Effect of physiological harvest stages on the composition of bioactive compounds in Cavendish bananas*

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Abstract: The combined influence of maturation, ripening, and climate on the profile of bioactive compounds was studied in banana (Musa acuminata, AAA, Cavendish, cv. Grande Naine). Their bioactive compounds were determined by the Folin-Ciocalteu assay and high-performance thin layer chromatographic (HPTLC) method. The polyphenol content of bananas harvested after 400 degree days remained unchanged during ripening, while bananas harvested after 600 and 900 degree days exhibited a significant polyphenol increase. Although dopamine was the polyphenol with the highest concentration in banana peels during the green developmental stage and ripening, its kinetics differed from the total polyphenol profile. Our results showed that this matrix of choice (maturation, ripening, and climate) may allow selection of the banana (M. acuminata, AAA, Cavendish, cv. Grande Naine) status that will produce optimal concentrations of identified compounds with human health relevance.

Key words: Banana, Ripening, Harvest ages, Polyphenol, Dopamine, Starch
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1 Introduction

The banana is now produced in about 120 countries on the five continents, and is among the most cultivated of all fruits (Lassoudière, 2007). About 85% of banana production is used for local consumption or industrial purposes, and only 15% is exported (Lescot, 2006). In the French West Indies (FWI), the banana (Musa acuminata, AAA, Cavendish, cv. Grande Naine) is almost the sole cultivar and unfortunately is often grown as an intensive monoculture. Despite its contribution to local economic activities and high production of up to 500000 t/a, the banana faces global competition, environmental and, more importantly, industrial processing issues. The quality screening for the industrial processing of banana requires knowledge of several parameters such as the cultivar, development stage, and postharvest characterization. Health awareness combined with novel functionality has increased the demand for banana-based products with good health benefits. The most abundant compounds in bananas such as carbohydrates, including starch, and soluble sugars have been studied, but few studies have focused on the kinetic accumulation of bioactive compounds.
Reports of the chemical composition of the banana have shown that it is rich in minerals and dietary fiber, and is a good source of vitamins C and E (von Loesecke, 1950). Similarly, the antioxidants galloclatechin, catechin, and epicatechin were previously identified in banana (Someya et al., 2002). However, the maturation stage and the postharvest treatments were not specified in the study. Despite the status of the banana as a climacteric fruit, the distribution of bioactive and nutritional compounds was poorly described as a function of major parameters. Here, the influence of maturation and ripening on the profile of bioactive compounds in banana (M. acuminata, AAA, Cavendish, cv. Grande Naine) was studied at the green developmental stages of 400, 600, and 900 degree days (dd). The general features and chemical composition of the bananas were assessed. We showed that pre-harvest factors (climate and maturation) affected fruit weight, starch and polyphenols/dopamine levels with an inverse correlation between maturity and compound concentrations. Also, dry periods and immaturity differentially increased the total content of polyphenols compared to the dopamine content. The postharvest factor (ripening) impacted the chemical evolution profile depending on the development stage.

This work may contribute to the FWI banana brand by validating nutritional data about the content of some bioactive compounds. Indeed, such data provide a more complete description of the organoleptic and chemical properties of FWI bananas (M. acuminata, AAA, Cavendish, cv. Grande Naine).

2 Materials and methods

2.1 Materials

The banana fruits (M. acuminata, AAA, Cavendish, cv. Grande Naine) used in this study were harvested in October 2010, during the hot humid season (wet period, WP) and in May 2011, during the cool dry season (dry period, DP) as previously described (Bugaud et al., 2007). All bananas were grown in the same soil zone and obtained from the CIRAD, Neufchâteau Station, at Sainte Marie, Capesterre-Belle-Eau, in Guadeloupe, France.

All tissues used in this study were harvested from six banana plants (M. acuminata, AAA, Cavendish, cv. Grande Naine) grown at the CIRAD research station (elevation: 250 m; andosol; rainfall: 3500 mm/a), Guadeloupe. During growth, fruit bunches on banana plants were covered with blue plastic bags to hamper insect infestations, and to streamline the development of whole fruits on the bunch. Based on the heat unit concept (Ganry and Meyer, 1975; Jullien et al., 2008), green fruits were harvested at three developmental stages, namely 400 (immature green or iMG-fruit), 600 (early mature green or eMG-fruit), and 900 dd (late mature green or lMG-fruit) corresponding to about 40, 60, and 90 d, respectively, after flowering (Mbéguié-A-Mbéguié et al., 2007). At each harvesting time, only internal fingers of the median hand on the bunch, considered as comparable (Liu, 1976), were taken into account for each bunch. After harvest and an antifungal bath, all fruits were kept for 24 h at 20 °C in chambers ventilated with humidified air before being treated with 1000 or 10 000 μl/L of acetylene for 24 h at 20 °C and ambient humidity. From 1 to 9 d after treatment (DAT), a sample of three fruits was taken daily and subjected to physicochemical analyses including color, peel hardness, pulp firmness, and dry matter (DM) measurement.

Peel tissue, without the apex and stalk, and pulp tissue were frozen separately in liquid nitrogen. Then, one part of the sample was stored at −80 °C for total phenol compound and dopamine analyses and the other part was freeze-dried for starch and soluble sugar analyses.

2.2 Color, peel hardness, pulp firmness, weight, pulp/peel ratio, and dry matter measurement

The colorimetric coordinates of fresh banana peels were measured using a Minolta Chroma Meter CR 400 (color space CIE L*, a* and b*). The rheological characteristics such as pulp firmness and peel hardness were measured on fresh bananas using a TA-XT2 penetrometer. A cylindrical metal borer with a diameter of 4.9 mm penetrated the fresh unpeeled fruit at constant speed (2 mm/s) to a depth of 10 mm. The maximum force applied to break up the peel represented the peel firmness (expressed in Newton (N)). The slope of the force/time curve represented the fruit firmness (expressed in N/s) as described by Breene (1975). For DM measurement, 2-g fresh FWI Cavendish banana was oven-dried at 105 °C for 18 h and then weighed.