Volatiles of 'Hass' avocado – Key to fruit quality and maturity determination?

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ABSTRACT

Fruit volatiles were extracted from freshly harvested 'Hass' avocados in two seasons, to investigate if a certain volatile, or a certain volatile composition, characterises different fruit maturity stages. Therefore, the ease of extraction of volatiles was investigated as well as the change in volatiles from early- and mid-season fruit determined. Two major volatile compounds were determined, α-humulene and β-caryophyllene, the concentration of which differed significantly between the early- and mid-season fruit. The volatile β-caryophyllene was the dominant volatile at both picking stages. Further investigations are required to ascertain if these volatile compounds or certain concentrations of these are responsible for the "immature" off-flavour of 'Hass' avocado and if early detection of their concentration, on the packing line, could avoid sending such "immature" fruit to overseas markets.

INTRODUCTION

Ripening of climacteric fruit, such as the avocado, involves a series of coordinated metabolic events which alter their anatomy, biochemistry, physiology and gene expression (Giovannoni, 2001). These alterations affect many characteristics, such as colour, flavour and texture of the fruit (Cai *et al*., 2006) resulting in a certain fruit maturity. Certain biochemical measurements used as maturity indices, as they change with fruit development, include titratable acidity, total soluble sugars, starch, carotenoids and physical measurements such as fruit weight, firmness and colour; however, these attributes are not always correlated with optimal quality (Cristo, 1994). Fruit dry matter as well as fruit starch – and, hence, soluble solids – can be predicted non-destructively using near-infrared spectroscopy (Saranwong *et al*., 2004). The dominant volatile compound during storage and shelf-life is the ripening indicator ethylene (Pratt *et al*., 1948). Several reports, however, have indicated that fruit volatiles are also associated with fruit quality and maturity (*e.g*. papaya, *Carica papaya* L.) (Almora *et al.,* 2004).

The harvesting period of avocado extends over several months; therefore, the fruit harvested last in a certain location remains several months longer on the tree, further accumulating sugars and oils (Tesfay *et al*., 2010). However, as these oils can be precursors to certain volatiles (Sánchez & Harwood, 2002), the volatile spectrum is also likely to change, possibly resulting in an "immature smell" of some early-season fruit compared with the "mature smell" of mid- or late-season fruit. Similarly, if fruit are kept beyond certain softness, off-flavour volatiles may become present. It would, therefore, be beneficial to be able to detect if fruit, when harvested early in the season, will develop such an "immature smell" once ripened.

This experiment, therefore, aimed to investigate the fruit volatile composition of fruit from two different picking seasons to be able to detect which volatiles are present at these various stages of avocado fruit development.

MATERIALS AND METHODS

Thirty-six 'Hass' fruit were harvested in both seasons. Nine fruit divided into four replications were harvested during the early- as well as the mid-season. Mesocarp samples of these fruit were analysed for volatiles using GC-FID according to Defilippi *et al.* (2005).

RESULTS AND DISCUSSION

Gas-chromatographic analysis of the volatile compounds revealed that only few volatile compounds are present in the mesocarp (**Figure 1**). Different patterns of fruit volatiles were produced at different maturity stages. In fruit of the early-season (oil content at picking 35%) *β*-caryophyllene was the dominant volatile compound, followed by *α*-humulene, 1-dodecanol and, lastly, 1-pentanol. As the season progressed and the oil content in the mesocarp increased to 39%, *β*-caryophyllene increased concomitantly, while α-humulene decreased (**Table 1**).

Therefore, *β*-caryophyllene could be one of the potential fruit quality indicators. However, in oil-accumulating fruit, like olive and avocado, fruit flavour components are commonly lipid breakdown products (Kalua *et al*., 2005), indicating that substances derived from the major fatty acids of avocado (oleic and linoleic acid, Moreno *et al*., 2003) are more likely to be typical flavour components. It might also be that the "immature smell" of some early-season fruit is derived from a combination of volatiles, and that the combination of very small concentrations of certain volatiles results in a typical odour of a mature 'Hass' avocado.

"Electronic noses", instruments mimicking the human sense of smell, are already used to detect odours in the pharmaceutical and drug industry as well as for environmental control. In future, it might be possible to detect avocado fruit maturity depending on their volatile composition determined non-destructively using such "electronic noses". Then, depending on this fruit volatile profile, the processing or marketing of a certain batch can be determined.

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Table 1. Volatiles in 'Hass' avocado mesocarp (non-soft, mature fruit, densimeter reading: 84).

Volatile	Oil %	Early season 35 %	Mid season 39 %
1-dodecanol		4.31e	5.72e
1-pentanol		2.89e	3.84e
α – humulene		21.33c	13.70d
β – caryophyllene		68.00b	77.39a

Numbers followed by different letters in the table indicate significant difference (p = 0.05)

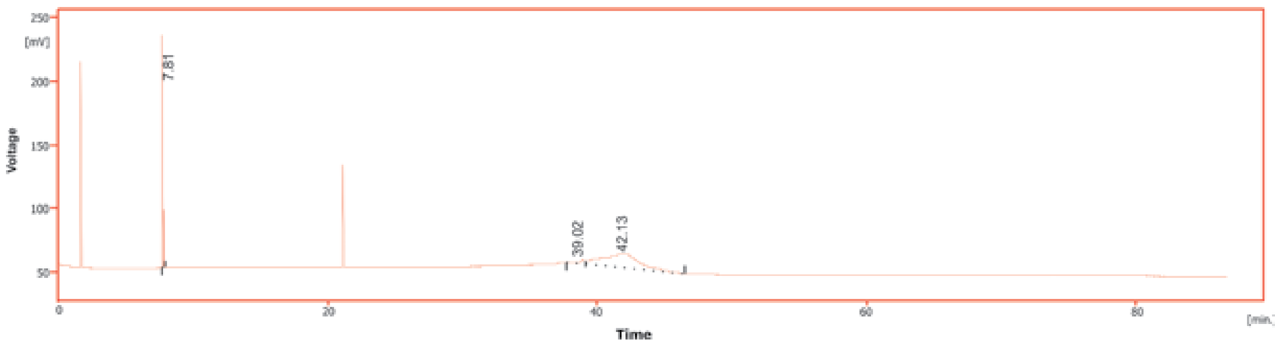

Figure 1. Typical chromatograms of mesocarp volatiles of freshly-picked (densimeter reading = 84) 'Hass' avocado (profile of early-season fruit).