ANATOMICAL STUDIES OF COMMIPHORA MUKUL ENGL. AND THE LOCALIZATION OF GUMS, RESINS AND TANNINS

S. I. Ahmed, Fatima Asad and S. Shahid Husain

Central Laboratories, Pakistan Council of Scientific and Industrial Research, Karachi

(Received March 9, 1965; revised June 2, 1966)

The macro and microscopic characters of the leaf and stem of *Commiphora mukul* Engl. have been studied. The leaf and young stem are characterized by the presence of trichomes. The young stem has multicellular, glandular capitate hairs whereas the leaf in addition to such hairs possessed simple uniseriate hairs. The stem shows very prominent secretory canals in the cortex region and tannins in the pith cells. Leaf is dorsiventral and contains sphaero-crystals in the parenchymatous cells.

Introduction

Commiphora mukul (Hook. ex Stocks) Engl., Syn. *Balsamodendron mukul* Hook. ex Stocks is commonly known as Indian Bdellium tree (Guggal in Sindhi) is a member of Burseraceae family. It occurs in the arid rocky tracts of Rajputana, Khandesh, Berar, Mysore, Sind and Baluchistan. In Karachi it occurs in the hillocks of North Nazimabad, Manghopir, Country Club Road, Korangi and the adjoining areas.[7] In the indigenous system of medicine the gum obtained from *C. mukul* is widely used for a number of diseases. It is a bitter stomachic, carminative, intestinal disinfectant and check for diarrhoea. It has also been recommended for bronchitis, whooping cough and pneumonia. It is also used as a mouth wash, gargle, for weak gums and chronic tonsilitis.

The present studies were made because of two main considerations. Firstly, information on the anatomical features of this plant was very meagre. Secondly, it was considered that if the secretory canals are located in a particular region of the plant, it might be possible to evolve a method for obtaining maximum quantity of gum. It was found that in this plant the large secretory canals were located in the cortical region. If this region could be separated from the adjoining tissues, it may be possible to obtain a large quantity of gum as compared to that obtained by making incisions on the stem.

Materials and Methods

The first collection of *Commiphora mukul* specimens was made from Korangi Creek and the subsequent collections from the vicinity of these Laboratories (Country Club Road), where it was found growing in abundance. This material included stem, leaf, flower and fruit. All these parts were fixed in Formalin Acetic Alcohol solution (F.A.A.) for microtome sectioning. After keeping the material for at least 24 hours in F.A.A., it was dehydrated by running it through alcohol-xylol series and embedded in paraffin wax (m.p. 56 –58°C The sections were stained with Safranin in combination with Fast-Green. Permanent slides were made by mounting the sections in Canada Balsam. In addition to microtome sections, hand sections of the fresh material were studied for anatomical details and microchemical tests. For the study of tissues comprising the vascular system, small portions of stem were macerated according to Jeffrey's method (equal volumes of 10% chromic acid and 10% nitric acid).

To give a vivid picture of the arrangement of tissues photomicrographs of T. S. and L. S. of stem and diagrammatic illustration of T. S. of leaf were made. Camera Lucida drawings of the macerated vascular tissues were drawn to provide proper illustrations. Microchemical tests were carried out in accordance with the procedures of Gurr[3] and Johansen.[5]

Botanical Description

C. mukul is a small tree, 4–6 feet high with more or less ascending branches which generally end in sharp spines (Fig. 1). Leaves 1–3 foliate, leaflets obovate, nearly sessile, margin toothed (Fig. $2A_1$-A_3). Flowers almost sessile, a few in each fascicle, unisexual or bisexual. Stamens are dimorphic, 8 (4 plus 4) in number. Ovary is bilocular with a simple style and slightly bilobed stigma. Calyx gamosepalous with four green sepals forming a cylindrical cup, glandular and hairy. Corolla gamopetalous with four, ligulate, brownish red petals, longer compared to calyx. The stem is covered by ash coloured bark which when becomes old peels off in thin papery rolls exposing the under bark. Yellowish-white viscous fluid exudes from cracks commonly formed in the bark or from incisions. This fluid hardens to reddish-brown masses.

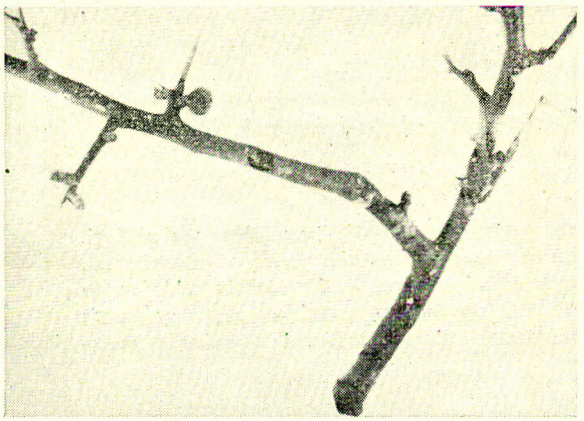

Fig. 1.—A branch of *C. mukul*, showing the morphology of stem, specially the acsending branches which generelly end in sharp spines.

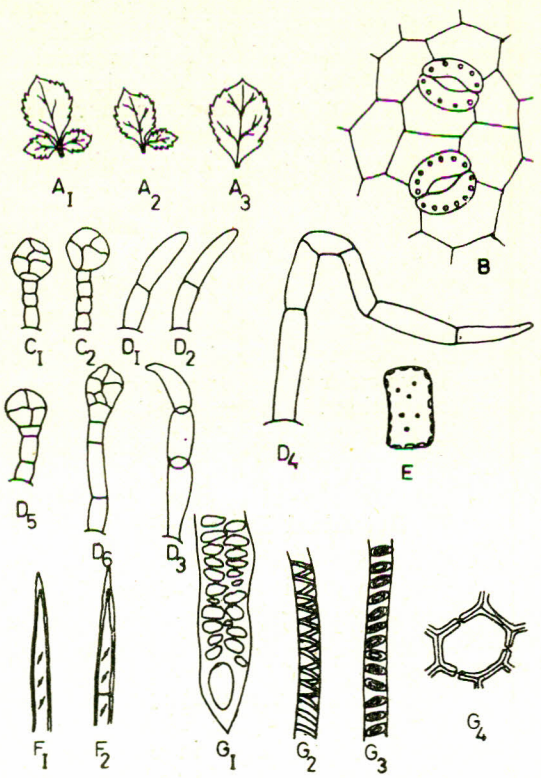

Fig. 2.—Camera Lucida drawings of: A_1- A_3- uni-bi-and trifoliate leaves; B- epidermal cells showing Ranunculaceous type of stomata; C_1- C_2- multicellular, glandular capitate hairs found on the stem; D_1- D_6- simple (bi-, tri-and multcelled) hairs and capitate glandular multicelled hairs found on the leaf; E- G_4- macerated tissues of xylem of the stem; E- xylem parenchyma, F_1- F_2 xylem fibers, G_1- G_4- xylem vessels showing annualr, spiral and scalarifrom thickenings as well as the pits.

Anatomy of the Stem.—The young stem has multicellular, glandular capitate hairs measuring 100-120 μ in length (Fig. $2C_1$-C_2). The epidermis consists of more or less rectangular cells which is covered externally by a thin cuticle. There is a single layer of sub-epidermal collenchymatous cells which are prominently larger compared to those of the adjoining regions. Underneath this area, there are 3–4 layers of sclerenchymatous cells, similar in shape and size to the thin-walled cortical cells. The thicnkness of their walls is uniform, whereas the thin-walled cortical cells vary greatly in shape and size. The cortical region is more prominent because the secretory canals traverse through it longitudinally in a large number. These secretory canals are invariably bordered by a single layer of thin-walled epithelial cells. The size of these canals varies greatly 20–65μ in diameter. There is an average of 8–10 canals per mm^2. The cortical cells contain certain chemicals which are darkly stained by Haematoxylin and Safranin. The endodermis and pericycle are indistinct. Vascular bundles are collateral, open and arranged in a ring with, endarc xylem. In between xylem and phloem, cambium cells are distinctly seen. Pith is broad, consisting of thin-walled parenchymatous cells which are also darkly stained by Haematoxylin and Safranin. Accumulation of certain chemicals is clearly noticed in this region (Fig. 3).

The arrangement of stem tissues after secondary growth is found as usual (Fig. 4). Narrowly fusiform, exclusively uniseriate rays are very closely observed in the longitudinal section (Fig. 5). The average height is about 0.5 mm, mostly 5–6 rays per mm^2, heterogenous with 1–3 rows of square or upright marginal cells. As the rays are exclusively uniseriate no intercellular canals are observed. Vessels are small (Fig. $2G_1$ -G_3), 0.02 –0.04 mm. in diameter, with annular, spiral and scalariform thickenings, 0.22 –0.82mm in length, solitary or in groups of upto 5, varying in number between 12 –15 per mm^2. Perforations are exclusively simple; intervascular pittings alternate with hexagonal borders, large (Fig. $2G_4$); pits to ray cells and parenchyma are large and simple. Parenchyma are paratracheal, composed of rectangular cells in optical section (Fig. 2E), pits are large and simple. Fibres are thin-walled (Fig. $2F_1$ -F_2), partly septate, mean length 0.9 –1.0 mm; pits are simple, small slit-like to almost round.

Anatomy of Leaf.—Leaf is dorsiventral (Fig. 6), covered by a cuticle on both the surfaces. Stomata is present on the lower as well as the upper surface. The frequency of these structures on the upper surface of leaf is much less than the lower. The stomata are of Ranunculaceous type, i.e.,

they are surrounded by ordinary epidermal cells (Fig. 2B). Beneath each stomata, a distinct stomatal space is noticed. Different types of hairs, namely multicellular, capitate glandular and simple (bi–, tri- and multicelled) hairs were present on the leaves (Fig. $2D_1$-D_6). The multicellular, glandular capitate hairs measure 0.09 to 0.15mm in length whereas the simple hairs range from

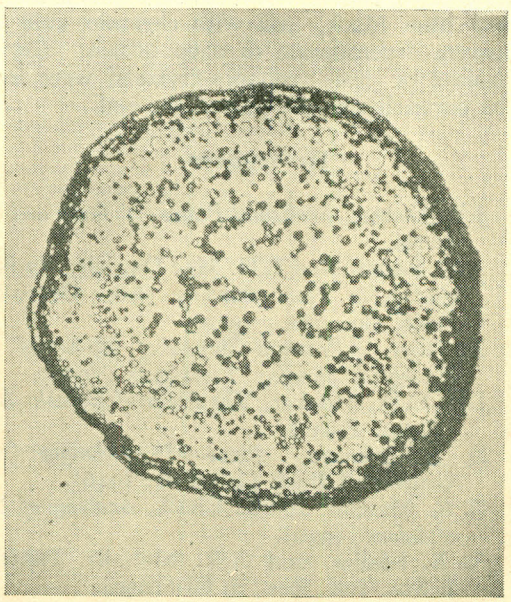

Fig. 3.—Photomicrograph of T.S. of stem showing primary tissues with prominent secretory canals in the cortical region.

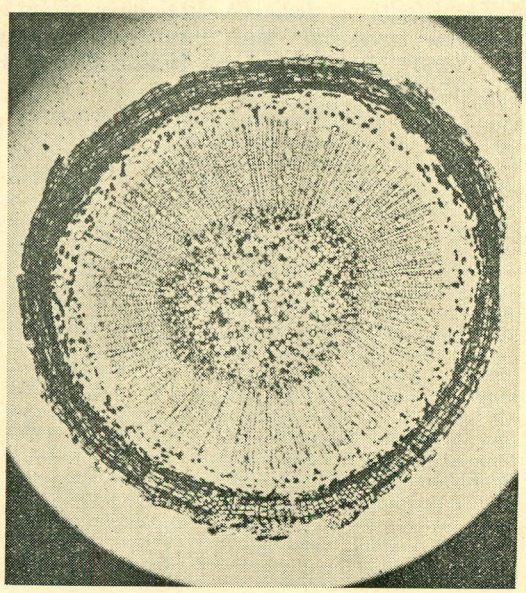

Fig. 4.—Photomicrograph of T.S. of stem after secondary growth, showing the xylem occupying a considerable space.

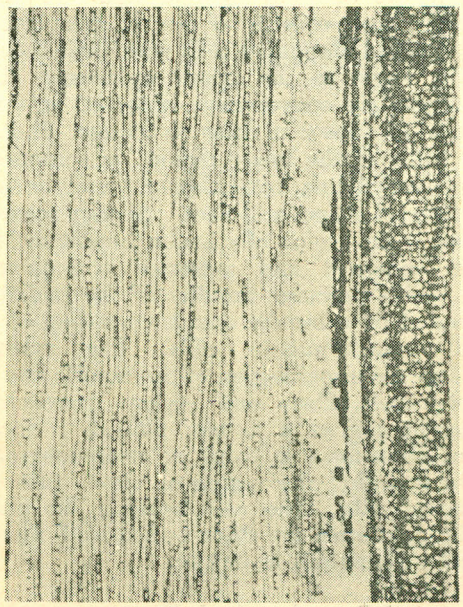

Fig. 5.—Photomicrograph of L.S. of stem after secondary growth, showing uniseriate rays and scalariform vessels.

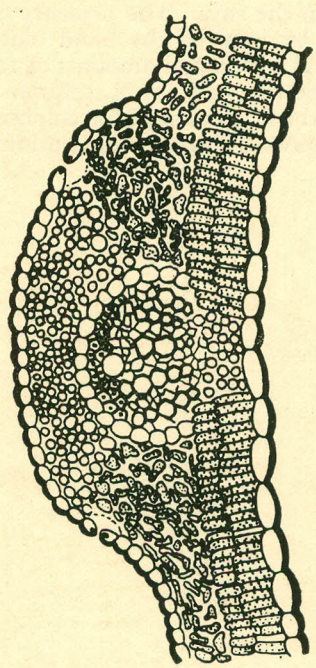

Fig. 6.—A diagrammatic illustration made from the microtome section of T.S. of leaf.

0.125 to 0.4 mm. The mesophyll cells were differentiated into palisade and spongy parenchyma. The palisade parenchyma is located just below the upper epidermis (except in the region between the vascular bundle and the upper epidermis) and consists of one to two layers of closely packed elongated cells with their long axis at right angle to the upper epidermis. Large chloroplasts are conveniently observed at a magnification of 1000× in these structures. Photosynthetic tissue of the lower region is composed of spongy parenchyma, consisting of loosely arranged cells of varied shapes and sizes. Spongy mesophyll cells below the region of vascular bundle are more or less spherical and possessed triangular air spaces. The vascular bundles of the midrib are surrounded by a bundle sheath consisting of thin-walled parenchymatous cells. The xylem is located in the upper region of the bundle and consists of vessels, fibres and xylem parenchyma. Beneath the region of xylem, phloem is located. Phloem fibres form a band of sclerenchymatous cells surrounding the region of sieve tubes and companion cells. The cells between the phloem and the epidermis are thick-walled and more or less collenchymatous in nature.

Microchemical Tests

Microchemical tests showed that gums and resins were present in the cortex region of stem and the phloem of both stem and leaf. Gums were also found in the rays. The presence of gums was determined by treating the hand cut sections of fresh material with equal amounts of 10% solution of caustic potash and 10% solution of copper sulphate, which gave sky blue colouration. The gums also gave a brown colouration when the sections were treated with a dilute solution of iodine. Presence of resins was determined by treating the sections with alkamin which showed red coloration.

Tannis were present in the pith region. When the sections were treated with ferric chloride the pith turned blue black, and with chromic acid and potassium dichromoate to deep brown. Crystals of oxalate of lime (sphaero-crystals) were found in the parenchymatous cells of the leaf.

References

1. J.F. Dastur, *Medicinal Plants of India and Pakistan.*
2. A.J., Eames, and L.H. Mac Daniels, *An Introduction to Plant Anatomy* (Mc- Graw-Hill Book Co., Inc., 1947).
3. E. Gurr, *A Practical Manual of Medicinal and Biological Staining Techniques* (1956).
4. J.D. C.D., Hooker, *The Flora of British India* (1879), Part I.
5. D. A. Johnsen, *Plant Microtechnique* (Mc-Graw-Hill Book Co., Inc., 1940).
6. C. R. Metcalf, and L. Chalk, *Anatomy of Dicotyledons* (1940).
7. A. B. Mallik, and A.R. Mohajir, Pakistan J. Sci., Ind. Res., **2**, 66 (1959).
8. T. S. Sabins, J. Indian Bot., **1**, 6 (1920).
9. G.E. Trease, *A Textbook of Pharmacognosy* (1961).
10. H. W. Yungken, *Textbook of Pharmacognosy*, (1948).
11. *The Wealth of India* (A dictionary of Indian raw material and industrial products 1950), Publication of Indian C. S. I. R., Vol II.