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Development of the pericarp, septa and zone of dehiscence in the fruit of *Cassia tora* L.

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Abstract

The pod of *Cassia tora* is the product of a single carpel consisting of 20-30 seeds enclosed one in each compartment formed by the ingrowth of the endocarpic tissue. There are three distinct histological zones of the pericarp Epicarp (a), Mesocarp (b) and Endocarp (c). The paracytic stomata and uniseriate multicellular trichomes are found only in the outermost layer of the epicarp. The epicarp is single layered. The outer mesocarp in later stages of its development has many collenchyma, particularly at dorsal and ventral margins. The mesocarp develops from the homogenous mesodermal tissue of the ovary wall. The middle mesocarpic tissue becomes sclerenchymatous above the main bundles providing rigidity at the two sutures where the zones of dehiscence develop inbetween them. The endocarp develops from the inner epidermis and 2-3 hypodermal layers. Due to frequent periclinal and anticlinal divisions and enlargement of the cells in the inner hypodermal layers, the septa are formed which never fuse; thus the so called compartment of the seed is not completely closed and the seeds slide off on separation of the valves. The inner hypodermal layers form the band of sclerenchyma above the septal cells. The inner margins without septa and sclerenchyma provide easy opening of the two valves from the chamber side.

INTRODUCTION

There are only a few reports on the anatomical structure of the leguminous pericarp (Deshpande, Untawale, 1971; Fahn, Zohary, 1955; Leela et al., 1972; Patel et al., 1976; Stant, 1972). The present study deals with the development of the fruits wall layers and the zone of dehiscence in *C. tora* pod.

Cassia tora known in Sanskrit as „Chakramarda" has a medical value. The pod is much curved when young and is obliquely septate. The seeds ground with some butter-milk are used to cure the itch irritation, or skin eruptions (Nadkarni, 1954).

MATERIAL AND METHODS

The flowers and fruits at different stages of development were collected in December-March from the widely growing *C. tora* in Vallabh Vidyanagar. They were fixed in FAA. The ovaries and fruits were measured (length and breadth).

The fruits were divided into basal, middle and terminal parts and then small pieces of these parts were dehydrated in alcohol and xylene and embeded (Johansen, 1940). 8-12 μm thick sections were cut on Spenser rotary microtome and stained with safranin and fast green (Berlyn, Miksche, 1976).

RESULTS

OUTER EPIDERMIS

The outer epidermis from developing and mature fruit have stomata and hairs. The stomata are mostly paracytic; variations in the number and arrangements of the cells adjacent to the guard cells are common. There are stomata flanked by two cells parallel to the guard cells, but divided obliquely, parallelly, or at right angle to the guard cells. Sometimes they are surrounded by 3-6 cells or 9 cells. The trichomes are uniserate and surrounded by 4-5 epidermal cells at the base.

Fig. 1 A-H. Transections of ovary and fruit

A — Ovary from flower showing the development of endocarp layers (at arrow) in the middle region, × 116; B — Cellular details of ventral side of the developing fruit from basal region, × 110; C — Developing fruit from the terminal region, × 55; D — Developing fruit showing the cellular details of ventral side at the terminal region, × 110; E — Dorsal side of mature green fruit at the extreme base (note granular starch in pith) and absence of dehiscing zone, × 110; F — Mature dry fruit from the dorsal side of the basal region showing the typical orientation of parenchyma inbetween and below the splitted dorsal vascular bundle, × 100; G — Mature green fruit from the terminal region with two septa (at arrows), × 40; H — Lateral side of mature green fruit showing compressed middle mesocarpic zone (at arrow) and elaborated parenchyma of endocarpic septum, × 95;

(Co — collenchyma, DS — dorsal suture, DZ — dehiscing zone, ES — endocarpic sclerenchyma, EX — exocarp, P — parenchyma, SC — sclerenchyma, SE — septum, VS — ventral suture)

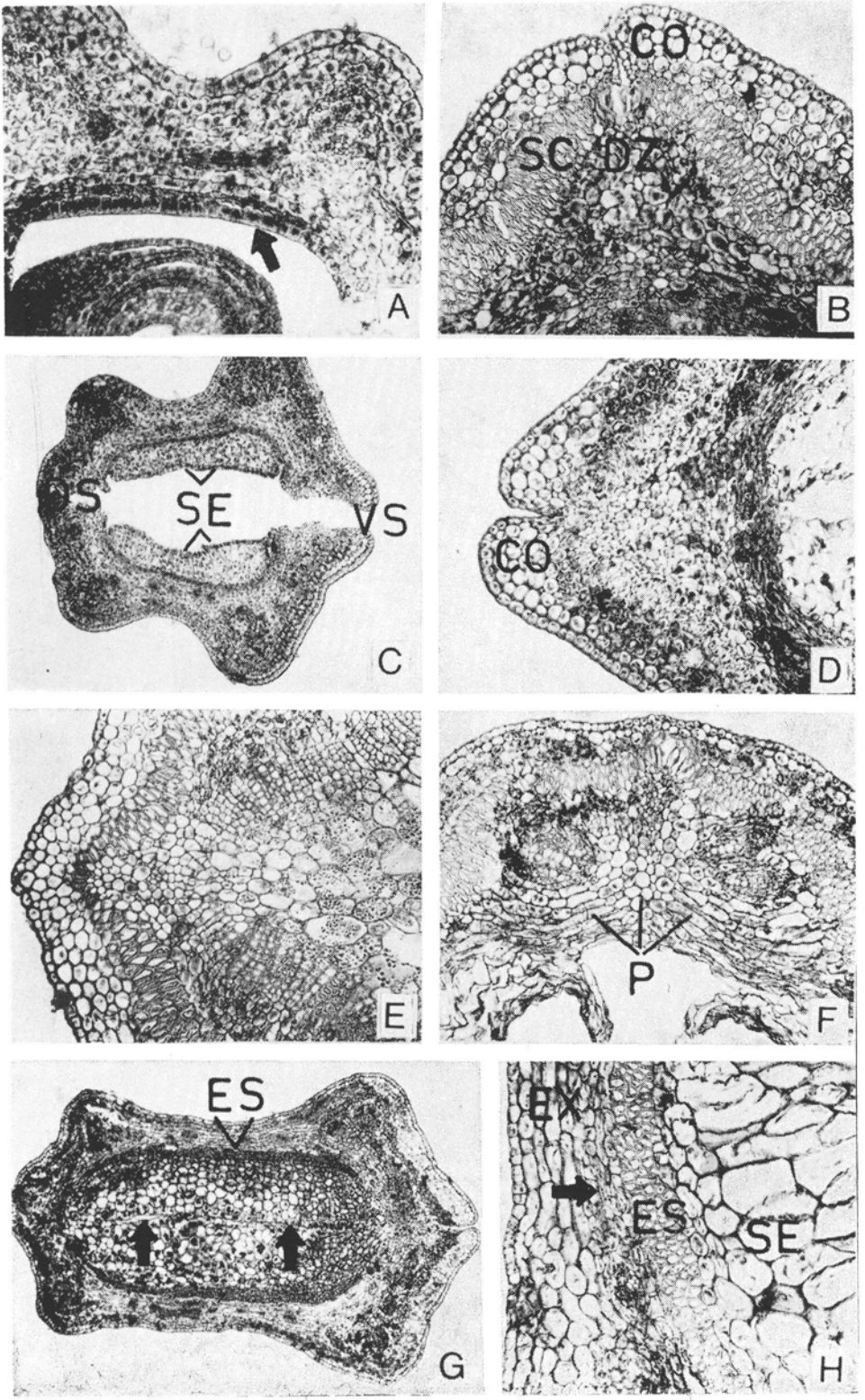

Fig. 1A-H

OVARY: (0.45-0.6 cm long, and 0.14-0.15 cm broad)

The basis vascular ring of the carpel consists of five main strands and the developing vascular strands inbetween. There are: one dorsal, two ventral and two lateral vascular bundles. The small chamber opens at the base of the ovary, where the ovary wall is 10-20 cells thick and almost homogenous.

The nuclei in the outer epidermal cells occupy approximately the central position. The ovary wall is about 17-20 cells thick, embedding a vascular ring which is 3-4 layers above the inner epidermis. Two to three layers of outer hypodermis simulate the outer epidermis, but the inner hypodermal layers are of smaller cells dense with cytoplasm and nuclei (Fig. 1A). The rest of the mesodermal cells are largely vacuolated parechyma.

DEVELOPING FRUIT: (1.3-4.6 cm long, and 0.21-0.35 cm broad)

The basic vascular ring is intervened in the ground parenchyma, between the ventral and lateral vascular bundles. The dorsal vascular bundles also split. The first 4-5 layers of the pericarp form the exocarp underlined by 2-4 layers of sclerenchyma developing from the mesocarp. The cells in 3-4 layers, including the inner epidermis undergo periclinal division and contributs to the endocarp and the endocarpic transverse septum. The septum is formed due to the rapid enlargement of the outer 2-3 layers, and the inner sclerenchymatous arcs are formed due to the rapid multiplication without enlargement and lignification of their compactly arranged cells.

In the further stages of the fruit development the extreme basal region shows the presence of tanniniferous cells above the phloem, and sclerenchymatous arcs in the endocarpic septa. Parenchymatous gaps are formed at the dorsal and ventral sutures of the fruit. One to three layers below the outer epidermis appear collenchymatous (Fig. 1B, D). The ventral notch is lined with smaller epidermal cells and below it the sclerenchyma are discontinued. However beneath the dorsal suture the continuity of sclerenchyma is broken again, and the zone of dehiscence with a gap of long polygonal parenchyma is observed. This gap is subtended by a narrow vertical band of smaller paranchyma. In the terminal region sclerenchyma is much compressed and forms a narrow band over the endocarpic septa (Fig. 1C).

MATURE GREEN FRUIT: (9.2-10.1 cm long, and 0.3-0.4 cm broad)

The pith cells of the extreme basal region show starch content (Fig. 1E), and sphaerocrystals are present in the mesocarpic parenchyma. The

parenchymatous endocarpic septa, growing obliquely from both the sides of the endocarp wall, leaves a narrow slit like a gap between them after enclosing the seed below (Fig. 1G; 2). Figure 1H reveals the details of the lateral fruit wall with a small vascular bundle uncapped by sclerenchyma; the 4-5 layered parenchymatous exocarp, with its cells elongated transversely or parallelly to the periphery of the fruit, and 4-6 cells thick band of endocarpic sclerenchyma. The subtetragonal fruit is broader on the ventral side and narrow on the dorsal side (Fig. 2). The dehiscing zone at the dorsal suture in the tip becomes indistinct and the chamber becomes narrow. The ventral notch appears deep with a parenchymatous dehiscing zone below.

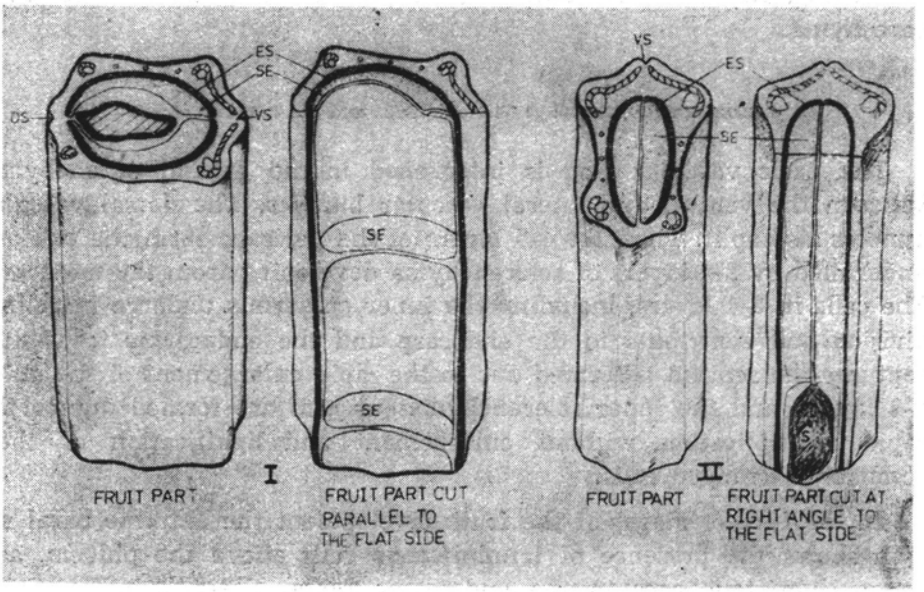

Fig. 2. Schematic illustration of endocarpic septa of fruit.
DS — dorsal suture, ES — endocarpic sclerenchyma, S — seed, SE — Septum, VS — Ventral suture

MATURE DRY FRUIT: (12.5-17.0 cm long, and 0.55-0.65 cm broad)

There is a complete well developed vascular ring at the basal region with tanniniferous content in the phloem and phloem parenchyma. The vascular ring is broken up into two ventral, two lateral and two dorsal bundles further entering the chambered zone. The side gaps between the lateral and ventral bundles are formed of elongated narrow parenchyma with large air chambers.

Inbetween two dorsal bundles some parenchyma are vertically alongated, and beneath them a band of compactly arranged polygonal

small parenchyma is present (Fig. 1F). Beneath the dorsal vascular bundles the mesocarpic parenchyma cells are transversely or obliquely elongated, radiating from the band of parenchyma inbetween the dorsal bundles. The vascular ring becomes narrow towards the extrems tip. The tip does not show the zone of dehiscence at the dorsal side.

DISCUSSION

The legumes opening is down the full length of both the ventral and dorsal sutures. When separating the valves, it twists rapidly causing the detachment of the seeds. The tension which results in the sudden dehiscence and twisting is due to the differential shrinkage of the soft outer tissues and an inner sclerotic layers of the fruit wall as the fruit dries in ripening (M c L e a n, C o o k, 1961). The single layered exocarp has mostly paracytic stomata. In *Cassia occidentalis* (P a t e l et al., 1976) the stomata are paracytic or anomocytic. In comparison to the simple, glandular and aglandular trichomes of *C. occidentalis* (P a t e l et al., 1976) *C. tora* has only simple uniseriate trichomes. When young, the outer mesocarp is parenchymatous or chlorenchymatous, but at maturity many of its cells become collenchymatous, particularly at the dorsal and ventral margins of the fruit.

DEHISCENCE

The origin of the mesocarp is from the homogenous mesoderm of the ovary wall. In further development they increase in number, become vacuolated and contain crystals or tannin. The middle mesocarpic tissue becomes sclerenchymatous providing rigidity at the two sutures where the zone of dehiscence develope inbetween them. Their absence in the mesocarp of lateral sides should be also considered significant as the twisting of the pericarp is facilitated at this region. The peculiarly oriented stretching parenchyma and sclerenchyma in mesocarp of basal regions also help in easy twist of the fruit when they shrink. The dehiscing zone as in *C. occidentalis* (P a t e l et al., 1976) becomes more distinct below a deep notch of ventral side than on the dorsal side, indicating that the first opening is on the ventral side of the middle region. The dorsal side of the tip region does not split till the opening of middle region, and only the twisting force separates the valves at the tip.

The endocarpic septal layers are free at the dorsal and ventral inner margins. The growth of the septum is more or less at the right angle to the longitudinal axis of the fruit. Both septa from opposite sides do not fuse in the chamber and, thus, allow the separation of the two valves, and the seeds to slide off (Fig. 2).

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