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Histological study of Ethylene induced Gum Duct formation in Gum Karaya (*Sterculia urens* Roxb.)

Vidya Bhushan Kuruwanshi, Pratibha Katiyar, Shabnam Khan and Bhavesh B Nair

Abstract
Gums and resins occupy a prime place among Non-Wood Forest Produce (NWFP/NTFP) and are known to mankind since time immemorial. Gums are important natural biopolymers demand from biological system under stress situation *i.e.* disease injury to bark etc. being used as a principal components in food, pharmaceutical industries and play a key role in social and livelihood of tribal communities. Gums are metabolic by-products of plant tissues either in normal course or often as a result of disease or injury to the bark or wood of certain plants and it cannot be re-enter with plant system. The process of gummosis related to biotic and abiotic stress of tree plant and plays significant role in production of biopolymers (gum/resin). The impact of gum enhance Ethephon was found significantly superior, regarding the production of biopolymers. Gum Karaya (*Sterculia urens* Roxb.) is a dry deciduous tree belonging to the family Sterculiaceae distributed throughout India and Chhattisgarh. Therefore, the physiological tool was used to impose artificial stress *via* various concentration of Ethephon (slow releasing substance of ethylene) as gum enhancer in stem of gum Karaya to find out the mechanism of gummosis and compared with mechanical tapping method undertaken in ICAR Network Project. The biological (anatomical), studies were done *via* taking the sample of soft (sapwood) after injecting the gum enhancer Ethephon at different time intervals. It can observed that the application of Ethephon enhance the process of gummosis, due to formation of gum duct. Karaya gum is the dried exudate obtained from trees of *Sterculia* species. The gum duct formation was observed in histological analysis of bark section within 2hrs of Ethephon treatment in gum karaka. The histological changes indicated that the gum ducts lysigenouslyare present in the pith and cortex of the young stem of *Sterculia urens* but absent in the xylem.

Keywords: *Sterculia urens*, Ethephon, IAA, gum tapping, gum duct formation

Introduction
Chhattisgarh is a pioneer state of India and has vast variety of minor forest produce to favorable agro climatic conditions resulting in good forest area *i.e.* 43.6 % of total. Gums are primarily categorized as Grade-I of Karaya (*Sterculia urens*) and Grade-II of Dhawda (*Anogeissus latifolia*), Babool (*Acacia indica*) and Khair (*Acacia catechu*) in Chhattisgarh state.

Gum trees are economically important and found in tropical moist and dry deciduous forests, produce a significant quantity of gum, which are widely used as industrial, food and medicinal purposes in India (Bhattacharya, 2012) [2]. Gums are metabolic by-products of plant tissues either in normal course or often as a result of disease or injury to the bark or wood of certain plants. The gum exudes from trees and shrubs in tear-like, striated nodules or amorphous lumps. It dries in contact with air and sunlight and forms hard, glass like lumps. Gum production increases at high temperature and limited moisture. (Sao *et. al.* 2012) [5] India is a rich center of plant biodiversity having more than 15,000 plant species including about 120 gum yielding plants. India produces annually about 2,81,000 tons of gum (Anonymous, 2013) [1].

Karaya gum is the dried exudate from the tree *Sterculiaurens*. It is also known as Thapsi Gum, Gum Kadaya, Kullo, Karei, Kandol,Katilo, Gulu, Katera, Katierain the trade (Plate.1a). *Sterculiaurens* is the source of karaya gum which is an important raw material in the textile cosmetic, food, pharmaceutical and other industries. The gum ducts normally occur in the pith and cortex of young stem of *Sterculia*urens. Time course experiments involving mechanical injury to both young and old stems indicate that gum ducts are also formed in the xylem within 30-40 minutes. These ducts, called as traumatic ducts, are formed as a result of breakdown of

xylem cells. A traumatic duct shows an irregular lumen without any distinct epithelial cells. Histochemical test reveals that the nature of the gum produced in these ducts is similar to that in the normal ducts. (Setia *et.al.*1983).Natural gums are present either in the intercellular space (ducts or cavities) of the plant parts or as exudate produced due to injury. The ducts or cavities formed due to injury are called traumatic ducts/cavities. The causes of gum and resin formation and their biosynthesis are not fully understood. Poor soil, drought and other hostile environmental conditions promote their production. Gums and resins do not re-enter the metabolism of the plant in which they are produced and therefore, they are considered as by-products or end products of certain metabolic changes. It is suggested that gum formation may be a pathological response of the plants to protect the injured part by sealing the region to prevent water loss and infection. The development of the duct is schizogenous (separation of the duct initials by dissolution of middle lamella), schizo-lysigenous (separation of the initials followed by lysis of epithelial cells) and lysigeneous (separation of the duct initials followed by lysis of epithelial cells) and lysigeneous (death of the initials). (Nair *et al.*, 1995) [4].

Plate 1(a): Gum karaya tree

Plate 1(b): Making hole with battery operated drill

Plate 1(c): Injected gum inducer ethephon

Plate 1(d): Covering the hole by moistened clay

Materials and Methods

An investigation was carried out at former Central Government Forest Division, Biladiat Tilda block of Raipur (Chhattisgarh) during 2015-16.

Gum tapping method

Two slanted hole of about 5mm diameter with 1" deep is made at one feet above the collar of the tree with the help of battery operated drill machine. After that,4 ml (2 ml each hole) dose of distilled water (Control) and ethephongum inducerinjected in the hole with help of syringe and immediately the hole iscovered (patched up) by moistenedclay (Plate.1 b).

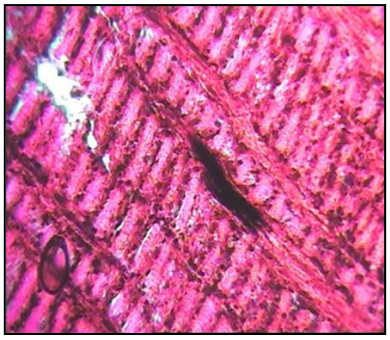


Plate 1(b): Chemical tapping method

Gummosis process in stem

The traumatic duct formation and studied the histological changes during their development tapping or injury. The gum enhancer treated tree bark was cut about 2.5 cm long pieces and removed square wood block about 3 cm^2area with hammer and chisel. The formalin acetic acid alcohol solution (FAA) solution was made of 90 ml of 70% ethyl alcohol, 5 ml glacial acetic acid and 5 ml acetaldehyde for 100ml solution. The treated bark were cut at 2, 4, 6 and 8 hrs time interval and fixed in (FAA) and embedded paraffin wax using conventional methods (Jensen, 1962) [3]. The histological/anatomical test of bark sample has been done in College of Forestry, Y.S. Parmar University of Horticulture and Forestry, Solan (Himachal Pradesh), India.

Results and Discussion

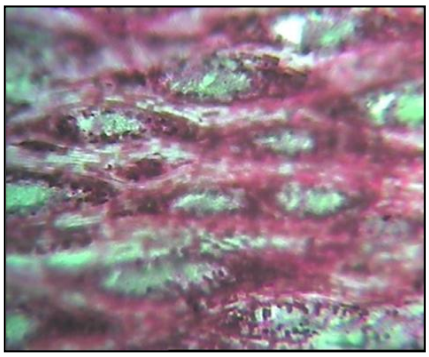
The observation was undertaken to elucidate the gum duct formation and histological changes in *Sterculiaurens* Roxb by gum tapping associated with gummosis process is presented in Plate.2 and summerized below:

In *Sterculiaurens* Roxb, control bark sample show the little presence of gum cavities. The stem has normal gum ducts only in the pith and cortex. Gum ducts or cavities are normally absent in the wood. Wood is characterized by diffuse or occasionally banded parenchyma, broad multiseriate rays and thick walled fibers. Administration of

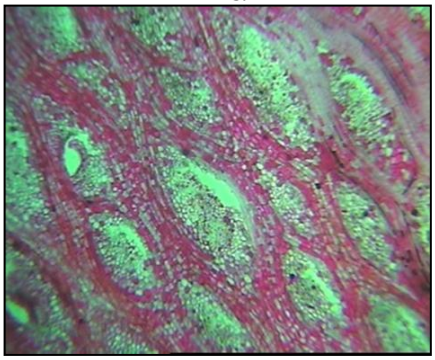
ethephon into the stem induced extensive development of gum cavities in the secondary xylem. The cavities are developed from the axial parenchyma cells formed after Ethephon treatment. Upon Ethephon treatment, the ray cells remain intact, but only axial parenchyma cells are formed from the fusiform initials. The cambium soon renewed its normal function and consequently a band of traumatic tissue consisting of only axial and ray parenchyma cells are formed in the outer sapwood. The axial parenchyma cells undergo active transverse divisions and the derivatives enlarge to form vertical files of isodiametric cells, the cavity initials. They are mostly thin walled, and have dense cytoplasm and large nuclei. The cavity initially develops Lysigenously from a group of such cells.

The lysis is triggered by the disintegration of the vertical file of cells proceeded by the darkening of cytoplasm and disappearance of nuclei. Lysis of more cells progresses in vertical and tangential directions forming a cavity. But a definite epithelium is not formed around the cavities. Tangential widening of a cavity is limited by multiseriate rays which remain mostly intact. Almost all axial parenchyma cells undergo lysis forming a system of tangentially anastomosing cavities around the intact islands of multiseriate rays. The cavity is filled with disintegrating cells and gummy substances. Nevertheless, at places of extensive cavity formation, some multiseriate rays also disintegrate. But always ray cells are the last to be affected. In radial longitudinal sections, the cavities appear as vertically elongated system interrupted by multiseriate rays.

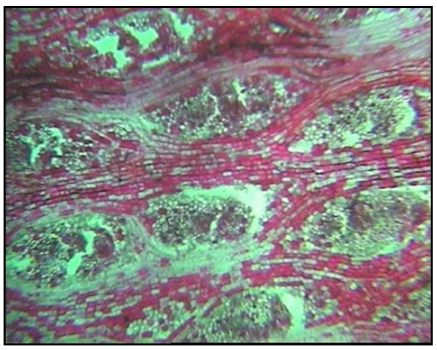
Shahand Setia (1976) [8] observed that the lysigenously formed gum ducts are present in the pith and cortex of the young stem of *Sterculia urens* but absent in the xylem. The gum cavities are induced upon ethephon treatment. Vander Molen *et al.* (1977) also reported that the cell walls are transformed into gum may be cells of mature xylem or of cells in specialized parenchyma groups which differentiate in the cambium and later disintegrate and form the gum and duct lumen. Similar findings were also reported by Wilde and Edgerton (1975) [11] and Setia (1984) [7].



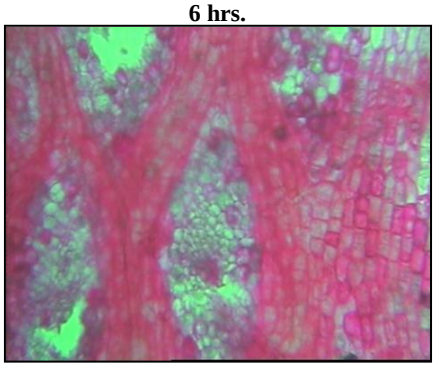
2 hrs.



4 hrs.



6 hrs.



8 hrs.

Plate 2: Anatomical section cutting of *Sterculiaurens* Roxb bark

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