I am among those who think that science has great beauty. A scientist in his laboratory is not only a technician: he is also a child placed before natural phenomena which impress him like a fairy tale.

Marie Curie (1867 - 1934)

Chemist

Chapter 8

DISCUSSION

Aerial plant parts are structured and presented in such a way as to ensure survival and procreation. They are also exposed to all possible forms of meteorological and environmental effects. Therefore, plant surfaces and immediate subcuticular tissue in particular, must ensure continued existence through the evolution of an array of mechanisms and morphological adaptations (Jeffree, 1996; Barthlott & Neinhuis, 1997). These adaptations all contribute to protection of plant tissue against extreme levels of light, debilitating temperatures, water stress (due to flooding or drought), wind induced strain, chilling and desiccation, weight stress in snow and rain, and salt spray (Kolattukudy, 1996). Biotic interactions such as microbial attacks, predation and competition also contribute to morphological adaptations (Kays, 1999). Fruit, with the single most important function of dispersing subsequent generations, are particularly vulnerable to all the aforementioned calamities.

Management of fruit crops therefore rely on successful intervention of these potentially detrimental factors. Crop management can take the form of manipulation of both nutritional and water status, disease control by biological and chemical means, physical alteration through horticultural practices, and genetically predetermined breeding strategies. Mango fruit cultivar development exemplifies the expansion of characteristics like shape, colour, texture, taste and smell, while simultaneously facilitating commercial production of cultivars suited to export markets dictated by consumer and cultural influences (Majumder *et al*., 1972; Saúco, 2004). In this way, custom, diet and trade provide the impetus for the growth of fruit production in general. Benefits in fruit trade lead to concurrent growth and development of applicable skills and knowledge bases, secondary industries, and community infrastructures.

Less obvious, yet as important, is the particular role of the fruit surface in all phases of crop management and cultivar development. It not only is the interface between fruit contents and environment, but it also is the primary sensory input for consumers. Lack of

knowledge of the fruit surface and its importance as environmental interface invariably leads to costly and time consuming inefficiencies (Joubert, 2001). The complexity of mango fruit surfaces revealed by the ontogenetical study of the epicuticular wax, and subsequent study of lenticel morphology, illustrates this point. Exhaustive attempts have been made to manage the manifestation of lenticel discolouration (O'Hare *et al*., 1999), with the cosmetic nature of the condition established by this study. It was found that wax crystalloid structures were not cultivar dependant, but that morphological characteristics of lenticels play an important role. Although unclear what evolutionary pressures lead to the development of chronologically and structurally intricate layers, their chemical and morphological distinctiveness would suggest functionalities not yet fully understood. However, the relevance of epicuticular wax in the propensity of some cultivars towards lenticel discolouration has been proven (Donkin & Oosthuyse, 1996). Lenticel discolouration is not only associated with lenticels of a particular size and shape, but also with the density and complexity of the wax crystalloids inside the lenticels. With known contribution of environmental volatiles to epicuticular wax (Riederer & Markstädter, 1996), the role of volatiles in the chemistry of mango wax must be established. These volatiles determine cultivar aroma (Beaulieu & Lea, 2003), and may contribute to lenticel discolouration. If this should be the case, such information may assist in the formulation of postharvest management practices aimed at controlling the condition.

However, both postharvest and preharvest management can benefit from better understanding of the dynamics in the epicuticular membrane, since all crop management practices impact on the fruit surface. The vulnerability of mango fruit during its development, and continually more stringent requirements for non-chemical crop management, necessitates continued consideration of alternative measures for preharvest crop protection (De Oliveira Fonseca & Salomão, 2004). Such measures, however, must be based on complete information that takes fruit physiology as well as morphology into account. To this extent, understanding fruit epicuticular wax and its role as part of the fruit-atmosphere interface is important, even more so in monoculture crops. Cultivar development must take innate physiological and morphological qualities of different commodities into account. Wax crystalloids act both as light attenuators to screen against harmful ultraviolet light (Grant *et al*., 2003), and assisting in light harvesting during fruit set (Kolb *et al*., 2001). With the high levels of solarisation in South Africa, sunburn is a very serious problem. Application of kaolin was found to be a promising alternative measure for both sunburn and insect control. Nonetheless, repercussions and interference with the epicuticular interface during fruit development are uncertain and warrant further study. This includes not only the chemical interaction of the kaolin and the fruit wax, but also the

effect of the kaolin on the morphological development of the fruit surface, since kaolin may impact on the fluidity of the cuticular wax and cutin integrity.

Both mechanical and chemical interference with epicuticular fruit structures cannot be avoided in commercially cultivated fruit such as mango. Application of commercial wax on the packline is the final and most severe interference with epicuticular structures. Wherever plausible, such interferences should augment the physiological resilience of the crop, as is the objective in commercial wax formulation development (López *et al.,* 1995; Manzano *et al.,* 1997). These applications completely negate the architecture of the fruit wax, integrating it with the commercial wax. Still, commercially applied formulations are important in ensuring an appealing appearance and prolonged shelf life of marketable fruit. Furthermore, despite this structural disruption, antimicrobial properties of fruit wax (Moyna & Heinzen, 2001) may continue to be imbued in the aggregate film. However, this was not established in the present study and, together with more detailed chemical analyses of the fruit wax, should be the topic of future research.

Although many new questions have arisen and are still unanswered, this study of the development, and structural and chemical complexity of the mango fruit epicuticular membrane has contributed to current understanding of the mango fruit surface.

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