LENTICEL DEVELOPMENT AND DISCOLOURATION IN THE FRUIT OF SOME MANGO (*Mangifera indica* L.) CULTIVARS

by

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ABSTRACT

Lenticels are macroscopic openings occurring on the surface of roots, shoots and some fruits like apples, pears, avocados and mangos and are responsible for gaseous exchange and transpiration. The discolouration of the lenticels of some mango cultivars is a serious problem, affecting the economic value of the fruit, especially in 'TA' and 'Keitt' while problems with lenticel discolouration are seldom found in 'Kent'. Mango fruit lenticels develop from ruptured stomata on fruit from about 20 mm in 'TA' and 'Keitt' and 30 to 40 mm in 'Kent'. Lenticels enlarge as the fruit grows due to stretching of the fruit surface, reaching their maximum size on adult fruit. Fully developed lenticels of 'TA' and 'Keitt' are larger in size than those of 'Kent'. 'Kent' lenticels are also better insulated than 'TA' and 'Keitt', having a thick cuticle in the lenticel cavity and in some instances a phellogen is also present, while both of above mentioned characteristics are absent in 'TA' and 'Keitt'. Resin present in the skin of the fruit plays an important role in the discolouration of 'TA' and 'Keitt' lenticels. The resin of both 'TA' and 'Keitt' fruit contain a considerable amount of an aggressive compound termed terpenes. These terpenes are volatile and are able to move out of the resin ducts via the sublenticellular cells to the outside of the fruit through the lenticels. The integrity of tonoplasts of the sublenticellular cells are lost due to the action of the terpenes, causing vacuolar bound phenols to come into contact with polyphenol oxidase present in the cell walls. The product of the resultant reaction is a quinone accumulating as a brownish deposit in the cell walls, visible from the outside as black markings around the lenticels. Lenticel discolouration may, however also occur due to maltreatment or rough handling of fruit, high temperatures in the warm water bath, extended brushing on packline or breaking of the cold chain and spilling of resin onto the surface of the fruit.

UITTREKSEL

Lentiselle is makroskopiese opening op die oppervlak van wortels, stingels en sommige vrugte soos appels, pere, avokado's en mango's en is verantwoordelik vir gaswisseling en transpirasie van die plant. Lentiselverkleuring by sommige mango kultivars is 'n ernstige probleem wat die ekonomiese waarde van die vrug beïnvloed, veral by 'TA' and 'Keitt' terwyl lentiselverkleuring selde by 'Kent' voorkom. Lentiselle ontwikkel vanuit beskadigde stomas op vruggies van ongeveer 20 mm by 'TA' en 'Keitt' en 30 tot 40 mm by 'Kent'. Lentiselle vergroot namate die vrug groei en die oppervlakkige selle onder spanning verkeer. Maksimum grootte word bereik wanneer die vrug volwassenheid bereik. Volwasse lentiselle van 'TA' en 'Keitt' vrugte is groter as dié van 'Kent'. 'Kent' lentiselle is ook beter geïsoleer as 'TA' en 'Keitt' lentiselle. 'n Dik kutikula is teenwoordig in die lentiselholte en soms is daar ook 'n fellogeen (kurk kambium) in 'Kent' lentiselle gevind, terwyl beide afwesig was in 'TA' en 'Keitt' lentiselle. Hars wat in die skil van die vrug voorkom speel 'n belangrike rol by lentisel verkleuring in 'TA' en 'Keitt'. Die hars van beide 'TA' en 'Keitt' vrugte bevat 'n aansienlike hoeveelheid aggresiewe verbindings wat terpene genoem word. Dié terpene is vlugtig wat dit moontlik maak om vanuit die harskanale, deur sublentisellêre selle via die lentisel na buite te beweeg. Die integriteit van die tonoplasts van die vakuole in sublentisellêre selle word versteur as gevolg van die teenwoordigheid van die terpene. Dit veroorsaak dat vakuoolgebonde fenole met die ensiem polifenooloksidase in die selmembraan in aanraking kom. Die produk van die reaksie is 'n bruinerige qunoon wat in die selwande akkumuleer en die swart kleur aan die verkleurde lentiselle gee. Lentisel verkleuring kan ook veroorsaak word deur swak hantering van die vrugte soos byvoorbeeld: rowwe hantering, te hoë temperature in die warm water bad, verlengde periodes op die borsels in die paklyn, breek van die koue ketting en die mors van hars op die oppervlak van die skil van die vrug.

INTRODUCTION

In the 2001/02 season, the South African mango industry produced a total of 88 000 tons of fruit of which 16 851 tons were exported to foreign countries. An amount of about 5.25 million cartons were exported at an FOB price of R18.52 per carton, adding up to a total of R97.19 million worth of mangos, making up a substantial percentage of the income for a large number of mango farmers (Elphick, 2002).

Produce from and supply of a top quality product is therefore essential to ensure prime prices on the export market. To comply with this requirement, a series of rather strict criteria such as ripeness, taste, size, general appearance, minimum chemical residues present and a certain threshold of pest and disease incidence are needed to comply with. The outer appearance of the fruit plays in most instances a major roll in determining its economic value and therefore is an aesthetic attractive fruit of great importance.

In most mango producing countries around the world, producers have problems with the discolouration of lenticels on the fruit surface, especially after harvest and packaging (Tamjinda *et al.,* 1992). It is a serious problem because the dark coloured spots gives an undesirable impression and, secondly, it is incorrectly associated with pathogenic infections, consequently depreciating its economic value (O'Hare and Prasad, 1992).

Lenticels in general are macroscopic openings occurring on stems, old roots where the periderm (cork) has formed and on several fruit types (Dietz *et al.,* 1988). Lenticels are essential to the plant, since they control gaseous exchange for photosynthesis, respiration and transpiration in the absence of stomata (Mauseth, 1988).

On fruit like apples, pears and cherries, stretching and rupturing of the stomata due to fruit growth and enlargement can mostly be the beginning of lenticel

development, though, the lenticels can not always be regarded as “true” lenticels. This is due to the absence of a distinct phellogen below the lenticels (Clements, 1935 and Wilson, 1972).

Much research on different causal aspects on mango fruit discolouration has already been undertaken. Post-harvest treatments previously shown to increase lenticel discolouration include dipping fruit in hot water (45°C) for 30 min (Jacobi *et al.,* 2001); a combination of hot water and hot air (Jacobi *et al.,* 1996); washing fruit in one of several disinfectants or soaps including Agral®, Cold Power® or Mango Wash® (Bally *et al.,*1997); or washing fruit in ambient water (O’Hare *et al.,* 1999).

In order to understand the structure, function and discolouration of mango lenticels better, it is essential to know their origin and development. Dietz *et al.* (1988) maintained that lenticels may originate in one of two ways viz. from a preformed stoma, or from shearing of the fruit epidermis as a result of rapid fruit growth. Tamjinda *et al.* (1992) found that cells directly below the lenticel are smaller than surrounding cells and have larger intercellular spaces conforming to the situation in stomata.

The limited and insufficient literature on the formation, development and detailed anatomy of mango lenticels (Tamjinda *et al.,* 1992) emphasized the need for a more detailed study on the ontogeny and structure of mango lenticels that could form a base for interpreting lenticel discolouration.

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