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ULTRASTRUCTURAL STUDIES OF MANGO FRUIT RIPENING CV. BANGALORA

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ABSTRACT : Mango is one of the most important climacteric fruits, showed a peak respiration immediately after harvest. The biochemical and physiological changes during mango fruit ripening were extensively studied. But, the reports for ultra-structural changes is rarely examined. In this study, major structural changes like wax layer, loosening of cell integrity and starch degradation were observed under light microscopy and scanning electron microscope. In unripe mango fruits the wax layers covered the filaments present beneath the pericarp were gradually visible when ripening starts, tightly packed cells were loosening and starch granule hydrolysis during fruit ripening were observed.

Key words : Mango, ultra structure, cuticular wax, intercellular space, starch granules and microscope.

INTRODUCTION

Mango (*Mangifera indica* Linn.) is the most important fruit crop of India and known as 'King of fruits'. Based on respiration rate mango is considered as climacteric fruit, because of its sudden upsurge in respiration rate after harvest. The main change of starch to sugar metabolism starts during fruit development in all mango cultivars except cv. Keitt (Simaao *et al*, 2008). Fruit ripening is an integrated process of structural, biochemical, physical and physiological changes. Structural changes associated with superficial structure of cuticular wax, starch degradation and intercellular space. Apart, increased solubility, depolymerization, de-esterification of polysaccharides and loss in neutral sugar side chains are some common phenomenon observed during ripening.

In general, mango fruit consists of exocarp, mesocarp and endocarp. Exocarp includes cuticle, single-cell epidermal layer and several thick cell wall layers. The cuticle is composed of a polymer matrix of long chain polyesters, the cutin; waxes are embedded in the cutin and deposited on its external surface (Storey and Price, 1999). In mesocarp of unripe mango fruits starch is the major polysaccharide. Starch granules disappear during fruit ripening due to different level of hydrolysis of starch granules. Intercellular space is one of the prominent structural changes during ripening. The pectin substance present in the middle lamella acts as cementing agent and joins the cells together through calcium ions. During ripening due to esterification of pectin substance the cells loosen their integrity and softening and intercellular space were formed. Since, the study of changes in physical aspect is studied less extensive, especially in Indian mango cultivars; this study was aimed to present the changes in prominent south Indian mango cultivar Bangalora.

MATERIALS AND METHODS

Mango cv. Bangalora is widely grown in south India. It also goes by the names Bangalora, Collector, Kallamai and Kili Mooku. According to Krishnagiri farmers Bangalora is considered as king of mangoes, because of its preference by mango pulp industries (Reference not cited).

Mango fruits of cv. Bangalora were harvested from Krishnagiri region of Tamilnadu during 2012, for studying the ultra-structural changes takes place at the time ripening. The unripe samples were examined immediately after harvest and after seven days ripe samples were collected from the fruit lot stored at ambient condition (Temperature: 27±3°C, RH: 60±5%) for further studies.

The fresh sample was collected from unripe and ripe mango fruits of cultivar Bangalora. The fruit pulp and peel were cut into segments of 2-3 mm length and 0.5 mm thickness with the help of a surgical blade and observed under digital microscope with 10 X magnification (Version 4.1 Biowizard image analysis software) and scanning electron microscope (SEM) (Model: Environmental Scanning Electron microscopy, Made: Switzerland, Detector: Large field sensory electron detector (LFD), Vacuum: 100 Pascal).

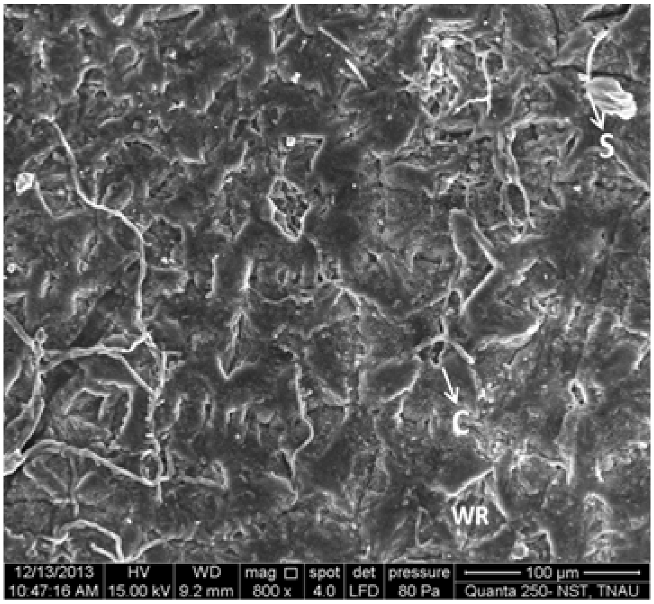

Fig. 1 : Superficial peel surface of unripe mango fruit cv. Bangalora (WR – Wax Ridges, C – Crack, S - Scale).

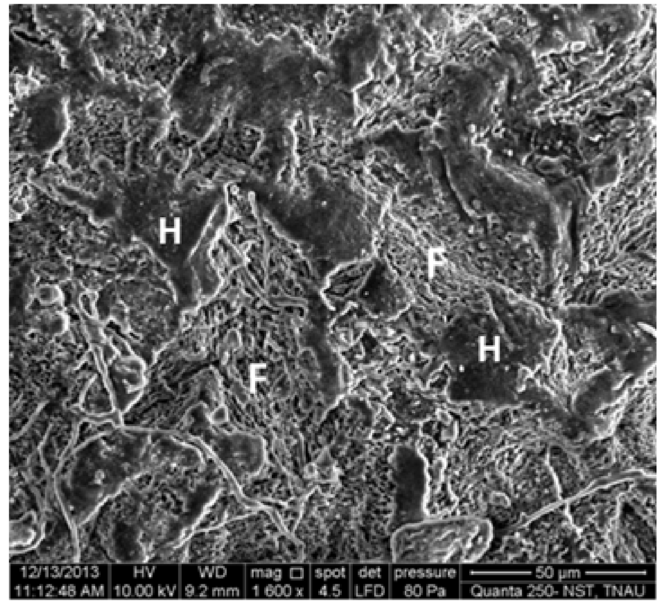

Fig. 2 : Superficial peel surface of ripe mango fruit cv. Bangalora (H – Holes, F - Filaments).

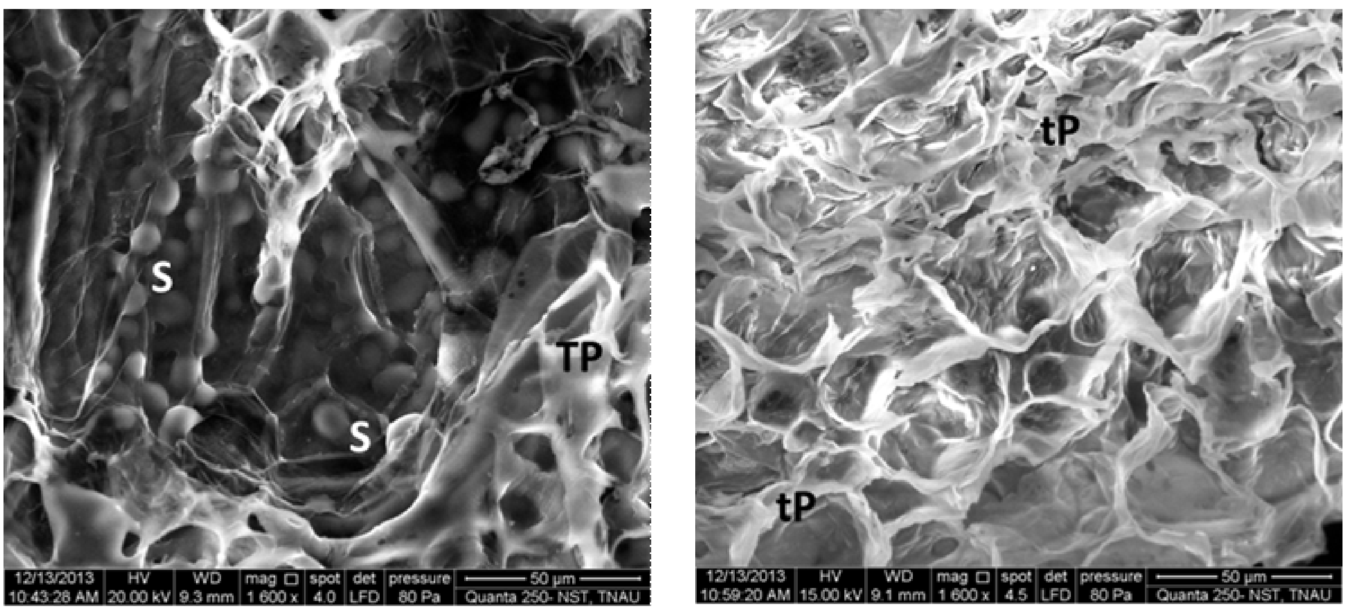

Fig. 3 : Scanning electron micrographs of starch hydrolysis in ripening of mango fruits cv. Bangalora (S – starch granules, TP – Thick parenchyma, tP – Thin parenchyma).

RESULTS AND DISCUSSION

Microscopy studies on ripening of mango fruits

The superficial surface of mango peel is made up of cuticles and wax. The cuticular wax consisted of wax ridges, they joined together and form a protectant layer to prevent the transpiration loss and minimize the gaseous exchange. The arrangement of wax ridges was compact in unripe fruits with few scales and cracks were also observed in immediately harvested mango fruits cv. Bangalora (Fig. 1). During ripening the wax layer present in the exocarp of the fruit disappeared. So that, the filaments like structure made up of parenchyma cells beneath the exocarp were visible in ripe mango fruits (Fig. 2). The wax layer became smooth and the Fig. 2 showed small holes due to extend of cracks among the wax ridges. The results were also supported by Han *et al* (2006) in Mango cultivar "Red 6". Their findings included that number of wax ridges per unit area was decreased during ripening.

In general, fruit mesocarp tissues are made of parenchyma cells. At the time of ripening the thick parenchyma cells become thin. The starch granules present in between the parenchyma cells were prominent

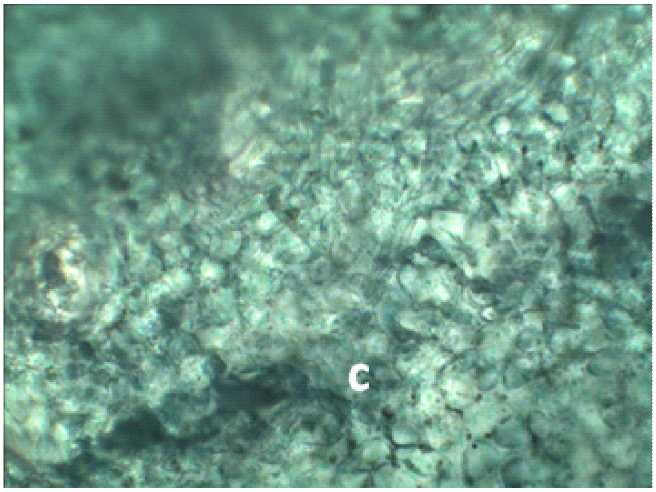

Fig. 4 : Light micrographic view of compact cell in unripe mango fruits cv. Bangalora (C- Cell).

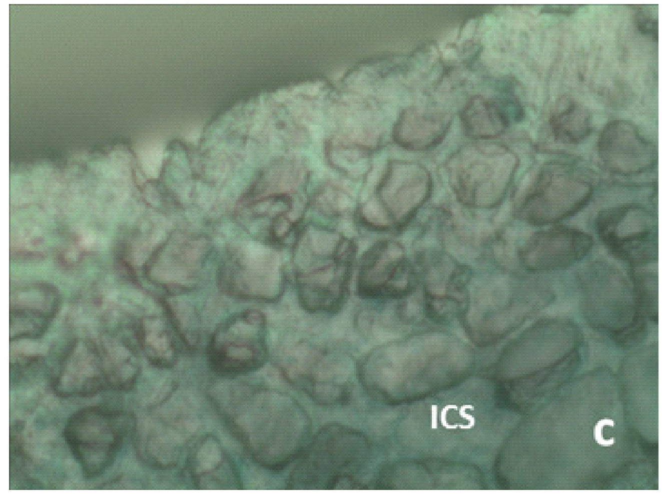

Fig. 5 : Light micrographic view of cells with intercellular space in ripe mango fruit cv. Bangalora (C- Cell, ICS – Intercellular space).

in unripe fruits and disappeared in ripe fruit (Fig. 3) because of starch hydrolysis. Numerous enzymes are involved in starch degradation, among then á- amylase and â- amylase are tremendously involved in starch hydrolysis. The action of these enzymes is conversion of the insoluble, semi-crystalline matrix formed by amylopectin to soluble sugars (Zeeman *et al,* 2007). The rate of starch degradation is apache when compared to other climacteric fruits like apple. The reason behind this is closely associated with corrosion of starch granules. The corrosion of starch granules takes place simultaneously at two points may lead to complete and rapid degradation of starch granules or sometimes form holes on starch granules (Simaao *et al*, 2008).

Light micrographs view (Fig.4) showed compactly arranged cell in unripe mango fruit cv. Bangalora and Fig. 5 the sample of ripe fruits showed prominent intercellular space and loss cells. The bulk of fruit tissue is composed of parenchyma cells which expand considerably during growth so that at maturity their walls are thin and their shape results in the formation of intercellular space (ICS) (Hobson, 2000). The major polysaccharides present in cell wall are cellulose, hemicellulose and pectin. Cellulose fibrils are embedded in hemicellulose substance and the pectin present in the middle lamella integrates the cells. During fruit ripening, increased pectin solubility was observed in almost all the fruits. The primary contributor of pectin solubility is depolymerization and degalactosidation (Rose *et al,* 1998). Loss of neutral sugars, pectin polymers like galactose and arabinose from cell wall (Chin *et al,* 1999). Xyloglucan a predominant hemicellulosic polysaccharide degrades during fruit ripening. The degradation of Xyloglucan accompanied by extensive breakdown of pectin may be due to increased hydrolase mobility (Wakabayashi, 2000).

CONCLUSION

The ultra morphological studied undertaken in mango during ripening process clearly demonstrated that the starch granules are prominent and clear at the early stage of ripening and got smudged and coalesced when the ripening is at the later stage. Starch morphological disintegration was visualized clearly under high resolution imaging using SEM.

REFERENCES

Chin L H, Ali Z M and Lazan H (1999) Cell wall modifications, degrading enzymes and softening of carambola fruit during ripening. *J. Exp. Botany* **50,** 767-775.

Han J, Tian S P, Meng X H and Ding Z S (2006) Response of physiologic metabolism and cell structures in mango fruit to exogenous methyl salicylate under low-temperature stress. *Physiologia Plantarum* **128,** 125–133.

Hobson G E (2012) Enzymes and texture changes during ripening. In: *Recent advences in the biochemistry of fruits and vegetables*. (eds. Friend J and Rhodes M J C), Academic Press Inc., London. pp-121.

Rose J K C, Hadfield K A, Labavitch J M and Bennet A B (1998) Temporal sequence of cell wall disassembly in rapidly ripening melon fruit. *Plant Physiol***. 117,** 345-361.

Simaao R A, Silva A P F B, Peroni F H G, Nascimento J R O D, Louro R P, Lajolo F M and Cordenunsi B R (2008) Mango Starch Degradation. I. A Microscopic View of the Granule during Ripening. *J. Agric. Food Chem.* **56,** 7410-7415.

Wakabayashi K (2000) Changes in cell wall polysaccharides durign fruit ripening. *J. Plant Res.* **113,** 231-237.

Zeeman S C, Delatte T, Messerli G, Umhang M, Stettler M, Mettler T, Streb S, Reinhold H and Kotting O (2007) Starch breakdowm: recent discoveries suggest distinct pathways and novel mechanism. *Fun. Plant Biol.* **34,** 465-475.