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EPICARPIC STUDIES IN THE DEVELOPING FRUIT OF *EUGENIA JAMBOS* L. (MYRTACEAE)

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The structural features of the outer epidermis of *E. jambos* fruit revealed small-sized polygonal or isodiametric cells containing dense cytoplasm with prominent nuclei. Some abnormal stomatal types such as contiguous, paired stomata having common subsidiary cell, single guard cell with or without pore have been observed along with normal stomatal types. The epidermal and stomatal frequencies have been found to be decreased due to the enlargement and elongation of epicarpic cells in the developing fruit. Clefts in epicarp are formed due to splitting of the cell walls.

Keywords: Epicarp; Epidermis; *Eugenia;* Fruit; Myrtaceae; Stomata.

Introduction

The bell-shaped berry fruit of *E. jambos* turns yellowish when it ripens. It develops from the bicarpellary inferior ovary with axile placentation. Anomocytic and paracytic types of stomata on the foliar epidermis of Myrtaceae have been reported[1-3]. The present investigation is undertaken to trace out the epidermal features and stomatal complexes in the developing fruit wall of *E. jambos*.

Materials and Methods

The different developmental stages of *E. jambos* fruits starting from the ovary to mature fruit were collected and fixed in F.A.A[4]. Epidermal peels from basal, middle and terminal regions of all developmental stages of fruit were obtained by treating the fruit walls with 60% HNO_3[5] and stained with iron haematoxylin or 1% aqueous safranine. Starch grains and oil granules were localized with I_2KI and Sudan Black B respectively[6]. Drawings were made using Austrian Projection Microscope (REICHERT). The frequencies of epidermal cells and stomatal complexes were counted under Olympus Microscope by taking field area in 400 X (Table 1) and the stoamtal index has been calculated[7].

Observations

The epidermal cells of the ovary wall are small, polygonal or isodiametric (Fig. 1A). However, occasionally they appear elongated and irregularly arranged. As the fruit grows, the size of the epidermal cells increases and cell walls become thick and beaded in nature. An abnormal wall thickening is also noticed in the epicarp of different parts of the fruit. Epidermal cells are found to contain dense cytoplasm with prominent and spherical nuclei along with starch grains and oil granules. Epidermal cells of the developing epicarp undergo divisions but the frequency of division is found to be decreased gradually towards maturity due to the enlargement and elongation of epidermal cells (Table 1).

Stomata: The epicarp of developing fruit possesses predominantly six types of stomata viz., anomocytic (Figs. 1 B-F), anisocytic (Fig. 1 G & H), paracytic (Figs. 1 K & L), hemiparacytic (Fig. 1 S), staurocytic (Figs. 1 I& J) and tetracytic (Fig. 1 M) (Table 1). There is no definite pattern of orientation of stomata as they are oriented in differnt directions. Anomocytic and anisocytic stomata are present more frequently than any other types. Anomocytic stomata are surrounded by three to seven epidermal cells (Figs. 1B-F), whereas staurocytic stomata are found with four subsidiary cells oriented in a crossed direction to the pore (Fig.1 I) or at 45° to it (Fig. 1 J). An unusual wall thickening is observed in the ledges of guard cells. Occasionally the outer cuticular ledge is more thickened on one side only (Figs. 1 E & I). The outer stomatal rim is quite distinct and their outline usually follows those of guard cells. Sometimes a constriction is also observed in the inner stomatal rim (Figs. 1 F & H) which may be single or double (Figs. 1 D, F & H) or may be without constriction (Fig. 1 C). The inner rim may be either opened on one polar end and closed on the opposite end (Figs. 1 B,L & P) or it may be completely closed (Figs. 1 J,K,P,S & V). The stomatal frequency varies from tip to base during different developmental stages and highest in the middle region of the fruit. The length and breadth of guard cells, pore size, stomatal index and stomatal frequency decreases significantly as the fruit matures (Table 1).

The occurrence of stomatal abnormalities like contiguous stomata (Fig. 1 P), paired stomata having common subsidiary cell (Fig. 1Q), stomata with one guard cell (Fig. 1 T), guard cell without pore(Fig. 1 U), stomata having two subsidiary cells parallel to guard cell on one side (Fig. 1 X), and stomata with aborted guard cells (Fig. 1 W) are also observed. Although a large number

Figs. 1 A to X: Fig. A. Outer epidermal cells from ovary wall; B. Anomocytic stomata showing the inner rim : the pore on polar side; C. Anomocytic stomata showing the inner rim not constricted but narrow and thinner than the outer rim; D. Anomocytic stomata showing more constricted inner rim; E. Anomocytic stomata showing thicker outer rim or ledge than the opposite one; F. Anomocytic stomata showing constricted inner rim; G. Anisocytic stomata showing inner rim not constricted but thinner than the outer rim; H. Anisocytic stomata showing double constricted inner rim; I. Staurocytic stomata showing only one side of the ledge thicker than opposite side; J. Staurocytic stomata showing thin and closed inner rim; K&L. Paracytic stomata; M. Tetracytic stomata showing thinner inner rim; N, O&R. Cleft; P. Contiguous stomata; Q. Paired stomata showing common subsidiary cell; S. Hemiparacytic stomata; T. Stoma with one guard cell; U. Guard cell without pore; V. Stomata in group; W. Stomata with aborted guard cell; X. Stomata showing two subsidiary cells lying parallel to one side of the guard cell. (Figs. 1 A-X : 790 X)

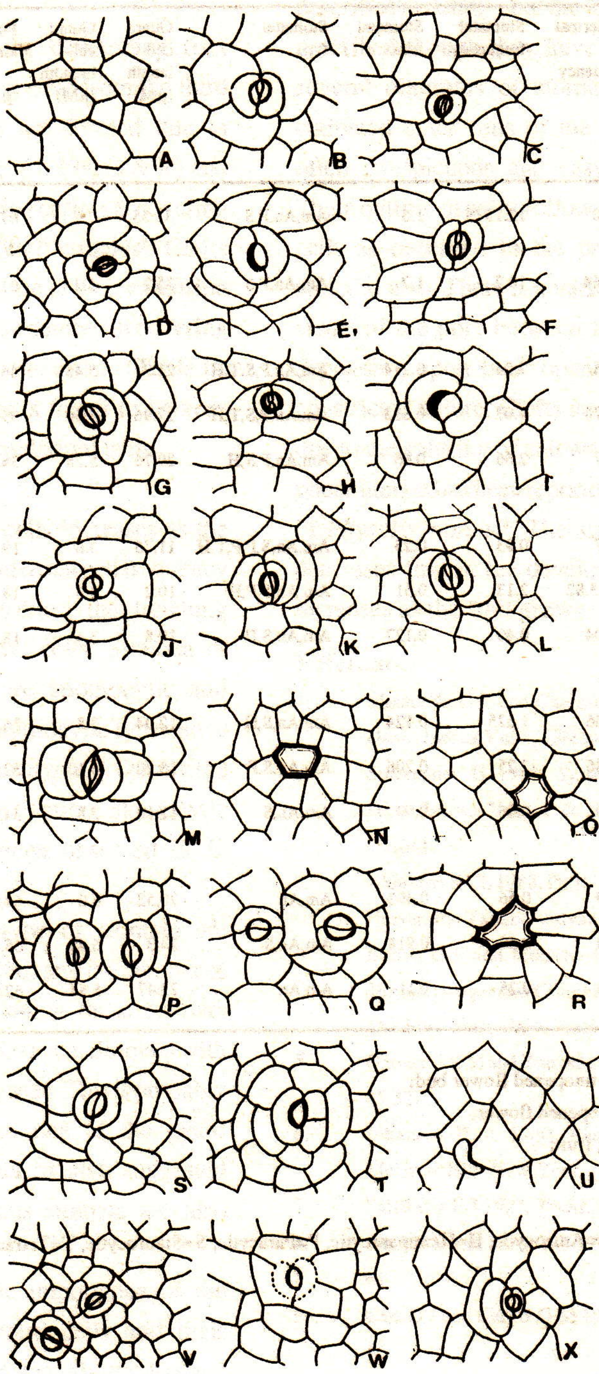
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Table 1 : Structural features of outer epidermis (i.e. epicarp) of *E. jambos* fruit.

Stage	Region	Epidermal cell frequency	Stomatal frequency	Stomatal index	Stomatal type	Guard cell length (μM)	Guard cell breadth (μM)	Pore size (μM)	Cleft frequency	No.of cells surrounding cleft or covering cleft
I	—	757.0	12.1875	1.5	Am,An,P,S	31.35	7.2	67.067	—	—
II	—	585.64	10.2	1.7	Am,An,P,S	25.2	6.2	61.049	—	—
III	Apical	492.8	2.06	0.214	Am,An,P,S.T,H	25.2	5.48	46.17	0.25	5
	Middle	559.75	4.07	0.613	Am,An,P,S,T,H	27.96	4.56	39.6	0.28	6
	Basal	396.7	2.66	0.66	Am,An,P,S,H	29.76	5.28	35.28	0.26	6
IV	Apical	401.7	0.93	0.23	Am,An,S,P,P,T,H	11.76	3.6	19.8	0.46	9
	Middle	41113.82	2.13	0.51	Am,An,S,P,H	10.2	3.6	18.216	0.88	11
	Basal	313.04	0.40	0.127	Am,An,S,H	10.8	3.4	18.34	0.77	9
V	Apical	327.36	1.625	0.124	Am,An,S,H	12.04	3.8	36.56	0.625	11
	Middle	341.86	2.25	0.206	Am,An,S,P	13.20	4.10	32.09	0.8	13
	Basal	286.0	0.86	0.09	Am,An,S	12.12	3.8	34.02	0.60	11
VI	Apical	230.0	0.56	0.493	Am,An	20.52	6.0	64.8	0.70	12
	Middle	290.0	0.60	0.918	Am,An,S	24.3	6.48	65.422	0.90	15
	Basal	223.0	0.25	0.11	Am,An	22.47	5.88	62.94	0.77	12

Stage I : Ovary from unopened flower bud;
II : Ovary from opened flower;
III-V : Developing fruit;
VI : Mature fruit.

Am-Anomocytic, An=Anisocytic, H=Hemiparacytic, P=Paracytic, S=Staurocytic, T=Tetracytic.

of abnormalities are found, their frequency is less.

Clefts: Epidermis of the developing fruit possesses clefts which appear from the third stage onwards. Clefts are formed due to splitting of cell walls (Figs. 1 N, O & R) and the number of surrounding cells (i.e. covering cells) increases as the cleft extends[8]. Clefts are of varied shape because of their extension in various directions. The number of covering cells is varying from five to fifteen (Table 1). The frequency of clefts is found to be very less in contrast to the epidermal cells.

Discussion

The size of epidermal cells increases as the fruit matures and the epidermal cell frequency decreases. It is probably due to the stretching of developing epidermal cells. Stomata of Myrtaceae members are anomocytic and paracytic types[1,8], but staurocytic types have also been reported in *Eucalyptus*[9]. During the course of present investigation, staurocytic type of stomata has been observed in *E. jambos.*

Anomocytic type of stomata are more common in *E. jambos* and the number of epidermal cells surrounding these stomata are varying from three to seven. Stomata with single guard cell are also seen. This is probably due to degeneration of one of the guard cells of normal stomata as also suggested by Ahmed[10]. Contiguous stomata are also found.

The diagnostic importance of the morphology of the guard cells and their cuticular ledges has been strongly emphasized and outer stomatal rim (ledge) has been described in detail[11], but the inner rims are not described though they have been shown in several diagrams of stomata. The highly cutinized outer rims of the guard cells are often conspicuous and easy to measure[11]. Their outline usually follows those of guard cells as observed in the presently studied material also. There is a variation in size and shape of the pore between the inner ledges depending upon their opened or closed or constricted nature. Clefts are found to occur due to the splitting of cell walls and a similar phenomenon has been reported in the epicarps of *Physalis minima*[8]. The size of guard cell decreases first in the developing fruit but it increases as the fruit grows.

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