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Impact of blanching, sweating and drying operations on pungency, aroma and color of *Piper borbonense*

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ABSTRACT

Low pungency, high aromatic potential and red color, give to *Piper borbonense* its originality when compared to *Piper nigrum*. Effects of blanching, sweating and drying on these characteristics were assessed. The three operations had no impact on the concentration of piperine and essential oil but affected the composition of essential oil slightly and considerably affected the color of the pepper. The "wet process", including blanching, sweating and drying, had the largest impact on the composition of aroma, increasing para-cymene content by 89% and reducing safrole content by 33% in dried pepper compared to fresh. Blanching increased the drying rate thus reducing drying time. Drying had a major impact on color, which changed from red to brown. The biggest differences observed led to reductions of 2.2, 7.9 and 8.4 units in L*, a* and b* values, when chromatic values measured in fresh pepper were compared to those of dried pepper.

1. Introduction

Pepper (*Piper* spp.) is the most common spice worldwide; 472 500 tons were produced in 2013 (FAO Statistics Division., 2015). Although, also known for its medicinal properties (Ahmad et al., 2012), pepper is mainly used to enhance the taste and flavor of food. The quality of pepper as a spice is measured throughout pungency, aroma and color (Gu, Tan, Wu, Fang, & Wang, 2013). Although more than 700 species grow in tropical and subtropical regions, most of which are wild (Sumathykutty, Rao, Padmakumari, & Narayanan, 1999), one single domesticated species – *Piper nigrum* is by far the most widely consumed. A wild pepper, named *Piper borbonense* grows in Reunion Island but has not been collected until now. Some very closely related wild species of pepper, local name Tsiperifery, grow in Madagascar and are picked for both local consumption and for sale, including for export. These wild peppers differ from domesticated *Piper nigrum* in their low piperine content, high essential oil content and particular red color (Weil et al., 2014). Although they are sold at high prices in Europe, these Malagasy peppers are of heterogeneous quality which could affect their reputation and valorization. As pepper quality varies with the species, origin, agricultural system (when domesticated), climate, or maturity, it may also be influenced by postharvest treatments. Dhas and Korikanthimath (2003) described the different types of processing of pepper and the advantages of each, but few studies have focused on the impacts of processing on pepper quality. Existing studies generally tested domestic cooking, and reported contradictory results. Wild pepper is currently not processed in Reunion Island. In Madagascar, wild peppers are processed according to "dry" and "wet" processes (Weil et al., 2014). The "dry" process only consists in drying, whereas the "wet" process includes blanching and sweating prior to drying. Traditionally, sweating, i.e. keeping the hot blanched product in a blanket for 24 h is widely used in the treatment of Malagasy vanilla beans. However, it is not used elsewhere on pepper and not described either in the literature. The objective of our study was thus to assess the impact of blanching, sweating and drying in controlled conditions on the quality of wild *Piper borbonense* pepper originating from Reunion Island. The quality characteristics considered in this study were pungency (piperine content), aroma (essential oil content and composition) and color (judged by eye and through L*, a* and b* chromatic values). The influence of blanching and sweating on drying kinetics was also assessed.

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2. Materials and methods

2.1. Plant material

We defined three maturity stages according to pepper color: A (immature green pepper), B (orange pepper – intermediate maturity) and C (red mature pepper). Wild mature (C) pepper spikes were picked in the south of Reunion Island. Spikes picked on different occasions were frozen at −80 °C (freezer Froilabo – Bio Memory, 690 L) before being pooled and mixed to form a single homogenous batch. Before processing, the peppercorns with their peduncles were separated from the fruit stems by hand and defrosted for two hours at room temperature. The defrosted pepper is called "fresh" pepper in the rest of this article.

2.2. Processing experiments

2.2.1. Blanching, sweating and drying

The processes consisted in three unit operations that were applied (alone or combined) to obtain different samples (Fig. 1). F: fresh pepper; B: blanched (B1: 60 °C/30 s; B2: 75 °C/180 s; B3: 100 °C/300 s); S: sweated (35 °C, 99% RH, 24 h); D: dried (60 °C, 20% RH, 39 h). Blanching consisted in soaking the peppercorns in a hot water bath (Memmert Gmbh type WB 22 Schwabach, Germany) at a ratio of 1:36 peppercorns to water in three different conditions: at 60 °C for 30 s; 75 °C/180 s; and 100 °C/300 s. Sweating consisted of storing the peppercorns in a climatic chamber (BIA Climatic – Type CL 125, Conflans Sainte Honorine, France) at 35 °C and 99% RH for 24 h. Drying was performed by placing aluminum trays (300 cm^2) containing 250 g of peppercorns arranged in a compact 1 cm thick layer for 39 h at 60 °C ± 1 °C, RH 20% ± 2% in the same climatic chamber. Hot air (60 ± 1 °C, RH 20 ± 2%) was circulated over the surface of the layer.

2.2.2. Drying kinetics

Drying of peppercorn samples used a cross flow pilot dryer, developed in our laboratory. In the treatment chamber (0.25 m long × 0.25 m wide × 0.92 m high), 150 g of peppercorns were placed on a sieve (0.25 × 0.25 m^2) in a single thin non-compact layer. Hot air (60 ± 1 °C, RH 20 ± 2%) was circulated downwards at 2.7 ± 0.1 ms^{-1} through the layer of peppercorns by a high-capacity fan. The air velocity was just high enough to have no significant effect on temperature when passing through the layer of peppercorns to ensure a proper treatment, and to enable statistical analyses. When the heat treatment was complete, the peppercorns were cooled by ventilation with air at ambient temperature. The water content, which was measured on a dry basis (noted X) as a function of time, was estimated in line, using the mass reading of the sieve. Water content kinetics $X^{(t)}$ were fitted with a cubic smoothing spline (Matlab® Version 5.2, The Mathworks Inc., USA). The drying rate (dX/dt) was calculated as the direct analytical derivative of the cubic smoothing spline function on $X^{(t)}$.

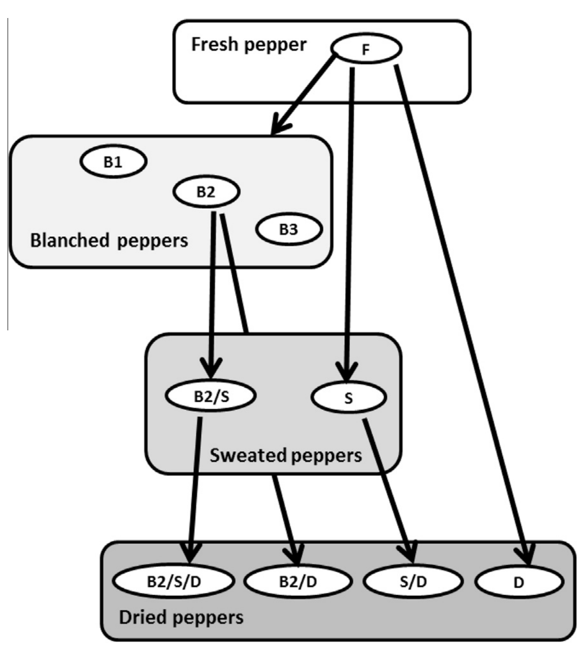

Fig. 1. Processes applied to pepper F: fresh pepper; B: blanched (B1:60 °C/30 s; B2: 75 °C/180 s; B3: 100 °C/300 s); S: sweated (35 °C, 99% RH, 24 h); D: dried (60 °C, 20% RH, 39 h).

2.3. Sample preparation

The samples resulting from the different processing operations were frozen at −80 °C for further preparation and analysis. The pepper samples were ground for 10 s at 10,000 rpm in mill (Retsch – Grindomix GM200, Retsch Gmbh, Germany) for all analyses except color which was measured on whole peppercorns.

2.4. Analytical methods

2.4.1. Dry matter content

The dry matter content (mean "essential oil free dry matter") was obtained by drying 5 g of ground pepper in an aluminum cup in the oven (ULE 400, Memmert Gmbh, Germany) at 105 °C for 30 h (i.e., until constant weight). Initial and final mass was determined with a precision balance (Scaltec SBC 22 model, Scaltec Gmbh, Germany). The mean standard deviation of repeatability was ±0.6% (n = 3). Water content expressed on a dry basis was deduced from essential oil and dry matter content.

2.4.2. Piperine content

The piperine content, expressed on a dry basis, was determined according to the spectrophotometric method described in ISO 5564 (International Standard Organization., 1982). The spectrophotometer used was a Thermospectronic Helios α v4.60 (Thermo Fisher Scientific, USA). The mean relative deviation of repeatability was ±7.3% (n = 3).

2.4.3. Essential oil content

The essential oil content, expressed on a dry basis, was determined using a method adapted from the standard ISO 6571 (International Standard Organization., 2008). One modification in the applied method was the elimination of xylene. The mean relative deviation of repeatability was ±2.2% (n = 3).

2.4.4. Color measurements

Color measurements (CIE L^*, a^* and b^* values, representing lightness, redness and yellowness, respectively) were made on whole peppercorns using a Minolta CR 400 and utility software. Ten measurements were made on each sample of peppercorns spread in a 1-cm layer in an uncovered Petri dish. The mean relative deviation of repeatability was 1.2%, 2.3% and 3.6% respectively for L^*, a^*, b^* (n = 10).

2.4.5. Identification and quantification of essential oil compounds

2.4.5.1. Separation on a polar column. Volatile compounds were analyzed on a GC (HP 6890), equipped with a Supelco-Wax polar column (Supelco −60 m × 320 μm × 0.25 μm) coupled to a MS detector. Aliquots (0.1 μL) of concentrated essential oil (obtained as described in Section 2.4.3. above) were injected into the GC–MS in split mode (1:30). The injector's temperature was 250 °C.