

BRC 2000064/14105

Epidermal and Phytochemical Studies in Some Species of the Family Bombaceae in Nigeria

O. T. Ogundipe* and G. O. Ajayi**

*Department of Botany, University of Lagos, Akoka, Nigeria.

**Department of Pharmacognosy, University of Lagos, Akoka, Nigeria.

(Received June 23, 2000)

ABSTRACT: Leaf anatomy and phytochemical investigation of some taxa of the family Bombaceae commonly used in traditional medicine in Nigeria were studied. The taxa studied were *Adansonia digitata*, *Bombax bounopozense* and *Ceiba pentandra*. Epidermal cells of the members investigated are either isodiametric or polygonal with straight, arcuate or wavy anticlinal walls. Cuticular striations are absent in *C. pentandra*. The cells varied in size and thickness both within and among taxa. The stomata distribution is hypostomatic with anisocytic type of stomata in all except *B. bounopozense* where anomocytic type also occur occasionally. Phytochemical analysis of the taxa reveals the presence of the secondary metabolites viz: tannins, flavonoids, carbohydrates and saponins.

Key Words: Traditional medicine; Medicinal plants; Phytochemistry; Bombaceae; *Adansonia digitata*; *Bombax bounopozense*; *Ceiba pentandra*.

Introduction

Bombaceae, a small family of about 20 genera and 140 species (Airy-Shaw, 1972) is an economically important family because of the medicinal properties, ornamental and other uses such as cutting to make platters, domestic utensils, doors and also “Kwarakwara” walking sticks in Northern Nigeria. In West Africa, three genera and five species (Hutchinson and Dalziel, 1963) belong to this family. Some members of the family are said to be, to some extent, anthropogene. They do not occur in virgin forests.

The young leaves of *Adansonia digitata*, known as the baobab or monkey tree, are popular in the diet as spinach used to make soup and sauces. In some parts of Nigeria, the trees are pollarded so as to produce an abundance of young leaves. The leaves are rich in mucilage and contain a high calcium content. Fresh leaves are rich in vitamin C which is usually lost during drying (Burkill, 1965). The fibre from the inner bark is particularly strong and durable. It is commonly used to make ropes and cordage, harness-straps, strings for musical instruments, baskets, nets, fishing lines, etc. The bark is a source of bast fibre. In Northern Nigeria, flat pieces serve as the soles of sandals, threaded with baobab fibres as the thongs. Soap can be made from the bark and the ash is valuable as fertilizer (Burkill, 1988). The seedpods are burnt as fuel in Northern Nigeria and the ash is used to make soap and for curing a disease known as “dankanoma”.

Medicinal uses of *A. digitata* also include the use of the leaves for their hypotensive and antihistamine properties. They are diaphoretic and promote sweating.

The stem bark of *Bombax buonopozense* contains a gum resin which has emollient properties. When it is pulped, it can be applied to treat ringworm. The stem bark with attached spine is an item of trade in markets for pulverizing and mixing with oil for an ointment which can be used for skin diseases. The Yoruba tribe in Nigeria regard the stem bark decoction as an emmenagogue while in Gabon it is regarded and used as febrifugal agents (Dalziel, 1937). In Ghana, the stem bark is used to increase lactation in women (NAPRALET, 1995). The floss is soft, silky, snow white or pale yellow and of beautiful luster. It is used locally for stuffing cushions, tender mattresses etc. (Burkill, 1988). The wood is cut or carved to make platters, domestic utensils, doors, stools and drums.

The wood of *Ceiba pentandra* (cotton tree, kapok tree) is used to make chairs, dishes and boxes, and for modeling drums and other musical instruments. Wood ash is widely used in Asfrica as a kitchen salt and in soap making. The bark contains a black mucilaginous gum which swells in water and resembles tragacath (Burkill, 1988). The bark also contains tannins.

The bark of *C. pentandra* is used in folk medicine in Nigeria for skin infections. A black decoction is used for tooth problems and as a mouthwash in Senegal and Liberia. It is also used for dysentery. The stem and root barks are considered as emetic and antispasmodic. Other medicinal uses include the treatment of diarrhoea and localized oedemas, and a decoction is used to wash sores (Burkill, 1988).

The aim of this investigation is to provide detailed microscopic evaluation of the leaves to enable the identification of these medicinal plants in the entire of powdered form. The study is also geared toward providing quantitative phytochemical data.

Materials and Methods

Fresh samples of the plants *Adansonia digitata*, *Bombax buonopozense* and *Ceiba pentandra* were collected in the wild and voucher specimens were deposited in the Lagos University Herbarium (LUH). The samples collected were used for the epidermal and phytochemical studies.

Epidermal Studies

Fresh plant specimens for anatomical studies were fixed and preserved in formalin-acetic acid-alcohol (F. A. A.). Small portions (about 5cm long) were taken from the middle of well-expanded leaves of each genus. The leaf portions were boiled for about 30 minutes in 90% alcohol in order to remove the chlorophyll. The leaf portions were rinsed in distilled water, boiled in 5% solution of sodium hydroxide for about one hour and kept in the solution for one to three days until the material becomes cleared or decolourised. The cleared or decolourised material was thoroughly rinsed in distilled water and further cleared in 50% of sodium hypochlorite for about 20-40 minutes and finally rinsed in distilled water.

Epidermal peels of both adaxial and abaxial surfaces of the leaf blade were made by placing the leaf blade on a glass tile and scrapping of the tissues on top of the desired epidermis with a sharp razor blade. Loose tissues and cells were washed away from the epidermal peels with the aid of soft camel hairbrush and water (Cutler, 1978; Ogundipe, 1991b). The epidermal peels were stained in 1% aqueous solution of Safranin O in and counter stained in Alcian blue for 1 to 22 hours in order to enhance the staining. The portions were rinsed in distilled water, dehydrated through the different grades of alcohol (30%, 50%, 70%, 95% with two changes in the latter) and cleared in xylene for 2 minutes. The dehydrated portions were mounted in Euparal. Drawings were made through camera lucida mounted on a M20 wild microscope.

The stomatal length and breadth, epidermal length and breadth and cell wall thickness in Table 1 are each based on 50 measurements.

Phytochemical Screening

The powdered samples of the leaves and stem bark of *Ceiba pentandra*, *Adansonia digitata* and *Bombax buonopozense* were separately extracted with two solvents viz ethanol (70%) and water using a Soxhlet apparatus. The extracts obtained were evaporated to dryness and stored in the freezer until required.

Qualitative chemical tests for various constituents like carbohydrates, saponins, flavonoids, alkaloids, anthocyanins, tannins, cardiac, anthraquinone and cyanogenetic glucoside were performed on the extracts

Table 1: Epidermal Features of members of Bombacaceae

| Taxa | Cell Shape | Anticlinal cell wall pattern | Epidermal cell size (µm) | Cell wall thickness (µm) | Stomatal size (µm) | Stomatal No. | Stomatal Index | Trichome |
|------------------------|-----------------|------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|--------------|----------------|-----------|
| | | | Length x Breadth (µm) (Mean ± S.E.) | Length x Breadth (µm) (Mean ± S.E.) | Length x Breadth (µm) (Mean ± S.E.) | | | |
| <i>B. buonopozense</i> | Ad: Polygonal | Straight/Arcuate | 53.8 ± 1.48x | 1.9 ± 0.7 | – | – | – | |
| | | | 53.8 ± 1.48 | 1.6 ± 0.7 | 28.5 ± 0.37x | 55 | 33.3 | Glandular |
| | Ab Polygonal | Straight/Curved | 39.7 ± 0.50x | | 18.9 ± 0.45 | | | |
| <i>C. pentandra</i> | Ab Isodiametric | Straight/Arcuate | 21.9 ± 0.60 | | | | | |
| | | | 30.5 ± 0.50x | 2.0 ± 0.5 | – | – | – | Glandular |
| | Ab Isodiametric | Arcuate | 20.3 ± 0.45 | | | | | |
| <i>A. digitata</i> | Ab Polygonal | Straight | 25.6 ± 0.60x | 1.5 ± 0.5 | 21.5 ± 0.75x | 24 | 37.5 | Glandular |
| | | | 15.7 ± 0. | | 8.5 ± 0.55 | | | |
| | Ab Isodiametric | Arcuate to wavy | 35.7 ± 0.75x | 3.0 ± 0.8 | – | – | – | Absent |
| | | | 25.4 ± 0.50 | | | | | |
| | | | 27.4 ± 0.50x | 1.8 ± 0.5 | 30.6 ± 0.72x | 16 | 44.4 | Absent |
| | | | 14.0 ± 0.50 | | 10.6 ± 0.40 | | | |

Ad - Adaxial;

Ab - Abaxial

obtained from the leaves and stembarks of the three plants using standard methods (Harborne 1972; Trease and Evans 1983 and Odebiyi and Sofowora 1978).

Observations

Epidermal Morphology

Epidermal complex

Epidermal cells are isodiametric to polygonal in shape. The anticlinal walls on the adaxial surface are straight in *B. buonopozense* and *A. digitata*, straight to arcuate to wavy in *C. pentandra*. The epidermal cells are variable in size within the three taxa examined. The epidermal cells are usually larger on the adaxial epidermis. *C. pentandra* has the smallest epidermal cells with $30.5 \pm 0.35 \times 20.3 \pm 0.45$ and $25.6 \pm 0.5 \times 15.7 \pm 0.45$ while *B. buonopozense* has the largest epidermal cells with $40.3 \pm 0.35 \times 30.0 \pm 0.39$ and $31.4 \pm 0.45 \times 22.5 \pm 0.50$ on the adaxial and abaxial epidermides respectively. The adaxial and abaxial epidermis vary in thickness from 6.0 ± 0.8 in *A. digitata* to 4.0 ± 0.45 in *C. pentandra* adaxially and 4.2 ± 0.7 in *B. buonopozense* to 2.5 ± 0.5 in *C. pentandra* abaxially.

Stomatal complex

Leaves are hypostomatic. Stomata are randomly distributed and are usually surrounded by three cells (anisocytic) which resemble the other epidermal cells. Anomocytic type of stomata occasionally occurs in *B. buonopozense* (Fig. 1). The stomata frequency is also of diagnostic feature for distinguishing genera in this family. The numbers of stomata on abaxial surface vary from 7 to 16 in the taxa. The size of the stomata varies from $21.5 \pm 0.75 \times 8.5 \pm 0.55$ to $30.6 \pm 0.72 \times 10.6 \pm 0.4$.

Trichome complex

Multicellular club-shaped trichomes occur on the abaxial and adaxial surfaces of *B. buonopozense* and *C. pentandra*. They occur usually along the costal areas in *B. buonopozense* and here and there in *C. pentandra* [Fig. 1G – I].

Cuticular Ornamentation

The cuticular ornamentation largely consists of fine and long or thick and short cuticular striations. Cuticular striations present on the abaxial and adaxial surfaces of *A. digitata*, abaxial surface of *B. buonopozense* but absent in *C. pentandra*. Where present they occur around costal zone or cell surrounding stomata and hair-bases.

Cell inclusions

Numerous starch grains druses were recognized in the 3 taxa. Tannins are also recognizing in *A. digitata* and *B. buonopozense*.

Phytochemical Studies

The results are as stated in Tables 2 and 3.

Table 2: Summary of phytochemical screening of the stem bark of *Ceiba*, *Adansonia* and *Bombax* of the Family Bombacaceae.

| | <i>Ceiba</i> | <i>pentandra</i> | <i>Adansonia</i> | <i>digitata</i> | <i>Bombax</i> | <i>Buonopozense</i> |
|--------------------------|---------------|------------------|------------------|-----------------|---------------|---------------------|
| Natural Products | Water Extract | Ethanol Extract | Water Extract | Ethanol Extract | Water Extract | Ethanol Extract |
| Alkaloids | - | - | - | - | - | - |
| Tannins | + | + | + | + | + | + |
| Flavonoids | + | ++ | + | + | + | + |
| Carbohydrates | ++ | ++ | ++ | ++ | ++ | ++ |
| Saponins | ++ | + | + | + | + | + |
| Cardiac glycosides | - | + | - | - | - | - |
| Cyanogenetic glycosides | - | - | - | - | - | - |
| Anthraquinone glycosides | - | - | - | - | - | - |

Key: ++ = Copiously present; + = Present; - = Absent

Table 3: Summary of Phytochemical screening of the leaves of the leaves of *Ceiba*, *Adansonia* and *Bombax* of the family Bombaceae.

| | <i>Ceiba</i> | <i>pentandra</i> | <i>Adansonia</i> | <i>digitata</i> | <i>Bombax</i> | <i>Buonopozense</i> |
|--------------------------|---------------|------------------|------------------|-----------------|---------------|---------------------|
| Natural Products | Water Extract | Ethanol Extract | Water Extract | Ethanol Extract | Water Extract | Ethanol Extract |
| Alkaloids | - | - | + | + | - | - |
| Tannins | + | + | + | + | + | + |
| Flavonoids | + | ++ | + | + | + | + |
| Carbohydrate | ++ | + | + | + | + | + |
| Cyanogenetic glycosides | - | - | - | - | - | - |
| Anthraquinone glycosides | - | - | - | - | - | - |
| Saponins | + | + | + | + | + | + |

Key: ++ = Copiously present; + = Present; - = Absent

Discussion

Although other features of members of Bombacaceae are relatively well known, the structures of its epidermis have not been fully described. Metcalfe and Chalk (1959, 1979) mention that stomata are confined to the abaxial surface of the leaf but they do not mention the type of stomata. However, the importance of the epidermal features of plants has been emphasized by workers such as Hagerup (1953), Stace (1965, 1984), Cutler (1979, 1984), Wilkinson (1979), Ogundipe and Olatunji (1991 a,b), Ogundipe (1992).

In this study the feature of the abaxial and adaxial surfaces of the leaves are diagnostic important for distinguishing between the three taxa. All species of Bombacaceae examined are hypostomatic. The studies of stomatal indices show that stomatal index is lowest in *B. buonopozense* and highest in *A. digitata*. Anisocytic stomata are found in all species studies, except in *B. buonopozense* where anomocytic type of stomata occasionally occur.

Observation on the side walls of the epidermal cells shows that the anticlinal walls on the adaxial surface are straight in *B. buonopozense* and *A. digitata*, but straight to arcuate in *C. pentandra*, while on the abaxial surface they are straight in *B. buonopozense*, arcuate in *C. pentandra*, but arcuate to wavy in *A. digitata*.

Leaf epidermal morphology is sufficient evidence for the taxonomic identification of these species even if only sterile specimens or leaf fragment are available.

The phytochemical investigation of the plants *C. pentandra*, *B. buonopozense* and *A. digitata* revealed the presence of these secondary metabolites viz: tannins, flavonoids, carbohydrates and saponins. The occurrence of these secondary metabolites in the three species can be said to be a common feature of the species within the Bombacaceae family, hence expected to have these secondary metabolites as some of its constituents. Other constituent present is alkaloid, which was present only in the leaves of *A. digitata*. The presence of cardiac glycoside in *C. pentandra* leaf was inconclusive.

In all the three species cyanogenetic and anthraquinone glycosides were absent. The presence of tannin in the three species can be linked to why some of the species within the Bombacaceae family are used in tanning which converts animals hides to leather as well as astrigent, these are some of the properties of tannin. Also the presence of tannin and flavonoid could be adduced to their use as antibacterial which justify the local use for the treatment of wound and skin diseases since tannins are known to have antiseptic property (Tyler et al., 1981).

References

- Burkill, H.M. (1985). The useful Plants of West Tropical Africa, 2nd Edition, vol. 1, Royal Botanic Gardens.
- Cutler, D.F. (1984). Systematic Anatomy and Embryology-Recent Developments; In Current Concepts in Plant Taxonomy; pp. 108 – 125 eds. V.H. Heywood and D.M. Moore, London, U.K.; Academic Press.
- Cutler, D.F. (1978). Applied Anatomy, Longman Inc., New York.
- Dalziel, J.M. (1956). The Useful Plant of West Tropical Africa; London, U.K. Academic Press.
- Harbone, J.B. (1973). Phytochemical Methods. A guide to Modern Techniques of Plant Analysis. Chapman and Hall, London.
- Hagerup, O. (1953). The morphology and systematics of the leaves of Ericales; *Phytomorphology* 3: 459-464.
- Hutchinson, J. and J.D. Dalziel (1963). Flora of West Tropical Africa. Vol. 2, 2nd ed.; London, U.K.; Crown Agent).
- Metcalfe, C.R. and L. Chalk (1957). Anatomy of Dicotyledons, vol. 1 (Oxford, U.K. Clarendon Press).
- NAPRALET, (1995). Computerised Retrieval System. Department of Pharmacognosy. University of Illinois, Chicago, U.S.A. (Personal Communication).
- Odebiyi, O.O. and Sofowora, E.A. (1978). Phytochemical Screening of Nigeria Medicinal Plants II. *Lloydia* 41: 234 – 246.
- Ogundipe, O.T. Leaf Epidermal Studies in the Genus *Datura* L. (Solanaceae). *Phytomorphology*, 42: 209 – 217.
- Ogundipe, O.T. and Olatunji, O.A. (1991a). Vegetative Anatomy of *Brachiaria obtusiflora* (Hochst. Ex. A. Rich) Stapf and *Brachiaria callupus* (Fig.) Stapf (Poaceae); Feddes Repetitorium, vol. 102, 5-12.
- Ogundipe, O.T. and Olatunji, O.A. (1991b). The leaf Anatomy of the species of *Cochlospermum* Kunth (Cochlospermaceae) in West Africa. Feddes Repetitorium, vol. 102: 183 – 187.
- Stace, C.A. (1965). Cuticular studies as an aid of Plant Taxonomy. *Bull. Br. Mus. Nat. Hist., Bot.* 4: 1 – 78.
- Stace, C.A. (1984). The Taxonomic Importance of the leaf surface. In Current Concepts in Plant Taxonomy; pp. 67-90. Eds. V.H. Heywood and D.M. Moore (London, U.K.: Academic Press).

- Trease, G.E. and Evans, W.C. (1984). "Pharmacognosy" 12th Edition. Publish by Baillere Tindall, London.
- Tyler, V.E., Brady, L.R. and Robbers, J.E. (1981). "Pharmacognosy" 8th Edition, publish by Lea and Febiger, Philadelphia, U.S.A.
- Wilkinson, H.P. (1979). The Plant surface (Mainly leaf): An Anatomy of the Dicotyledons, vol. 1 (2nd Edition), pp. 97 - 165 eds. C.R. Metcalfe and L. Chalk (Oxford, U.K. Clerendon Press)
- Willis, J.C. 1973. A Dictionary of the Flowering Plants and ferns, 7th Ed.; Cambridge, London: Cambridge University Press).