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Secretory Duct Structure and Phytochemistry Compounds of Yellow Latex in Mangosteen Fruit

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Yellow latex is the main problem in mangosteen agribusiness, because it is one factor lowering the fruit quality. The structure of yellow latex secretory ducts in the flower and fruit as well as in the root, stem and leaf of mangosteen (*Garcinia mangostana* L.) seedling and the qualitative phytochemistry of yellow latex were studied. The ducts were branched, canal-like type. They were found in the exocarp, mesocarp, endocarp, aril of the fruit, flower, stem, and leaf. In the fruit, the biggest diameter of the secretory ducts was found in the endocarp. There were continuous secretory ducts from fruit stalk to the fruit. Ultrastructural observation showed that the ducts surrounded by specific epithelial cells, which were living cells containing dense cytoplasm with plastid, mitochondria and golgi apparatus organelles. The qualitative test indicated that the yellow latex collected from stem bark, outer part of fruit, young fruit pericarp, mature aril and young aril contained terpenoid, flavonoid and tannin, but not alkaloid, saponin and steroid, except in the young aril containing the steroid.

Key words: secretory ducts, yellow latex, endocarp, aril, epithelial cells

INTRODUCTION

Mangosteen (*Garcinia mangostana* L.) is one of the main commodities of Indonesian export, known as the Queen of Tropical Fruits. Even though the fruit has been exported, the avaibility of good quality fruit is still inadequate.

The quality of the fruit varies from one production center to an other, because mangosteen plantations are managed traditionally and its production system depends on the nature. One factor lowering the fruit quality is the yellow latex disease. Yaacob and Tindall (1995) suggested that the yellow latex is a physiological disorder which showed symptoms of yellow fruit aril. At present, the yellow latex is the main problem in mangosteen agribusiness, since it does not only damage the appearance and cleanliness of outer part of fruit but also makes the aril bitter. The absence of the yellow latex is one of the criteria of mangosteen fruit to be exported to East Asian countries (Taiwan, Japan, and Korea) and Middle East countries (United Arab Emirates, Saudi Arabia, and Kuwait).

The exact causal agent of yellow latex disease has not been known yet. It is assumed that yellow latex is the natural latex found in mangosteen fruit similar to the latex found in the twig, petiole, leaf, and stem bark of Guttiferae family. The whole parts of the plant will excrete yellow exudate whenever wounded. Gamboge as resin exudate found on various plants from the family of Guttiferae originated from the broken resin canal/duct (Asano *et al*. 1996; Pankasemsuk *et al.* 1996). Any physical damage to the latex vessels could be caused by excessive watering after drought, punctures by sucking insects (capsids), strong wind, rough harvesting, and handling (Verheij 1992). The yellow latex in the mangosteen fruit may be excreted by unknown secretory tissues. Therefore, research concerning tissue or structure producing yellow latex is necessary to be carried out.

The continuity of secretory duct in the fruit and the fruit stalk is also necessary to be examined. The yellow latex found in aril may be excreted from endocarp, therefore, the density, and the size of the yellow latex secretory ducts in the endocarp is necessary to be studied. Research on compounds isolated from mangosteen leaf and pericarp has been conducted (Parveen *et al*. 1991; Ketsa & Atantee 1998). Whereas research on those from the yellow latex originated from mature and young aril, young fruit pericarp, outer part of fruit, and stem bark has never been reported. Therefore, the phytochemistry compounds of the yellow latex on those parts will also be conducted.

MATERIALS AND METHODS

Fruit sampling in the field was carried out on the production center of mangosteen in Cengal, Karacak village (6°60'S and 106°60'E, 490 m above sea level with an annual rainfall appoximately 1,515 mm), Leuwiliang subdistrict, Bogor regency, Indonesia. Ten of 20-years-old productive mangosteen trees were used in this research.

Sampling. Fruit samples were chosen randomly from the trees of mangosteen for further fruit anatomical study. Anatomical study of the fruits were examined in different development stages from buds until mature fruits. Each week

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ten flowers and fruits were taken routinely started one week before anthesis until 105 days after anthesis (DAA). There were 17 times observation namely -7, 0, 7, 14, 21, 28, 35, 42, 49, 56, 63, 70, 77, 84, 91, 98, 105 DAA.

Histological Study Using Light Microscope. Observation of yellow latex secretory structure of the fruit samples was carried out on pericarp and fruit stalk. As comparison yellow latex secretory ducts in root, stem and leaf of one-month-old mangosteen seedlings were also observed. Microscopic slides of cross and longitudinal sections were prepared by using paraffin method (Johansen 1940). The fruits were fixed in FAA solution (5 ml formaldehyde, 5 ml acetic acid glacial, 90 ml 70% alcohol). Dehydration and infiltration process was conducted by soaking the samples in Johansen series solutions. The samples were sectioned 10 µm thick by using rotary microtome. Then double staining using 2% safranin and 0.5% fast-green was carried out. Characters observed were distribution, density (number/mm^2), and diameter of yellow latex secretory ducts (µm). Observations under light microscope were carried out on five view area with three replication.

Histological Study Using Transmission Electron Microscope (TEM) was Prepared as Follows. The aril and the mesocarp tissues of 28 DAA fruit were fixed in 5% glutaraldehyde in 0.1 M sodium cacodylate, pH 7.4, temperature 4 ^{o}C for 24 hours, then postfixed in 2% osmium tetroxide in the same buffer 4 ^{o}C for 2 hours. The tissues were dehydrated in a gradual series of ethyl alcohol and infiltrated by propylene oxide and embedded in Spurr's resin. Ultrathin section (70 nm thick), cut with the ultracut Reichert ultramicrotome using a diamond knife and stained with 2% uranyl acetate and 4% triple lead and then were observed with a JEM 1010 transmission electron microscope at 80 kV.

Determination of Phytochemistry Compounds on the Yellow Latex. The yellow latex samples collected from mature and young aril, young fruit pericarp, outer part of fruit, and stem bark were analyzed qualitatively to check the presence of triterpenoid, flavonoid, tannin, alkaloid, and steroid compounds following the methods used by Harborne (1987). Availability test of triterpenoid and steroid used Lieberman-Burchard reactant (anhydrous acetic acid + concentrated H_2SO_4 + alcohol). Red indicated positive reaction for triterpenoid, green showed positive reaction for steroid. Flavonoid test used Mg powder several drops of concentrated HCl and amyl alcohol. Orange layer of amyl alcohol showed positive reaction of flavonoid. To examine the existence of tannin, 10% Fe Cl_3 was added to the filtrate. Greenish black indicated positive reaction of tannin, while saponin content showed positive reaction if the filtrate was strongly shaken and stable foam appeared. The existence of alkaloid compounds showed positive reaction if there were orange, white, and brown sediments successively after being reacted with Dragendrof, Mayer, and Wagner reactants.

RESULTS

Distribution of the Yellow Latex Secretory Ducts in Mangosteen Fruit. The ducts were found on flower bud (-7 DAA) and anthesis (0 DAA), in their ovaries (Table 1). The ducts were also found in young fruit stages (7-35 DAA), medium fruit stages (42-70 DAA), and mature fruit stages (77-105 DAA). In those stages, the ducts were found on the fruit pericarp either on exocarp, mesocarp or endocarp. The ducts were also seen in the fruit aril (Figure 1). The more mature was the fruit the lower the density of the ducts was on the fruit mesocarp. The less dense the ducts found, the bigger was the diameter of the ducts (Table 1).

Based on the cross section of the fruit pericarp, the structure type of the ducts consisted of a big lumens surrounded by specific epithelial cells (Figure 2). While on the longitudinal section of its pericarp, the ducts were elongated and branched (Figure 3). The yellow latex appeared on the aril when the fruit was 14-weeks-old. This can be seen on the damage of epithelial cells (Figure 4). Therefore, it can be said that the yellow latex seen on the aril originated from the endocarp secretory ducts.

The Yellow Latex Secretory Ducts in the Fruit Stalk. The result of longitudinal section of fruit and stalk indicated that the structure ducts in the fruit stalk was continuous with those of the fruit (Figure 5). The ducts in the fruit stalk were found in the cortex and among the vascular bundles. The diameter of the ducts among the vascular bundles was bigger than that in the cortex, which were 30-162.5 µm and 30-100 µm respectively.

The Yellow Latex Secretory Ducts in the Seedling. The objective of yellow latex secretory duct observation in one month seedling after sowing was to study the continuity of the yellow latex secretory ducts. The ducts were not found in the root. The observation of the ducts in the stem was carried out on various positions from one cm from the soil surface

Table 1. Diameter (µm) and density (number/mm^2) of yellow latex secretory ducts on various stages of mangosteen on ovary of the flower and pericarp of the fruit

Stages	Yellow latex secretory ducts diameter (µm)				Density* (number/mm^2)
	Outer ovary/exocarp	Mesophyl ovary/mesocarp	Inner ovary/endocarp	Aril	
Flower					
Bud	10.0-17.5	25.0-43.5	30.0- 67.5	-	-
Anthesis	12.5-27.5	31.3-68.8	35.0- 75.0	-	57.7-96.3
Fruit					
Young	22.5-50.0	56.3-112.5	50.0-145.0	25.0-100.0	8.3-20.5
Medium	27.5-67.5	62.5-168.8	62.5-190.0	45.0-112.5	6.5-7.6
Mature	30.0-82.5	67.5-175.0	112.5-262.5	45.0-137.5	5.1-6.3

*Yellow latex secretory ducts in mesophyl ovary or mesocarp.