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STANDARDIZATION OF TERMINOLOGY WITH REFERENCE TO BARK ANATOMY

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Bark is one of the potential sources of medicinal, industrial and commercial products. Knowledge of the structure and organization of the bark enables efficient utilization of barks. Descriptive terminology of bark tissues is the basic aspect in the study of bark. It seems that many of the terms used to describe the bark structure are ambiguous. A large number of synonymous terms reveal the lack of concise terminology of bark anatomy that could be preserved or discarded in order to maintain uniformity in the description of the structural spectrum of the barks.

Keywords: Bark anatomy; Standardization; Terminology.

Introduction

Barks serve the trees as metabolic sink of potential chemical products, which can be shunted to those organs that need them for various activities. Certain barks possess photosynthetic tissues, which function as subsidiary assimilating unit, especially for the deciduous trees. Many chemical compounds stored in the bark have been found to possess high therapeutic values and they also contribute significant share to the industries[1-3].

Anatomical studies on the barks lag much behind those on the woods. Bark perspectives have many dimensions of utility. Microscopic and surface features of the bark can be readily employed for botanical diagnosis of standing trees or logs, without involving much large damage to the wood of the trees. Fragmentary bark samples procured from the markets for formulations can be checked for their genuineness through microscopic parameters.

Realizing the need of a well developed, internationally applied terminology of bark anatomy, equivalent to that of wood anatomy, a few extensive surveys and discussions of bark anatomical terminology have been attempted[4-8]. The terminology proposed by Trockenbrodt[6] is mainly based on bark anatomy, Junikka[8] has pointed out the relevance of external morphology of the bark, especially in the identification of standing trees. Unfortunately, in most of the pharmacognostic books and articles on barks the terms used in the description of the barks seem to be ambiguous and are based on misconception or inaccurate observations. A large number of synonymous terms that permeates the bark anatomical descriptions reveal the lack of concise terminology of bark anatomy. Based on the literature already published and from the personal studies[9], the present paper highlights certain terms of bark anatomy and points out the terms that could be preserved/discarded while describing the barks.

Primary phloem and Secondary phloem - Primary phloem is differentiated from the procambium during early growth of the stem and root. After formation of the vascular cambium and subsequent differentiation of the secondary phloem from the cambium, the primary phloem gets collapsed. During further growth of the stem or root, more and more secondary phloem is added forming a wide prominent part of the bark. In some of the literature the primary phloem is named primary bark, and the secondary phloem is secondary bark[10], Rothe[11] calls the primary phloem as primary cortex and secondary phloem by the term secondary cortex. The German authors call them primary bast and secondary bast.

The term secondary cortex is also sometimes applied to phelloderm[13] or to the dilated outer zone of the phloem rays. The term bast is used to denote the bundle sheath fibres of the monocotyledonous leaves.

It is suggested that the term cortex may be restricted to denote the primary tissues between the epidermis and the vascular system of the stem/root. Further, phelloderm is the inner zone of the periderm, derived from the phellogen and it is no way related to the cortex and the term secondary cortex is a misnomer for the phelloderm. So also the terms primary bark, secondary bark and bast. It is suggested to retain the terms primary phloem and secondary phloem and to discard other ambiguous terms.

Periderm and Cork - The term periderm was introduced

by Von Mohl[14] and according to de Bary[15] the periderm consists of a meristamatic layer called phellogen, which gives rise to phellem outward and phelloderm inward. In many pharmacognosy papers, phellogen is said to be two or more layered and this is attributed as a diagnostic value. Phellogen is conceived to be single layered meristem and its visibility and activity fluctuates seasonally[16-18]. As such, phellogen seems to have no diagnostic value. However its place and mode of origin are variable and these observations may offer some diagnostic clues.

In most of the anatomy books and pharmacognosy articles, the term cork is used to denote either phellem or the entire periderm. There are many confusing terms to describe the tissue zones of the periderm[6]. In bark anatomical investigations the term cork, which is a technical term for the commercial product, may be restricted to the cork obtained from *Quercus* species. The precise terms, periderm, and its component tissue zones, namely phellem, phellogen and phelloderm may be used and the term Cork may be discarded.

Phellogen and Cork cambium - Since the term cork is to be restricted to the commercial cork of *Oak* sp. and periderm/ phellem is to be employed instead of cork, the term cork cambium becomes eventually to be discarded. Further, the term cambium may lead the reader to get confused with the term Vascular cambium (shortly called cambium). So, the term phellogen is to be used to denote the meristamatic cell layer responsible for the development of periderm.

Medullary ray and Vascular ray - In most of the pharmacognosy publications[19-21] the radial bands of parenchyma cells lying in the secondary phloem and secondary xylem are termed "medullary rays ". As the term indicates, medullary refers to the pith or medulla; the ray that runs from the medulla or pith to the cortex in the stem or any other axis is called medullary ray or pith ray; it is primary in origin and simple in structure. The rays that occur in the secondary phloem and secondary xylem are produced by the vascular cambium towards outside and inside respectively. The rays of xylem and phloem are more complex in structure and function. They are persistent in the xylem and phloem in contrast to the medullary rays, which are not distinguishable soon after the establishment of the secondary growth. Thus, the term medullary rays to refer the phloem and xylem rays are misnomers. The term vascular rays should be commonly used for all rays that originate from the vascular cambium. The rays outside the vascular cambium, which radially pass through the secondary phloem, are called phloem rays and the rays inside the vascular cambium running through the secondary xylem are called xylem rays.

Pseudocortex- In many barks, the periderm originates from deeper part of the cortex and consequently the original cortex may be sloughed off. During growth of the bark, the phloem rays will assume meristamatic activity and produce wide rays called dilated rays. The dilated rays will have tangential blocks of rectangular cells. The rays will move outward and occupy the position of the original cortex. By virtue of its position in the bark and its function as storage tissue, the dilated rays were named Pseudocortex. This term was introduced by Whitmore[13] while dealing with the barks of Dipterocarpaceae; the pseudocortex is a cortex like outer zone of living tissue merging with the secondary phloem in just as the way the primary cortex does in twigs. However, Esau[22] criticizes this term, because she assumes that the so-called pseudocortex is identical to original cortex, but is tangentially expanded by dilation growth. For the sake of convenience of descriptive purpose of the bark, the term pseudocortex may be used to designate the dilated phloem rays if they occupy the place of the original cortex and simulate its function.

Outer bark, middle bark and inner bark - In many papers on bark anatomy, a distinction is made between outer, middle and inner barks. According to many investigators, the inner bark is the part of the secondary phloem, extending from the vascular cambium up to the periderm or last formed rhytidome[4,13,18,23,24]. Roth[11] applies the term inner bark to the conducting part of the secondary phloem. The term middle bark is applied to different tissue zones of the bark. It is used to denote the tissues between the conducting phloem and beginning of the dilation growth of the phloem rays[11]. It is also applied to such different tissues as cortex, primary phloem and periderm. The term outer bark is applied to the rhytidome[17,18,23,24]. It may be pointed out that these three terms are used in confusing way.

To avoid such ambiguity, the following terminology can be followed. Instead of the term outer bark, the unambiguous terms rhytidome or periderm can be used. Since no accurate determination of the boundaries of the middle bark is possible, these terms may be avoided. In place of the term inner bark, the precise term secondary phloem, the tissue up to the last formed periderm may be used.

Phloem fibres and bast fibres - Fibres and sclereids are found in the barks of many plants. The arrangement of sclerenchyma elements in the bark is one of the characters of diagnostic value. To refer the sclerenchyma components of the phloem tissue, terms such as bast fibres and bast

sclerenchyma are being used; hard bast and hard bark are also prevalent in the bark literature. As mentioned elsewhere, since the term bast is objectionable, the terms phloem fibres and phloem sclereids are preferable[6,11].

Tissue zones of secondary phloem - The phloem tissue at certain distance away from the recently formed phloem may undergo collapse of the sieve tubes and companion cells due to the growth pressure exerted by the inner and outer tissues. Such crushed cells can be recognized in the bark sections as dark, tangential lines. Phloem ray dilation, if it occurs, may also contribute to the crushing of the sieve elements. A narrow zone of phloem near the cambium will have intact sieve elements and narrow rays. These two zones are readily visible with a hand lens and it is a common phenomenon in the barks of many trees. Several terms are used to designate the crushed phloem and non-crushed intact phloem. The collapsed phloem is called by such terms as non-functioning[17,18,25] and non-conducting phloem[11,13]. It is also called inactive phloem. The intact phloem is called functioning, conducting and active phloem.

The two zones of the phloem are recognized on the basis of crushed or collapsed sieve elements and their associated cells and non-collapsed phloem or intact sieve elements. The term conducting phloem for non-collapsed phloem seems to be inaccurate, because, the non-collapsed sieve elements do not necessarily have to be conducting one; due to deposition of callose on their sieve plates either temporarily or permanently, they become non-conducting elements. Further more, it is not always possible to distinguish conducting sieve elements from non-conducting ones using light microscope. The terms nonfunctioning and inactive phloem to the collapsed phloem are also objectionable on the grounds that the cells other than the crushed sieve elements in the collapsed phloem show considerable storage, secretary and excretory activities. Therefore, differentiation of phloem tissues on the functional basis is not possible in the anatomical studies. As per the proposal suggested by Trockenbrodt[6], the terms based on the microscopic characters, collapsed phloem and non-collapsed phloem are suggested for the two zones of phloem.

On the basis of afore discussed terminology, a table of terms to be retained and to be discarded is presented

Table 1.

Terms to be retained	Terms to be discarded
1. Primary phloem	Primary bark ; Primary cortex ; Primary bast
2. Secondary phloem	Secondary bast; Secondary cortex
3. Periderm	Secondary cortex
4. Phellogen single layered	Phellogen two or three layered
5. Phellem Phelloderm Periderm	Cork
6. Phellogen	Cork cambium
7. Vascular rays (Phloem and Xylem rays)	Medullary rays
8. Outer bark	Periderm/Rhytidome
Inner bark	Secondary phloem
9. Phloem fibres	Bast fibre
Phloem sclereids	Bast sclereids
10. Collapsed phloem	Non functioning Non conducting Inactive phloem
11. Non collapsed phloem	Functioning Conducting Active phloem

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