Determining Volatile Compounds in ‘Hass’ and ‘Fuerte’ Avocado Flowers with Comprehensive Gas Chromatography Time of Flight Mass Spectrometry

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Introduction

The supplying of bee hives in avocado orchards to improve pollination and fruit set is highly expensive for avocado farmers, as for some reason avocado flowers are not very attractive to bees. Therefore, there is a need to find out why. Research has been done on flower structure and functioning, but there are still important aspects that need to be addressed such as the origin and identification of volatiles emitted from the flower. According to Afik *et al.* (2007), bees have to collect pollen as well as nectar in order for them to visit the male and also the female stage flowers. If they collect only pollen, they will not visit the female flowering stages and pollination cannot occur. The nectar component is therefore quite important and it could, most possibly, be the nectar that releases volatiles. Afik *et al.* (2014) also found that avocado nectar and honey were rich in a wide range of minerals including phosphorus and potassium, both of which are repellent to bees, however, the authors have not investigated the volatile compounds from the flowers. Therefore, the aim of this study was to determine the volatile profiles from avocado flowers.

Materials and Methods

The study was done in an orchard on the Experimental farm of the University of Pretoria in South Africa. Four replicates each of male and female stage flowers of ‘Hass’ and ‘Fuerte’ **(Figure 1)** were collected in Petri dishes containing a gel made up of 8% agar. Replicate sample sets (n=4) were sampled during late morning and late afternoon. The headspace of avocado flowers in agar was sampled using an inhouse developed sorptive method (Naudé & Rohwer, 2013). After headspace sampling analyses were done by thermal desorption with comprehensive gas chromatography time of flight mass spectrometry (TDS-GC x GC-TOFMS). The data were statistically analysed.

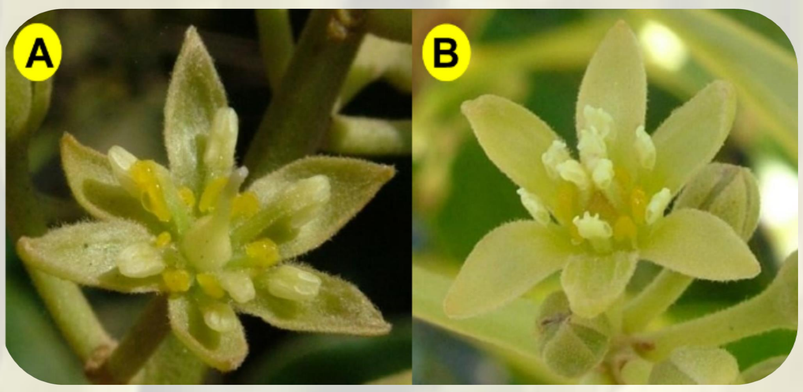

Figure 1. Photographical illustration of a female stage (A) and male stage (B) of an avocado flower

Results and Discussion

‘Hass’ and ‘Fuerte’ avocado flowers in the male and female stages released 185 compounds in total. ‘Hass’ and ‘Fuerte’ flowers had very different volatile chemical profiles. There was also a significant difference between the volatile profiles of male and female flowers within each cultivar.

To highlight a few, monoterpenes seem to be released abundantly in ‘Fuerte’ flowers **(Figure 2)**, especially Eucalyptol (fresh camphor odour), Limonene (fresh citrus odour), alpha-Pinene and beta-Pinene (woody, green, pine odour). Alpha-Pinene is released predominantly high in the ‘Fuerte’ female flowers.

The sesquiterpene Germacrene D (green, woody odour) was prominent in ‘Fuerte’ male and female flowers **(Figure 3)**. Other sesquiterpenes that was high in ‘Fuerte’ female flower samples were Humulene (alpha-Caryophyllene) (woody, earthy, herbal odour) and Copaene (woody odour). Beta-Caryophyllene (spicy, peppery, clove, woody, camphoreous odour) was prominent in ‘Fuerte’ female flowers as well as ‘Fuerte’ male flowers. Longifolene (sweet, woody, rose odour) was prominent in ‘Hass’ female flowers, whereas Cis,trans-alpha-Farnesene (floral odour) was prominent in ‘Hass’ male flowers **(Figure 3)**.

Estragole (licorice, anise odour) was abundant in ‘Fuerte’ flower samples and compounds of interest which were prominent in ‘Hass’ flower samples were esters, such as butyl butanoate (sweet, fruity odour) (Data not shown).

Figure 4 depicts the score plot of a Principle component analysis (PCA) of compounds present in the headspace of avocado flowers. The chemical profile of ‘Fuerte’ flowers differs from that of ‘Hass’ flowers. Furthermore, the chemical composition of male and female flowers also differs from each other **(Figure 5 and 6)**.

In general, ‘Fuerte’ flowers had pungent, spicy scents while ‘Hass’ flowers had sweeter scents.

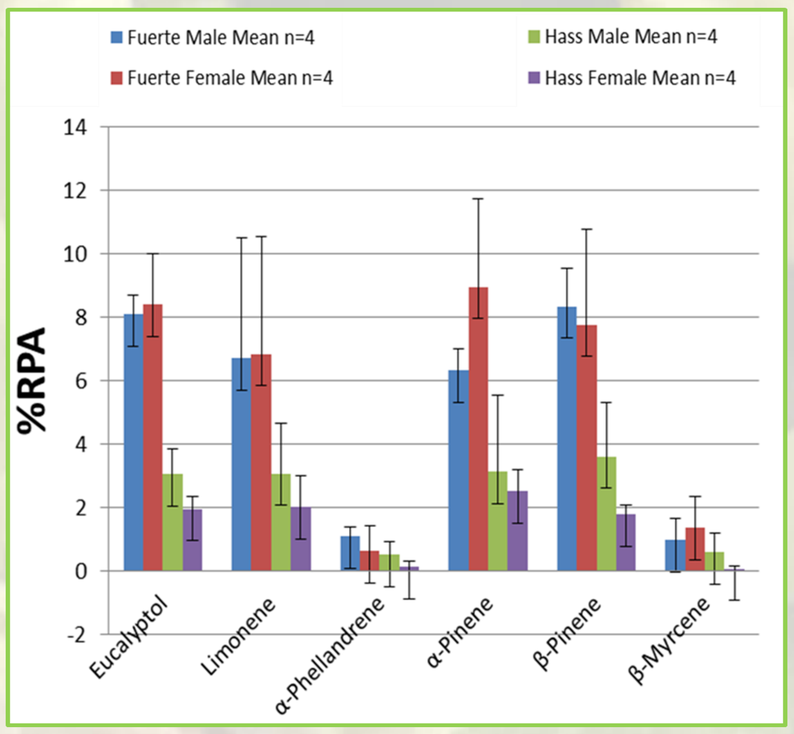

Figure 2. % Relative Peak Areas (%RPA) of selected Monoterpenes released by avocado flowers.

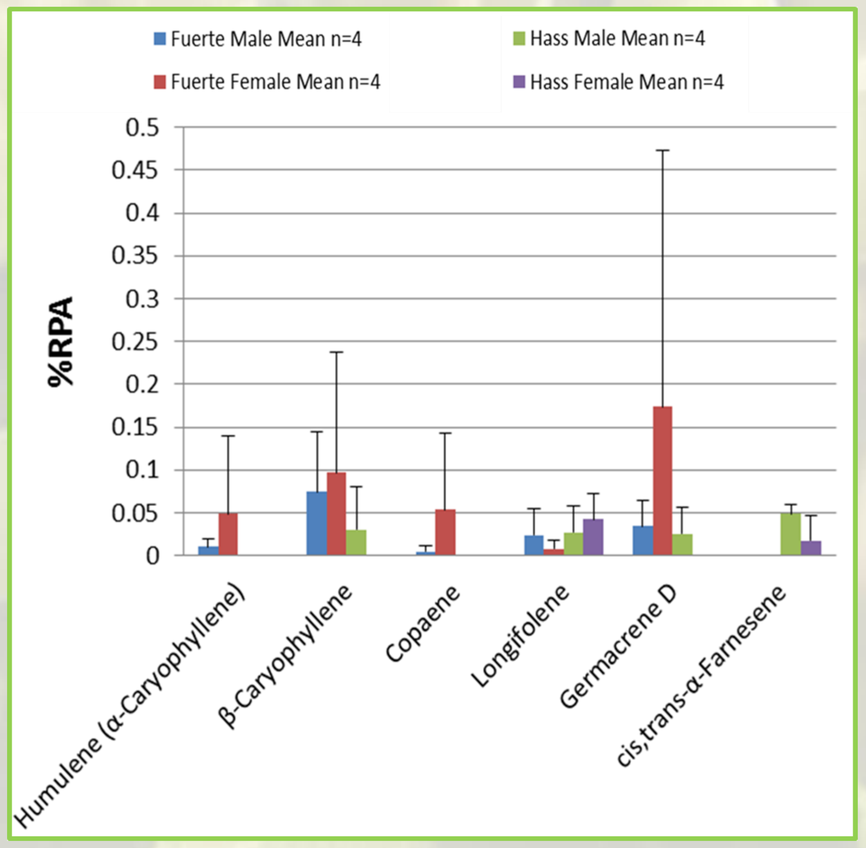

Figure 3. % Relative Peak Areas (%RPA) of Sesquiterpenes released by avocado flowers.

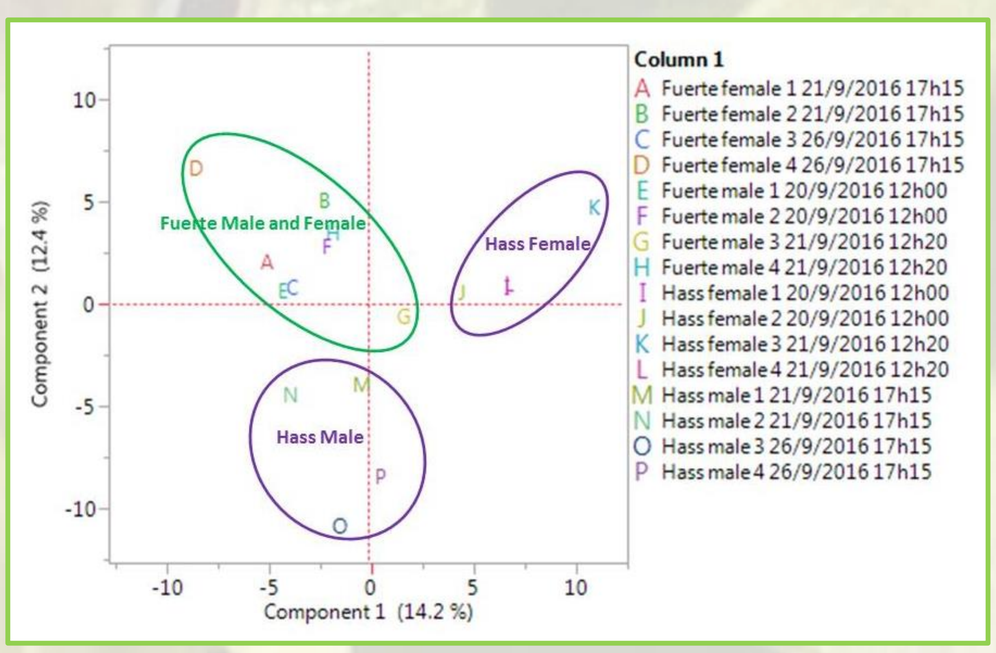

Figure 4. Score plot of a principle component analysis of the chemical compounds detected in the headspace of ‘Fuerte’ and ‘Hass’ male and female flowers.

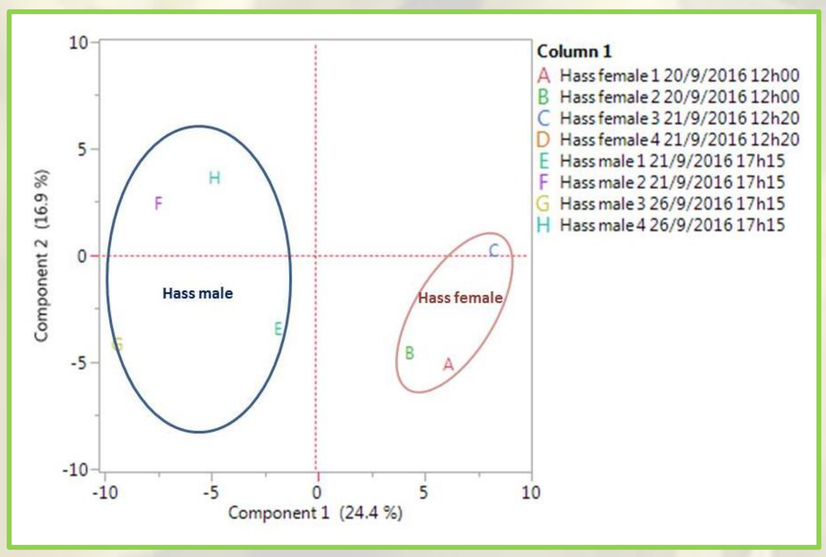

Figure 5. Score plot of a principle component analysis of the chemical compounds detected in the headspace of ‘Hass’ male and female flowers.

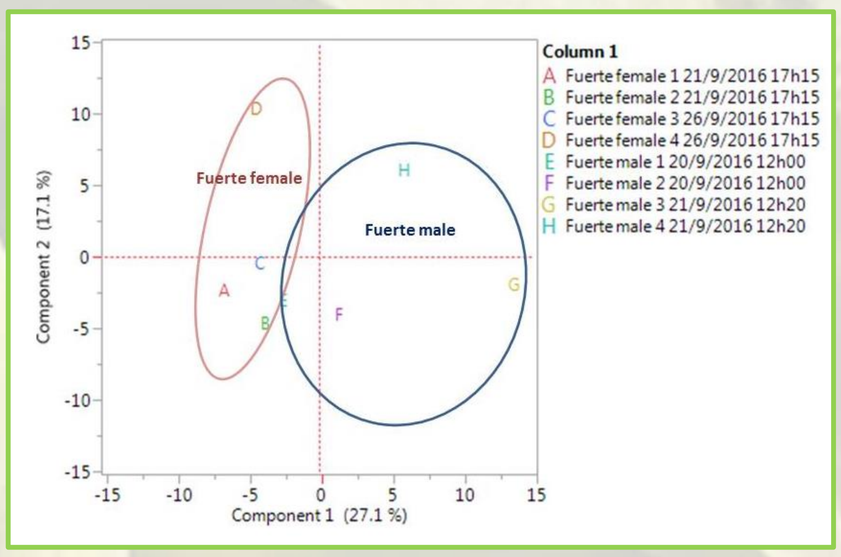

Figure 6. Score plot of a principle component analysis of the chemical compounds detected in the headspace of ‘Fuerte’ male and female flowers.

Conclusion

Avocado flowers produce a large number of volatile compounds which differed between the male and female phases of the flowers and also between the two cultivars that were studied.

Acknowledgements

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References

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