prepared and served monadically at 75 °C to each participant to ensure a constant temperature across coffees. The participants had to wait 4 min between tests before asking a sensory staff member for the next sample using a timer displayed on computer-screen. During the break, participants were required to eat crackers and then rinse their mouth with water.

A two-way ANOVA “coffee” (fixed factor) × “panelist” (random factor) with interactions highlighted significant differences for crema quantity ($F(3,55) = 15.5$, $P < 0.01$) between the four samples (Fig. 1)

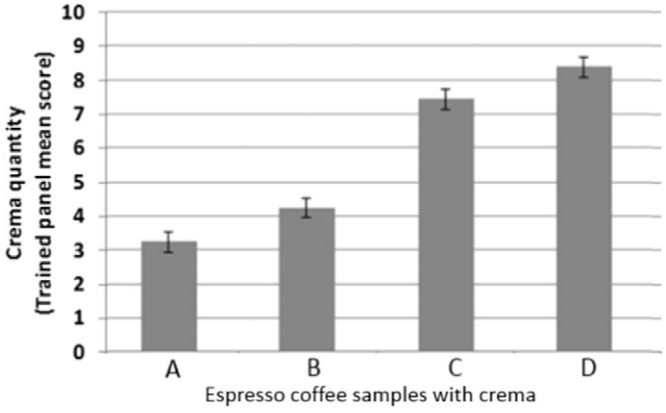


Fig. 1. Averaged crema quantity (±SEM) for the four espresso coffees with crema.