

PHARMACOGNOSTICAL STUDY OF ROOT BARK OF *ERYTHRINA INDICA* LAM.
PARIBHADRA*

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ABSTRACT

Paribhadra, one of the reputed drugs of the indigenous system of medicine, is equated with *Erythrina indica* Lamk. Syn. *E. variegata* Linn. var. *orientalis* Linn., Family Fabaceae. Some other species of *Erythrina* viz. *E. suberosa* Roxb. and *E. stricta* Roxb., have also been mentioned as 'Paribhadra' in different text books on Indian Medicine and are used as substitutes for the genuine drug, *Erythrina indica*.

The pharmacognostical study is made of the root and root bark of *E. indica* Lamk., as based on material collected from authentic specimens and covers macro- and microscopical characters highlighting the diagnostic features, micro-chemical tests, examination of the powdered drug and preliminary phytochemical investigation.

Paribhadra, one of the important drugs of the indigenous system of medicine is largely used for its laxative, anthelmintic and galactagogue properties. The drug is pungent, astringent, promotes gastric disorders, destroys pathogenic parasites and used for relieving pain in the joints and in liver troubles.

Different parts of the plant are used for various medicinal purposes. Various properties and uses of the drug *Paribhadra* have been described in Ayurvedic texts and various "nighantus" like Shaligram, Sodhal, Raj Nighantu, Kaidev and Bhavaprakasha (Sharma, 1956 ; Misra, 1965). *Sushruta* recommends the use of its bark in snake bite. The bark is astringent and used as febrifuge, antibilious and anthelmintic. It is also employed as collyrium in ophthalmia.

Singh and Chuneekar (1972) reported that the bark is being used as a substitute for Rohitaka bark. *Aphanamixis polystachya* (Wall.) Parker probably due to its action in liver complaints. The young roots of the white flowered variety have aphrodisiac properties. The root also helps to regularise the menstruation cycle and the root bark is employed in diabetes and cancer. Continuous administration of this drug reduces blood sugar. A preparation, *Paribhadra Panchang* with coconut oil, is applied in eczema and *Paribhadrakshar* is used in piles, jaundice and ophthalmia (Chopra *et al*, 1956 ; Kirtikar and Basu, 1933 ; Misra, 1949 ; Nadkarni, 1914 ; Sharma, 1956 ; Vaishya, 1953 ; Watt, 1972).

Paribhadra has been equated with *Erythrina indica* Lamk. in books on Indian Materia Medica by competent authorities. Aiyer and Kolammal (1963) reported that there seems to be no confusion regarding its botanical identity. However, *Erythrina stricta* Roxb., which is a closely similar plant is occasionally used as a substitute. There

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is one more species, *Erythrina suberosa*, which is also known as 'Paribhadra' in some parts of the country. The name *Erythrina* has been taken from the Greek word *Erythros* or *Erythrinus* meaning red or coral red. The specific name *indica* refers the country, showing its nativity. All the species have similar properties as that of *E. indica*. The barks and roots of the different species also contain alkaloids. The Chinese drug, *Hai Tung Pi*, which is the dried bark of *Erythrina* spp. possesses bacterio-static action against *Staphylococcus aureus* and is nontoxic.

The drug is known by various names in different parts of the country :

SANSKRIT NAMES

Nimbataru, *Mandara*, *Kantaki-palash*, *Raktapushpa*, *Kantaki*, *Bahupushpa*, *Kantakimshuka*, *Raktakeshar*, *Raktakusuma* and *Paribhadra*.

1. Bengali : Palitamadar, Paltemadar.
2. Gujarati : Pararu, Bangaro, Panarva, Panderava.
3. Hindi : Pharhad, Dadap, Mandar, Parijata.
4. Kannada : Paribhadra.
5. Malayam : Kalayanamurikku, Kari-murikhu, Mandaram, Kul-murikhu, Murikku.
6. Marathi : Pengara, Pongro, Pangaru, Mandar.
7. Tamil : Kaliyanamurukku, Kavir, Mudhi, Mullumurukku, Pal asan.
8. Telugu : Baridamu, Possbhadrakamu, Paribhevyamu.
9. Uriya : Mondoro, Palodhua, Sal-tonya.
10. English : Indian Coral Tree.

BOTANICAL DESCRIPTION (Plate I)

Erythrina indica Lam. is a medium-sized, deciduous tree upto 15 m or more in height having grey fissured bark armed with sharp spine, conical, usually black.

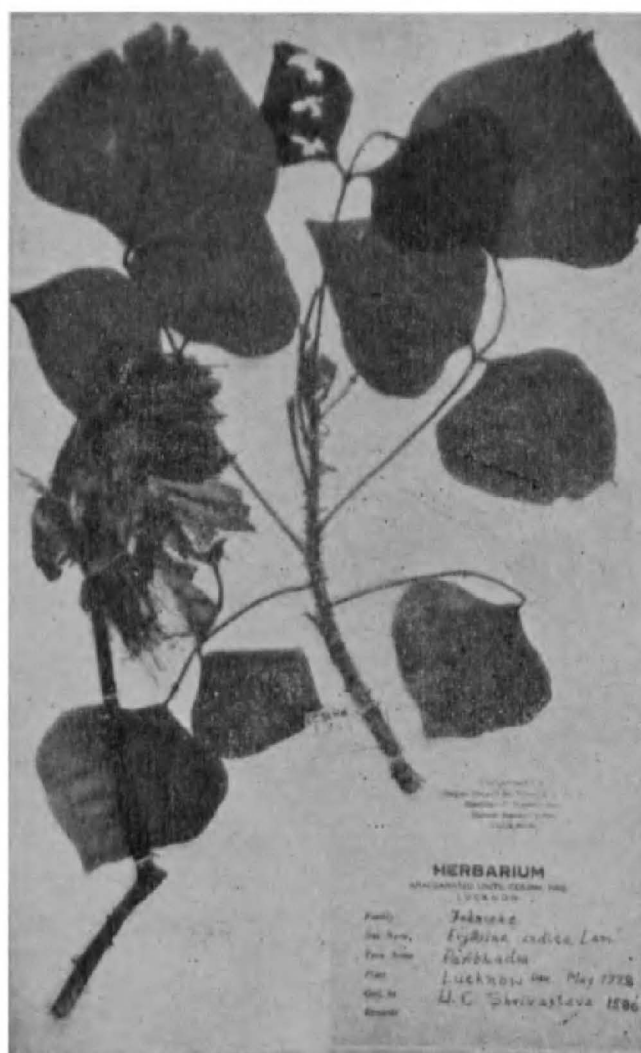


Plate I : A twig of *Erythrina indica* Lam. showing leaves and flowers.

Leaves 3 foliolate, leaflets membranous, glabrous, the end one round-cuspidate, 9.5-15.0 cm. long and nearly as broad and truncate or broad-rhomboidal at the base. Flowers large, coral red in dense racemes. Calyx with a very oblique mouth from the first, subglabrous minutely 5-toothed at the very tip. Petals very unequal, standard broad, wings are subequal, anthers uniform. Ovary stalked, many ovuled, style incurved, beardless, stigma, capitate. Pod long, distinctly torulose (Hooker, 1879).

Distribution : *Erythrina indica* is found wild throughout the deciduous forests of India from the foot of the Himalayas southwards

as far as Kanyakumari. It is common in Assam, Bengal, Konkan, N. Canara, Madras, Kerala, Andaman and Nicobar Islands. It is often cultivated in gardens as an ornamental trees. (Bambar, 1916 ; Bentham, 1864 ; Choke, 1958 ; Duthie, 1960 ; Gamble, 1935 ; Haines, 1910 ; Hooker, 1879 ; Maheshwari, 1961, 1963 ; Nairne, 1976 ; Patel, 1968 ; Prain, 1905 ; Santapau, 1953 ; Talbot, 1949 ; Wight, 1834).

CULTIVATION

This is one of the easiest tree to grow either from seeds or through vegetative propagation. For raising plants from seeds, ripe pods are collected in June. Seeds taken out are sown 8.5-12.5 cm apart in nursery beds. When the seedling attains a height of 12-20 cm in one year, they are dug out and planted. A number of horticultural forms are recognised. Among them the well known ones are forma *alba* with white flowers and forma *parcell* with variegated leaves.

BRIEF REVIEW OF CHEMICAL WORK DONE

In view of the importance of this drug a fair amount of phytochemical work has been carried out on this drug. Tuggane (1920) and Sahashrabuddhe (1933) have done the analysis of the leaf and gave the following values : moisture 6.85%, ether ext. 5.35%, Albuminoids 16.73%, digestible carbohydrates 37.12%, woody fibre 22.50% and ash 11.25%. They contain nitrogen 1.45%, potash 1.81% and phosphoric acid 0.5%. The leaves are reported to contain non-nitrogenous inert substance (m.p. 83) and a mixture of alkaloids, one of which melt at 117°. Hypaphorine is present.

The bark contains resin, fixed oil and fatty acids (0.60%), alkaloids (0.05%) including hypaphorine, an inert alkaloid decomposing at 97°, betaine and choline, potassium chloride and potassium carbonate are also

present (Chopra and Ghosh, 1935 ; Rao, 1945). Bhakuni and Khanna (1959) studied an alcohol extracts of the bark and isolated a wax alcohol m.p. 73° indicated to be decosyl alcohol, β -sitosterol, some other entities giving positive colour tests for sterols and certain uncharacterized non-nitrogenous fractions. Ghosal and co-workers (1972) have reported the isolation of erysotrine, erysodine, erysovine, erythraline, erysopine, erysopitine, erysodienone, erysamine, hypaphorine, hypaphorine methyl ester and N, N-dimethyl tryptophan methyl ester from the bark of *Erythrina variegata*. Recently Singh and Co-workers (1975) have studied the chemical constituents of *Erythrina variegata* var. *orientalis* bark. The petroleum ether extractive of the bark was fractionated and shown to be composed of wax, alcohols and wax acids, alkyl ferulates, alkyl phenolates, stigmasterol, sitosterol, campesterol and possibly citrostadienol/24-methylenelophenol. The ethanol extractive yielded chloroform soluble and water soluble bases, identified as erysovine and stachydrine respectively.

Further, Singh and Chawla (1970) investigated the seeds of *Erythrina variegata* var. *orientalis* and reported the presence of erythraline and free, liberated erysovine. Pharmacological studies of the alkaloids of *E. variegata* (Mandar) var. *orientalis* Linn. Syn. *E. indica* were carried out. Pharmacological studies conducted with alkaloids isolated from the stem bark of *E. variegata* showed that they produce relaxation of smooth muscles, antispasmodic action, curare-mimetic skeletal muscle relaxant action, depressant action on heart, a hydrocholeretic action, central nervous system depressant activity and anticonvulsant action. The alkaloids had no significant action on blood pressure, heart rate and respiration in dog, and were devoid of analgesic, antipyretic, anti-inflammatory, laxative and diuretic activities (Bhattacharya, et al 1971).

In the field of pharmacognosy the study has been carried out on the stem bark of *Erythrina indica* var. *orientalis* in the name of *Rohitaka* by Prasad *et al.* (1967), who reported that this bark is sold in the crude drug market of Northern India in the name of *Rohitaka*.

Maheshwari (1961) has given some taxonomic notes on the Indian Coral tree, *Erythrina variegata* L. var. *orientalis*. Kupchuin *et al.* (1975) have studied the micro-anatomy of 18 species including, *Erythrina variegata* var. *orientalis* Merr. in order to identify the plants present in pills and powder. Ghose & Sabir (1974) have studied the intrusive growth in the phloem fibres of *Erythrina indica*. Further, Ghose & Yunus (1976) have determined the ratio of ray and fusiform initials in vascular cambium of *Erythrina indica* and *E. suberosa*.

Despite the varied uses in the indigenous system of medicine, it is found that no pharmacognostic work has been carried out on the root, leaf and flower of this drug. Only the morphological and anatomical study has been made on the stem bark by Aiyer and Kolammal (1963). Later Prasad *et al.* (1967) carried out the Pharmacognostic investigation on the stem bark along with the stem bark of *Amoora rohituka* and *Tecomella undulata*. Since no pharmacognostical work on the root bark is on record, the present investigation has been undertaken. A preliminary phytochemical study has also been carried out.

MATERIAL AND METHODS

Fresh specimens of roots and root bark were collected from the National Botanical Garden and also from the locally growing trees. Their identity was established and the specimens were lodged in the herbarium of National Botanical Research Institute collected by U. C. Srivastava (Voucher No. 1586 date May 1978). The macro- and microscopical characters were studied. The histochemical tests for the cell contents were

performed according to Johansen (1940) and Kay (1938). The measurements of the individual tissues were recorded (Table-I). The behaviour of the powdered drug on treatment with different chemical reagents was observed (Table-II). The fluorescence analysis of the powdered drug was carried out under Ultra-violet light (Table-IV) according to the method described by Kokoski *et al.* (1971). The determination of total and acid insoluble ash and alcohol and water soluble extractive values (Table-III) was done according to the method of I. P. (Anon, 1966) and the same method was followed in conducting the phytochemical tests (Table-IV).

MACROSCOPICAL CHARACTERS (PLATE 2 A & B)

Root :

The roots are long, 0.5 to 2.0 cm in diameter, buff coloured, woody, rough due to the presence of lenticels and longitudinal striation. Fracture short and odour characteristic.

Root Bark :

Occurs in flat pieces, varying from 10-16 cm in length, 20 cm in breadth and 4-6 mm in thickness. The outer surface of the bark is light brown or buff coloured, longitudinally wrinkled, rough due to the presence of lenticels and longitudinal cracks of the thin cork. The cork is sometimes peeled off as flakes, exposing the phelloderm region, which is smooth and cream coloured. The inner surface is cream coloured, longitudinally striated. The bark is slightly astringent in taste, odour characteristic. Fracture tough, not easily brittle.

MICROSCOPICAL CHARACTERS (PLATE 3, FIGS. 1-5)

Young Root :

The transverse section of young root shows a single layered epidermis, followed by 5-6

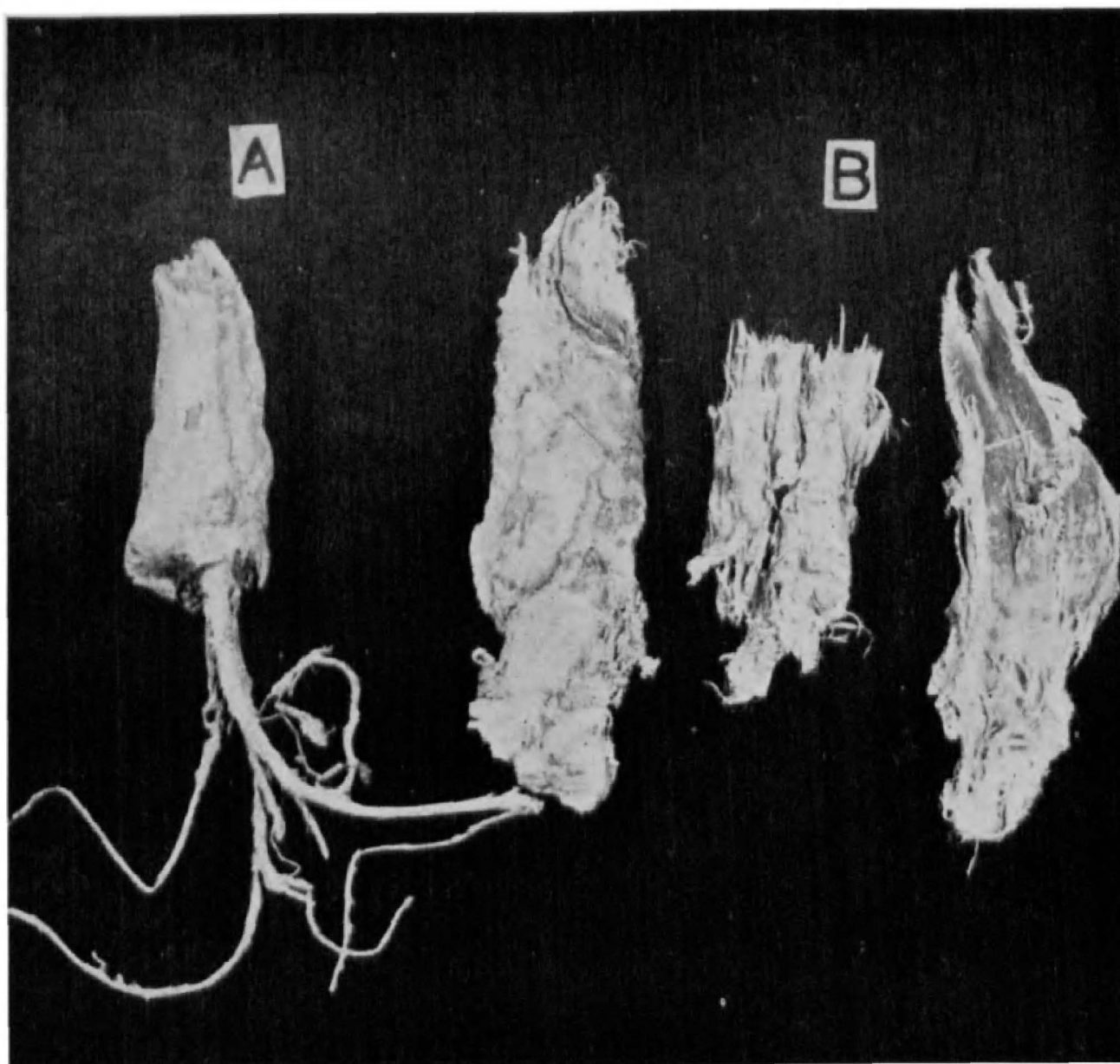


Plate II : Pieces of Root and Root bark of *Erythrina indica* Lamk. showing macroscopical characters.

layers of cortical parenchyma with distinct endodermis and pericycle, which encloses a distinct di- to tetrarch stele. Epidermal cells are cubicular and sometimes pentagonal in shape, the pericycle is composed of small parenchymatous cells. The cortical cells are round to polyhedral in shape with small intercellular spaces.

The secondary growth starts in the normal way. The cork cambium arises quite early in the pericycle. It cuts off cork on the outside and phelloderm cells on the

inner side. A few cells of the phloem parenchyma form small groups of thick-walled fibres which become lignified later. Soon the endodermis and outer tissues rupture off. Even very young rootlet shows a fair amount of secondary growth with a layer or two of cork cells. Prismatic crystals are present in the cortical parenchyma.

In a root of 1-2 mm diameter, the cork is 4-6 layers thick, thin-walled more or less rectangular, brown, followed by 2-3 layers of phellogen and 5-6 layers of phelloderm.

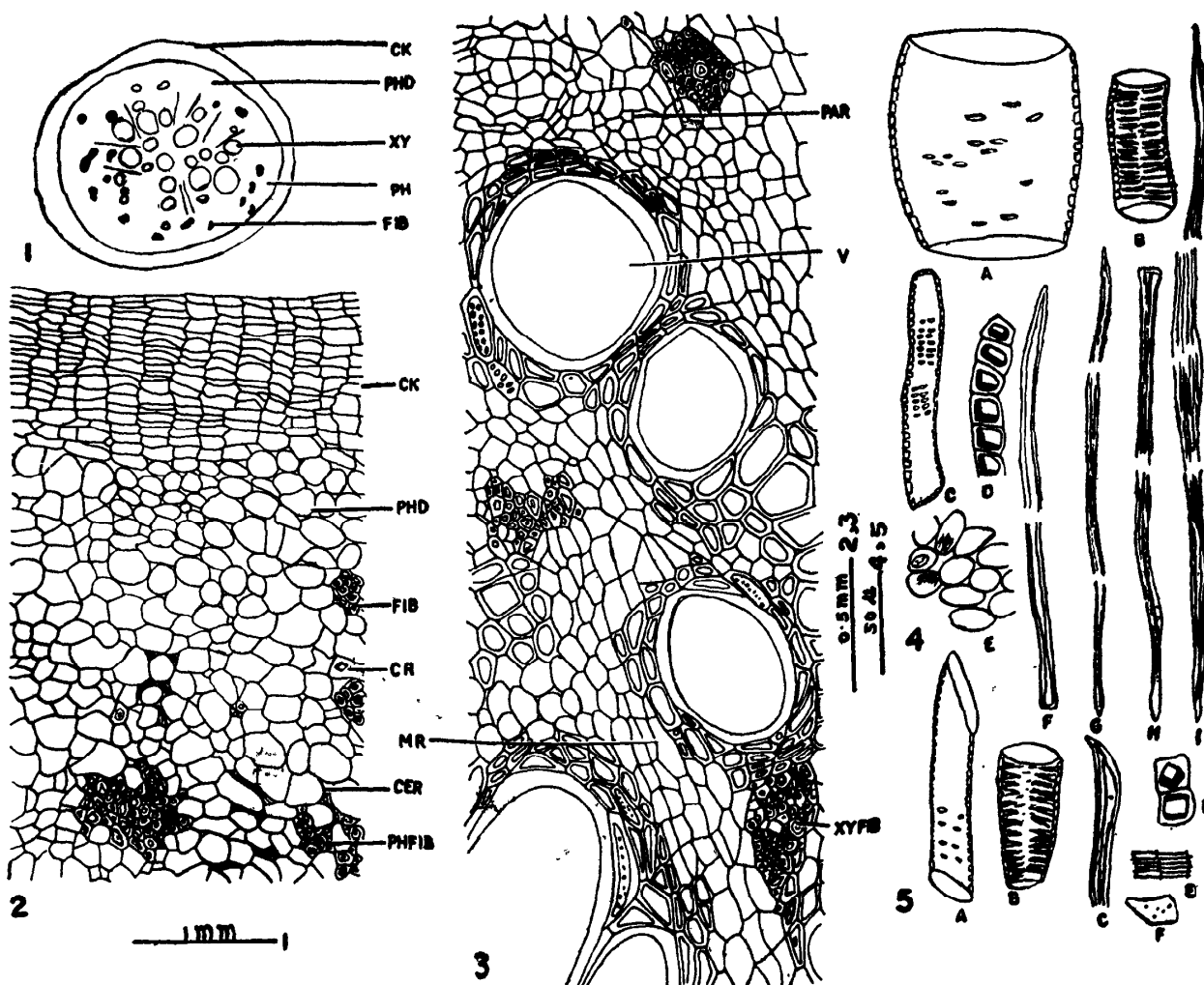


Plate III : Microscopical characters of the young root of *Erythrina indica* Lam.

Phelloderm cells consist of thin-walled rectangular or slightly tangentially elongated parenchymatous cells, one of which form small strands of phelloderm fibres.

The phloem is a continuous zone composed of sieve tubes, companion cells, phloem parenchyma, phloem fibres and elliptical sacs which is traversed by thin-walled medullary rays.

The secondary xylem is composed of xylem vessels, tracheids fibres and parenchyma traversed by medullary rays, which are thick-walled. Tracheids are filled with yellowish brown contents.

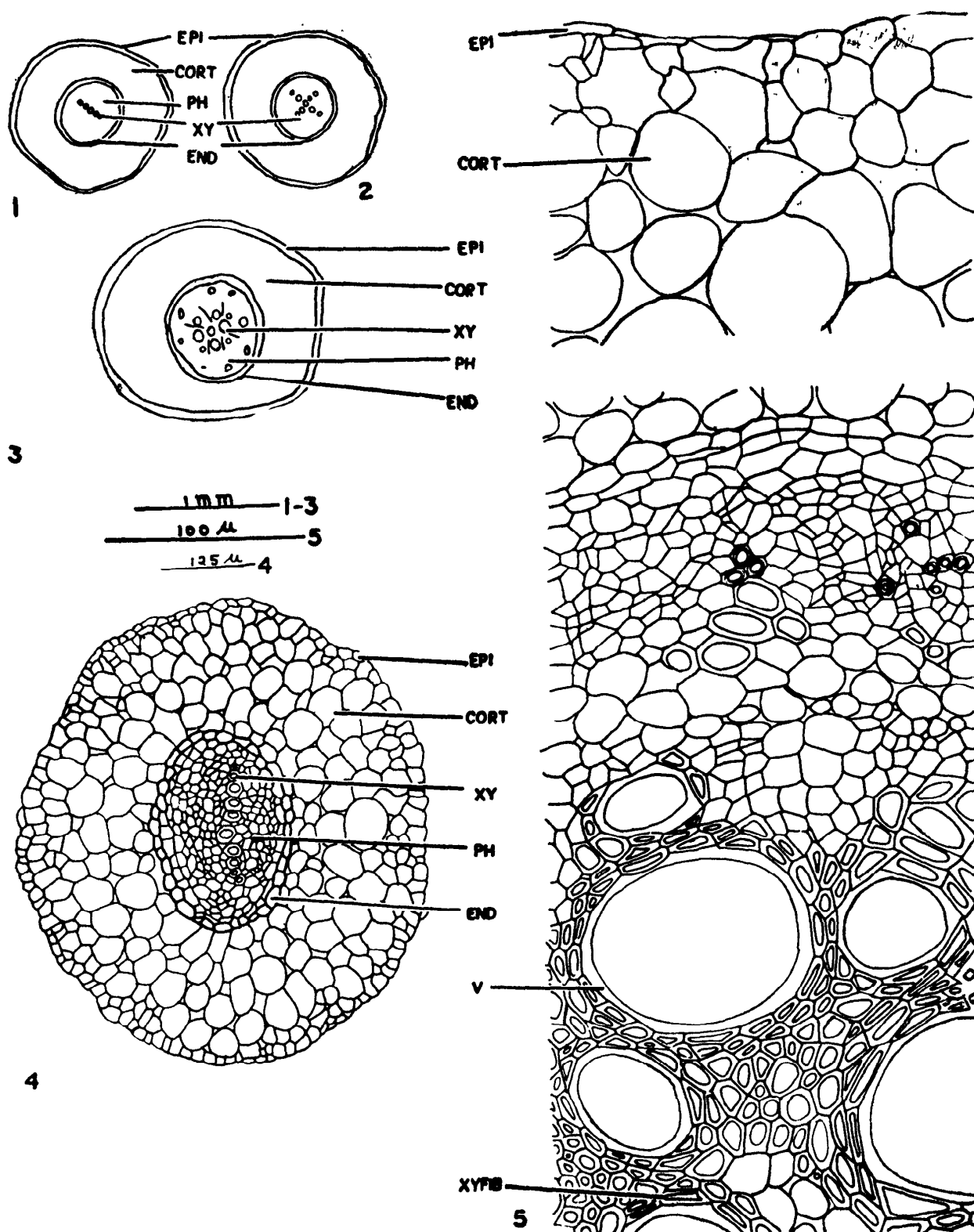
Mature Root (Plate I : Figs. 1-5) :

In a root of about 3 mm diameter, the cork remains usually 15-16 layers thick.

The cells are thin-walled. The phellogen is 2-3-layered and phelloderm is 4-5-layered. Fibres in the groups of 2-5 are also found in this region.

The secondary phloem is comparatively wider than the phelloderm and is composed of small groups of ceratenchyma and phloem parenchyma alternating with small strands of fibres which later get converted into stone cells. Yellowish brown contents are present in the phloem region which are resinous in nature.

The secondary xylem occupies the $\frac{1}{3}$ rd of the tissue and is composed of vessels, tracheids, xylem fibres and xylem parenchyma separated by xylem rays. Small groups of xylem fibres are present in the

Plate IV : Microscopic characters of the mature cot of *Erythrina indica* Lam.

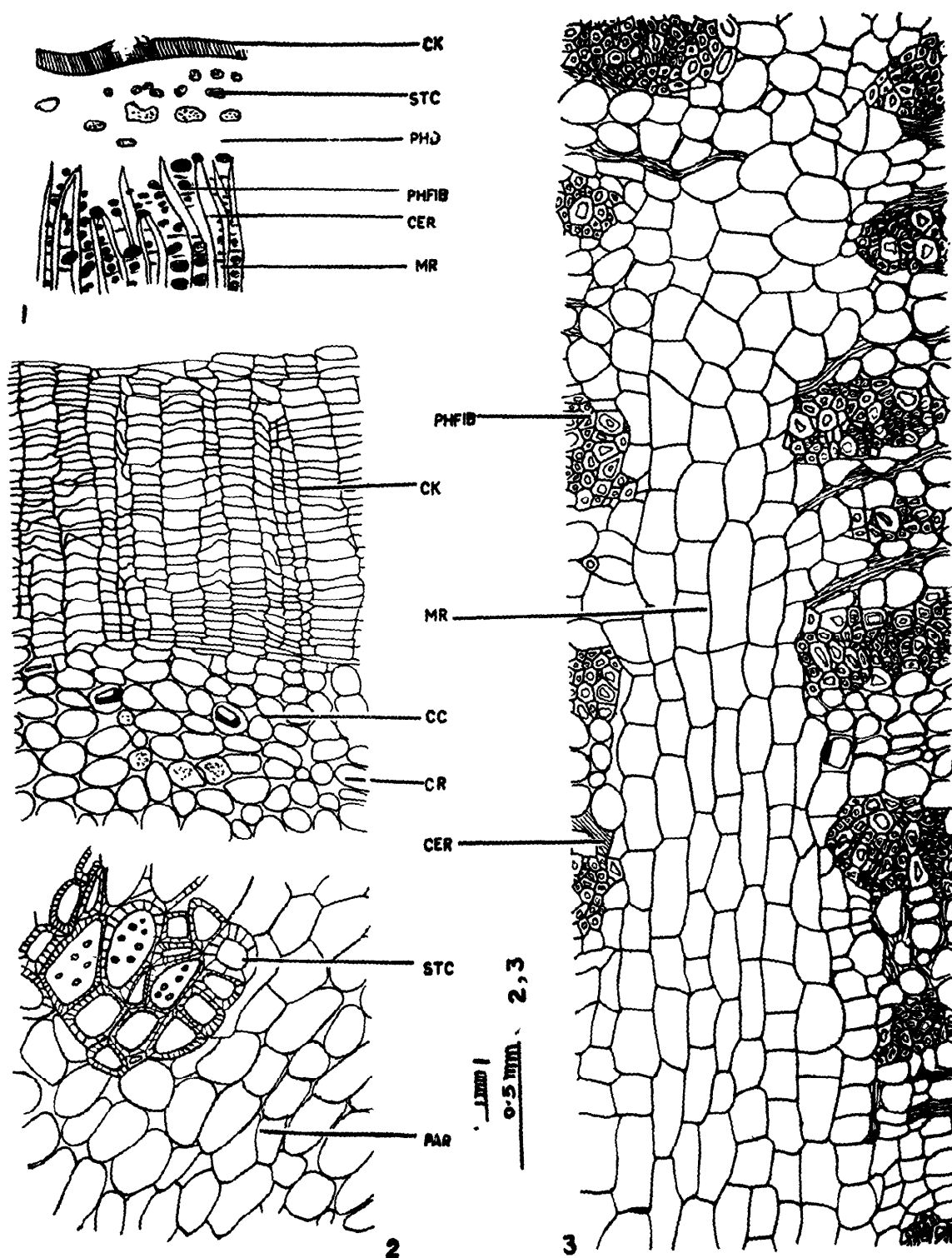


Plate V : Microscopical characters of the root bark of *Erythrina indica* Lam.

wood region. The vessels are circular to somewhat elliptical in T. S. and very sparsely distributed in a diffuse manner. They have transverse to oblique articulations and well marked perforation rims. These perforations are simple and present towards the end on the side walls. The tracheids are few in number having tapering but blunt ends. They have also bordered pits on their walls. The xylem fibres are found in great abundance having elongated and tapering, blunt or sharply pointed ends. Some have also chisel like or forked ends and a few show peg like lumen is quite narrow but wider in the centre. The xylem parenchyma consists of thick-walled cells and the rectangular in shape. They also possess simple pits in the walls.

Root Bark (Plate 5 : Figs. 1-3) :

The transverse section of the root bark shows cork cells which are 20-26 layered, rectangular, thick-walled and suberised. Phelloderm consists of thin-walled parenchyma, tangentially elongated and groups of stone cells.

The secondary phloem is a broad zone consists of ceratenchyma phloem parenchyma, alternating with stone cells and phloem fibres and are arranged in a concentric manner. Phloem fibres are long, thick-walled and lignified and tapering ends are pointed or chisel like. The central portion is more broader. Stone cells are square or rectangular in shape, thick-walled, lignified and pitted. Some of these fibres contain a number of prismatic crystals of calcium oxalate which are serially arranged.

Abundant prismatic crystals of calcium oxalate and yellowish brown contents are present in the parenchyma.

Microchemical tests :

Prismatic crystals of calcium oxalate are present. Some of the cells contain yellowish brown content which are resinous in nature. Tannin and sterol are present.

TABLE I

Measurement of the individual cells and tissues of the root and root bark of Erythrina indica Lamk.

Tissues	Microns
Epidermis	8-13-18 × 8-13-20
Cortex	35-40-50-60 × 35-40-53-68
Stone cells	10-13-15-20 × 8-10
Cork	28-38-50 × 10-13-15
Phelloderm	28-35-40-50 × 13-18-25-30
Crystals	23-28-35 × 5-8-10
Isolated elements	
Vessels	400-900-1100-1700 × 160-200-500-700
Phloem fibres	400-500-1650 × 20-30-40
Wood fibre	200-500-850-1100 × 20-30-40
Stone cells	50-60-70 × 50-60-80

Study of the Powders :

Powder is buff-coloured with no characteristic odour, taste slightly astringent. Microscopically it shows fragments of lignified thick-walled fibres, groups of stone cells, fragments of phelloderm cells and cork cells, abundant prismatic crystals of calcium oxalate and cells with reddish brown contents.

TABLE II

Behaviour of powdered drug on treatment with different chemical reagents

Treatment	Behaviour
Picric acid	No change
Conc. H ₂ SO ₄	Black
Conc. HNO ₃	Buff with light orange
HCl (Sp. gr. 1.18)	Light brown
Acetic acid	No change
Lactic acid	No change
Iodine	Black
Ferric chloride	No change
Sudan III	Red

TABLE III

Physical Constant Values

Total Ash	8.41%
Acid insoluble ash	0.002%
Alcohol soluble ext.	8.2%
Water soluble ext.	10.133%

TABLE IV
Fluorescence Analysis of Powder Drug

Treatment	Colour under Light	U-V
Drug + Nitrocellulose in amylacetate	Green	
Drug + IN NaOH in methanol	Green	
Drug + IN NaOH in methanol dried and mounted in nitrocellulose	Green	
Drug + IN HCl		
		Drug + IN HCl dried and mounted in nitrocellulose in amylacetate
		Green with black tinge
		Drug + IN NaOH in water
		Green
		Drug + IN NaOH in water dried and mounted in Nitrocellulose
		Green with black tinge
		Drug + HNO ₃ diluted in equal volume of water
		Green
		Drug + H ₂ SO ₄ diluted in equal volume of water
		Dark purple with green tinge
		Drug as such
		Green

Preliminary Phytochemical Tests for the Presence of Active Constituents in the Root Bark of *Erythrina indica*

Extract	Colour Nature	Percentage	Sterol	Reducing sugar	Flavonoid	Alkaloid	Polysaccharide	Tanin	Saponin	Resin
Hexane	Brown crystalline	5.98	+	—	—	—	—	+	—	—
Acetone	Dark brown oily	3.71	—	+	—	—	—	—	—	+
Chloroform	Dark brown sticky	2.17	—	+	—	+	—	—	—	—
Alcohol	Dark brown sticky	9.13	—	+	—	+	—	+	—	—
Water	Yellow sticky	0.68	—	+	—	+	+	—	+	—

The root contains sterol, reducing sugar, glycoside/polysaccharide, resin, alkaloids and saponins.

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REFERENCES

- AIYER, K. N. AND M. KOLAMMAL. Pharmacognosy of Ayurvedic drugs Series 1 ; No. 7 : 5. Kerala, 1963.
- ANONYMOUS. Pharmacopoeia of India 947. 1966.
- The Wealth of India : Raw Materials. Vol. III : 197. 1952.
- BAMBER, C. J. Plants of Punjab, 24. 1916.
- BARTON, D., H. R. CHRISTOPHER AND W. DAVIDA. Phenol oxidation and Biosynthesis part XXII on the Benzylterahyd's Isoquinoline-origin of *Erythrina* alkaloids. *Journ. Chem. Soc. Perhari, Trans.* 1-13: 346, 348. 1974.
- BENTHAM, G. *Flora Australiensis* 253. 1864.
- BHAKUNI, D. S. AND N. M. KHANNA. Chemical examination of the bark of *Erythrina indica* Lam. *Journ. Sci. Ind. Res. Sect. B* 18 : 494. 1959.
- BHATTACHARYA, S. K., P. K. DEBNATH, A. K. SANYAL AND S. GHOSAL. Pharmacological studies on the alkaloids of *Erythrina variegata* (Mandar). *Journ. Res. Indian Med.* 6(3) : 235-241. 1971.
- CHOPRA, R. N., S. GHOSH AND B. N. SEN. Some common indigenous remedies : *Erythrina indica*. *Indian Journ. Med. Res.* 22 : 265. 1934.
- , S. L. NAYAR, AND I. C. CHOPRA. Glossary of Indian Medicinal Plant. C.S.I.R. New Delhi. 1956.
- COOKE, T. *Flora of Presidency of Bombay* Vol. I : 390. 1958.
- DRURY, H. *Useful plants of India* 212. 1958.
- DUTHIE, J. F. *Flora of Upper Gangetic Plain*. Reprinted edition : 219. 1960.
- DYMOCK, W., C.J.H., WARDEN AND D. HOOPER. *Pharmacographia Indica* Vol. I : 451-454. 1890.
- GAMBLE, J. S. *Flora of Madras*, Vol. I : 249. 1935.
- GHOSAL, S., S. K. DUTTA AND S. K. BHATTACHARYA. *Erythrina* : Chemical and Pharmacological evaluation Part II. alkaloids of *E. variegata*. *Journ. Pharm. Sci.* 61 (8) : 1271-1274. 1972.

- GHOUSE, A. K. M. AND DURDANA SABIR. Intrusive growth in the phloem fibres of *E. indica* and *Pongamia glabra* ISI. *Journ. Bot.* 23(4) : 223-225. 1974.
- AND M. YUNUS. Ratio of ray and fusiform initials in vascular cambium of certain leguminous tree. — Eloro (Jene) 165(1) : 23-28. 1976.
- GRAHAM, A. AND A. B. TOMB. Palynology of *Erythrina* (Leguminosae) Papilionaceae, Preliminary survey of the subgenera, *Lloydia* 37 (1-4) : 465-481. 1974.
- HAINES, H. H. A forest flora of the Chota Nagpur. 325. 1910.
- HOOKE, J. D. Flora of British India : Vol. II. 188. 1879.
- JOHANSEN, D. A. Plant Microtechnique. New York. 1940.
- KAY, A. L. The microscopical study of Drugs, London. 1938.
- KIRTIKAR, K. R. AND B. D. BASU. Indian Medicinal Plants. Vol. 1. Allahabad.
- KOKOSKI, C. J., R. J. KOKOSKI AND SALAMA. Histochemical tests on *Erythrina* spp. *Journ. Amer. Pharm. Assoc.* 17(10) : 715. 1971.
- KRUKOFF, BONIS, A AND R. C. BARNEBY. Notes on the species of *Erythrina* VI. *Phytologia* 25 : 1-31. 1972.
- KRUKOFF, A. BORRIS. Notes on the species of *Erythrina* VIII. *Ibid.* 33(5) : 342-356. 1976.
- AND R. C. BARNEBY. Notes on the species of *Erythrina* VII. *Ibid.* 27 (2) : 108-140. 1973.
- KRUKOFF, B. A. & R. C. BARNEBY. Conspectus of species of the genus *Erythrina*. *Lloydia* 37 (1) : 332-459. 1974.
- KUO-CHUN, HSU CHEN, LINGWEN. CHIN-YUNGLUAN, LW. JN. G. HAN. AND HSU-LUO-SAN. The study of microscopical identification of powdered chinese drugs. *Acta Bot. Sin.* 16(4) : 342-353. 1974. *Biol. Abst.* 61(7) : 38209. 1975.
- LEWIS, W. H. Chromosomes and Phylogeny of *Erythrina* (Fabaceae) *Lloydia* 37 : (1-4) : 460-464. 1974.
- MAHESHWARI, J. K. Taxonomic notes on the Indian Coral tree. *Bull. Bot. Surv. India* 3(1) : 45-48. 1961.
- Flora of Delhi. 129. 1963.
- MISRA, BHAVA. *Bhavaprakash Nighantu*: 379. Chowkhambha Sanskrit series, Varanasi. 1949.
- NADKARNI, K. M. Indian Plants and Drugs with their Medicinal properties and uses, 1914.
- NAIRNE, A. K. The flowering plants of Western India. 87. 1976.
- PATEL, R. I. Forest Flora of Palghat. 113. 1968.
- PRAIN, D. Novicae-Indicae. Some additional species of Indian Plants 1905.
- RAVEN, P. H. *Erythrina* (Fabaceae) : Achievements and opportunities, *Lloydia* 37 (1-4) : 321-331. 1974.
- RAMA RAO, M. Flowering plants of Travance : 119. 1914.
- RAO, V. S. Trees of the Dhas and Terais, 45. Calcutta 1957.
- RAO, J. VIRABHADRA. Chemical examination of E. India (White variety). *Curr. Sci.* 14 : 198. 1945.
- ROMEO, JOHN, I. AND E. A. BELL. Distribution of amino acid and certain alkaloids in *Erythrina* Spp. *Lloydia* 37(4) : 543-568. 1974.
- SHARMA, P. V. *Dravya Gun Vijnan*, Vol. 2-3 : 84-86, Chowkhambha Vidya Bhawan, Varanasi, 1956.
- SANTAPAU, H. Records of Bot. Survey of India 16 (1) : 75. 1963.
- The Indian Coral tree : 59. 1966.
- SARAN, A. B. Some observations on the flowers of *Erythrina indica* Lam. *Journ. Indian Bot. Soc.* 12 : 92-95. 1933.
- SINGH, B. AND K. C. CHUNKAR. *Glossary of vegetable drugs in Brhatrayi* 245. The Chowkhambha Sanskrit series, Varanasi, 1972.
- SINGH, H. AND A. S. CHAWLA. Study of the chemical constituents of seeds of *Erythrina variegata* var. *orientalis*. *Planta Med.* 19 : 71. 1970.
- , CHAWLA, A. S., A. K., JINDAL, H. C. ANTHONY, AND J. W. ROWE. Investigation of *Erythrina* Spp. VII: Study of chemical constituents of seed of *E. Variegata* var. *orientalis*. *Ibid.* 1971. 1970.
- TALBOT, W. A. The tree, shrubs and woody climber of Bombay Presidency 193. 1949.
- VAISHYA, SHALIGRAM. *Shaligram Nighantu* : 322. 1953.
- WATT, G. Dictionary of Economic Products of India, 3 : 269. 1903.
- WIGHT, R. *Prodromus florae peninsular India orientalis* : 260. 1834.