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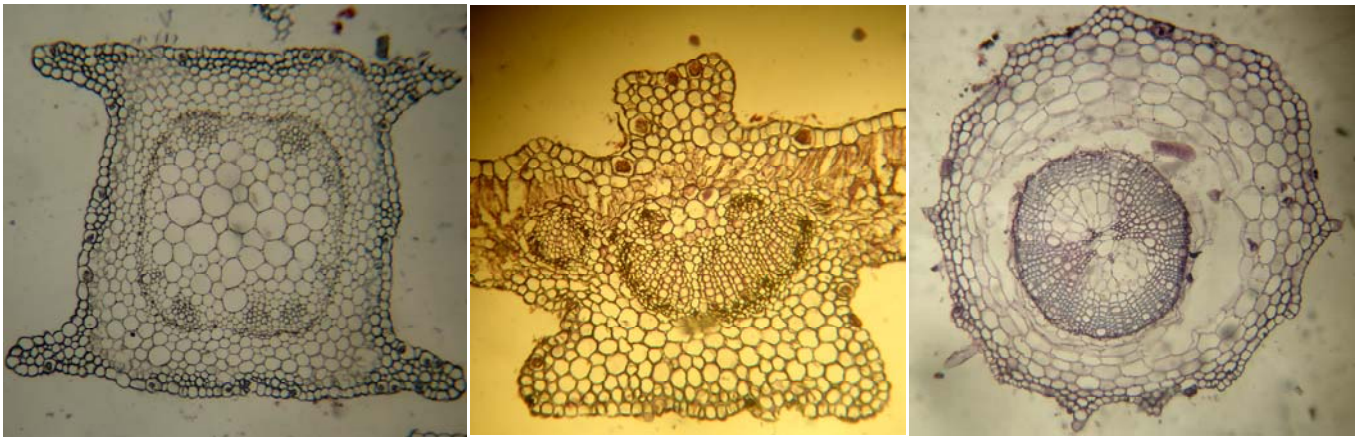
Morphological and Anatomical Characteristics, Phytochemical Analysis, and Uses of *Andrographis paniculata* (Burm.f.) Wall. ex Nees grown in Yezin, Nay Pyi Taw



By

Daw Kyi Kyi Khaing, Dr. Thida Cho, Daw Aye Nyein Chan

Wood Anatomy Section, Forest Research Institute, Yezin

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Contents

ဆေးခါးကြီးပင်၏ ပြင်ပရုပ်သွင်၊ အပင်ခန္ဓာဗေဒလက္ခဏာ၊ ဓာတုဗေဒပေါင်းပါဝင်မှုတို့ကို ခွဲခြမ်းစိတ်ဖြာခြင်းနှင့် အသုံးပြုမှုများကိုလေ့လာခြင်း။

ကြည်ကြည်ခိုင်၊ ဒေါက်တာသီတာချို၊ အေးငြိမ်းချမ်း
သစ်တောသုတေသနဌာန၊ ရေဆင်း

စာတမ်းအကျဉ်း

ဆေးခါးကြီးပင်၊ Andrographic paniculata (Burm.f.) Nees, Bitterweed ခေါ် King of Bitters) သည် Acanthaceae မျိုးရင်းဝင်ဖြစ်သည်။ နေပြည်တော်၊ ရေဆင်းတွင် ပေါက်သော ဆေးခါးကြီးပင်များကိုစုဆောင်း၍ လေ့လာပြီးမျိုးမည် ဖော်ထား ပါသည်။ ဆေးခါးကြီးပင်၏ ပြင်ပရုပ်သွင်၊ အတွင်းအင်္ဂါပိုင်းတို့ကိုလေ့လာ၍ ပုံများနှင့်တကွ ဆွေးနွေး တင်ပြထားပါသည်။ အပင်ဓါတုပါဝင်မှုစမ်းသပ်ခြင်း(phytochemical tests) ရလဒ်များနှင့် အသုံးဝင်ပုံတို့ကို ဖော်ပြ ထားပါသည်။ မြန်မာနိုင်ငံတွင် ဆေးခါးကြီးပင်ကို ဆီချို၊ ငှက်ဖျား၊ အဖျားရောဂါများ၊ အစာ မကြေလေနာခြင်း၊ သွက်ချာပါဒရောဂါ၊ ထိုင်းမှိုင်းခြင်း၊ paresis, tingling တို့တွင်သုံးသည်။ ဆေးခါးကြီးပင်သည် တစ်နှစ်ခံ ပင်ပျော့(annual herb)ဖြစ်ပြီး ရွက်ဆိုင်ထွက်သည်။ အမွေးမရှိ။ ပန်းခိုင်မှာ panicles ဖြစ်၍ ထပ်ဆင့်ပွင့်ကိုင်း သုံးကြိမ် အထိရှိသည်။ အမွေးမရှိ(glabrous)။ ပန်းပွင့်များသည် တတိယနှင့် စတုတ္ထ ထပ်ဆင့် ကိုင်းများပေါ်တွင် အပေါ်ဘက်ပိုင်းမှ ထောင်မတ် ၍ ထွက်သည်။ ပန်းပွင့်မှာ နှစ်ခြမ်းညီ (zygomorphic)၊ အထက်တည်မ(hypogynous)ဖြစ်သည်။ ပွင့်ချပ်အုံ(calyx)မှာ အဝိုက် ၅ ခုဆက်နေသည်။ ရှေ့အဝိုက် ၃ ခုဆက်နေပြီး၊ အလယ်အဝိုက်တွင် ရှည်သော ခရမ်းရောင် အကွက်ပါသည်။ ဘေးဘက်အဝိုက်နှစ်ခုမှာ ခရမ်းရောင်အဆင်းပါသည်။ အသီးမှာ အက်ကွဲသီး (capsule)ဖြစ်သည်။

ရွက်ပြား၏ကျည်ထောက်ပုံ ရွက်တွင်းသားဆဲလ်များ (palisade mesophyll) တစ်ထပ် ဖြစ်သည်။ ဆစ်စတိုးလစ်(cystolith)ခေါ် ပုံဆောင်ခဲများပါသည်။ လေပေါက် (stomata)များမှာ diacytic အမျိုးအစားဖြစ်၍ အရွက်မျက်နှာပြင် နှစ်ဘက်စလုံးတွင် ရှိသည်။ ရွက်လယ်ကြော၏ ဖြတ်ပိုင်းပုံ(cross section of midrib)မှာ မညီညာသော လေးထောင့်ပုံဖြစ်ပြီး အပေါ်မျက်နှာ ပြင်ဘက်တွင် ခုံးထွက်နေသည်။ အက်ပီဒါးမစ် (epidermis) တွင် ဆစ်စတိုးလစ် ခေါ် ပုံဆောင်ခဲ များပါသည်။ အစာရေကြောစည်း (vascular bundle)မှာ ကြီးပြီးဘေးဘက်တွင် အပိုအစာရေ ကြောစည်း(accessory bundles) ငယ်နှစ်ခုပါသည်။ ရွက်ညှာဖြတ်ပိုင်း(cross section of petiole) သည်

မညီညာသော လေးထောင့်ပုံ ရှည်မျောမျောပုံရှိသည်။ အပေါ်မျက်နှာပြင်တွင် ခုံးနေသည်။ အစာရေကြောစည်းမှာ ကြီးပြီးဘေးဘက်တွင် အတောင်ကဲ့သို့ အင်္ကျီများပါသည်။ အက်ပီဒါးမစ် (epidermis)တွင် စစ်စတိုးလစ် ခေါ် ပုံဆောင်ခဲများပါသည်။ အစာရေကြော စည်းမှာ အုပ်စုလိုက်ရှိပြီး လေးထောင့်ကွင်းပုံဆက်နေသည်။

အပင်ဓါတုပါဝင်မှု စမ်းသပ်ခြင်းအရ အရွက်မှုန့်တွင် အယ်ကာလွိုက်များ၊ အယ်လ်ဖာအမိုင်နိုအက်ဆစ်များ၊ ကာဗွန်ဟိုက်ဒြိုက်များ၊ ဖလာဗိုနွိုက်များ၊ ဂလိုင်ကိုဆိုက်များ၊ ဖီနော အုပ်စုပါဒြပ်ပေါင်းများ၊ ဓါတ်နုတ်သကြားများ၊ ဆက်ပိုနင်များ၊ ကစီဓါတ်များ၊ တယ်နင်များ ပါဝင်သည်။ အမြစ်နှင့်ပင်စည်တို့တွင် ဖလာဗိုနွိုက်များ၊ ဂလိုင်ကိုဆိုက်များ၊ ဖီနောအုပ်စု ပါဒြပ်ပေါင်းများ၊ ဓါတ်နှုတ်သကြားများ၊ ဆက်ပိုနင်များ၊ ကစည်ဓါတ်များ၊ စတီးရွိုက်များ၊ တယ်နင်များ၊ တာပင်နွိုက်များပါဝင်သည်။ အရွက်၊ ပင်စည်၊ အမြစ်တို့မှ ခွဲထုတ်လိုက်သော ဒြပ်ပေါင်းများ၏ တက်ကြွအုပ်စု (functional group)မှာ ဇန်သန်ကော်စေး(Xanthan gum) ဖြစ်ကြောင်း သိရသည်။ ဇန်သန်ကော်စေး (xanthan gum)သည် ဆီးချိုရောဂါရှိသောသူများကို သွေးတွင်းပါသကြားနှင့် ကိုလက်စထရောကို လျော့ချနိုင်သည့်အပြင် အခြားဆေးဘက်များတွင် လည်းသုံးသည်။ ထို့အပြင် အရွက်မှုန့်တွင် ကြေးနီ၊ သံ၊ ဆိုဒီယမ်၊ ပိုတက်ဆီယမ်ဒြပ်စင်များ ပါဝင်သည်။

Morphological and Anatomical Characteristics, Phytochemical Analysis, and Uses of *Andrographis paniculata* (Burm.f.) Nees grown in Yezin, Nay Pyi Taw

Kyi Kyi Khaing, Dr. Thida Cho, Aye Nyein Chan
Forest Research Institute, Yezin

Andrographis paniculata (Burm.f.) Nees, Bitterweed or King of Bitters, Sega-gyi in Myanmar, belongs to the family Acanthaceae, was collected in Yezin area, Nay Pyi Taw District, studied, identified, their morphological and anatomical characteristics, phytochemical tests and uses were descried, discussed and their phtotographs and photomicrographs were presented. In Myanmar, it is indicated for diabetes, malaria, fevers, indigestion, colic, paresis and paralysis, tingling and numbness. *A. paniculata* (Burm.f.) Nees is annual herb with opposite and decussate, leaves glabrous. Inflorescences are panicles with secondary, tertiary and quaternary peduncles, pubescent. Flowers are born on only upper side of tertiary or quaternary peduncles, and upright, flowers zygomorphic and hypogynous. Corolla are 5-lobed, anterior 3 united and larger than to posterior ones middle one with long purple blotches, the lateral two with two purple stresks. Fruits are capsules. In laminae, palisade mesophyll is one-layered cystoliths and stomata present on both surfaces, stomata of diacytic types; midribs irregularly quadrangular in outline in transverse section with convex surface at adaxial side, cystolith present in epidermial cells, vascular bundle large with two accessory bundle; petiole irregularly quadrangular-oblong in outline in transverse section with convex surface at adaxial side, vascular bundle large with two accessory bundle; stem quadrangular in outline in transverse section with wing-like structures at four angles, cystolith present in epidermal cells, vascular bundles in groups forming a quadrangular ring. Phytochemical test of leaf powder showed the presence of alkaloids, α- amino acid, carbohydrates, flavonoids, glycosides, phenolic compounds, reducing sugars, saponins, starch, tannin and terpenoids; stem and root powder showed flavonoids, glycosides, phenolic compounds, reducing sugars, saponins, starch, steroid, tannin and terpenoids. The functional groups of isolated compound from the leaves, stems and roots could be assigned as xanthan gum. The xanthan gum is used for lowering blood sugar and total cholesterol in people with diabetes and other medicinal purposes. Moreover, leaf powder contained copper, iron, sodium and potassium elements.

Key words – *Andrographis paniculata* (Burm.f.) Nees, morphology, anatomy, phytochemical constitute, medicinal uses.

LIST OF FIGURES

LIST OF TABLES

Morphological And Anatomical Characteristics, Phytochemical Analysis, And Uses Of Andrographis Paniculata (Burm.F.) Wall. Ex Nees Grown In Yezin, Nay Pyi Taw

1. Introduction

As in many developing countries, a great population of Myanmar people relies heavily on traditional practitioners and medicinal plants to meet their need for primary healthcare. Among of many numbers of the medicinal plants, Andrographis paniculata (Burm.f.) Wall. ex Nees., commonly known as Bitterweed or King of Bitters, Sega-gyi in Myanmar, is well known for its utility value in Myanmar traditional medicine. In Myanmar, it is a popular plant used in the treatment of fever and diabetes for a long time.

A. paniculata (Burm.f.) Wall. ex Nees. is one of the famous medicinal plants and belongs to the family Acanthaceae, and it is widely and wildly growing in the country. It is also used in ancient oriental and ayurvedic medicine.

It is also one of the most popular medicinal plants in Asia, America and Africa and it is used traditionally for centuries in the treatment of many diseases because of possessing several photochemical constituents with unique and interesting biological properties. This plant is used for cancer, diabetes, high blood pressure, ulcer, leprosy, bronchitis, skin diseases, flatulence, colic, influenza, dysentery, dyspepsia and malaria (Okhuarobo et al. 2014).

According to Ali (2014) who had reviewed the paper of Okhuarobo et al. (2014), diterpenes, flavonoids, xanthones, noriridoides and other miscellaneous compounds have been isolated from the plant and extract and pure compounds of the plant have been reported for their anti-microbial, cytotoxicity, anti-protozoan, anti-inflammatory, anti-oxidant, immunostimulant, anti-diabetic, anti-infective, anti-angiogenic, hepato-renal protective, sexual function modulation, liver enzymes modulation, insecticidal and toxicity activities.

The family Acanthaceae comprises of about 40 species. Only a few are popular for their use in folk medicine for assorted health concerns. Of these few, A. paniculata (Burm.f.) Nees. is the most important plant (Okhuarobo et al. 2014).

A total number of 4 species of the genus Andrographis is recorded in Myanmar including A. paniculata (Burm. f.) Wall. ex Nees, known as Sega-gyi or Se-khar-gyi in Myanmar, a shrub distributed in Kachin and Kayin States, Magway, Mandalay and Sagaing Regions (Kress et al. 2003).

The family Acanthaceae comprises of about 250 genera and about 2500 species worldwide (Becker 1965, Cronquist 1981), about 1500 species (Hooker 1985), 250 genera and 2000 species (Heywood 1978), about 250 genera and over 2500 species (Dassanayake 1988), and over 250 genera and 2500 species (Sharma 1993).

A total of 53 genera and 253 species of Acanthaceae was recorded growing in Myanmar by Hundley and Chit Ko KO (1987)

Thazin Phyu (2017) gave a taxonomic description of A. paniculata (Burm.f.) Wall. ex Nees. in her floristic study on Angiospermae of Moeswe area of Naglaik Reserve Forest, Central Myanmar.

In Myanmar, Department of Traditional Medicine had listed some 59 medicinal plants of Myanmar in Volume 1, including A. paniculata (Burm.f.) Wall. ex Nees. with a short description of its habit and uses. It is indicated for diabetes, malaria, fevers, indigestion, colic, paresis and paralysis, tingling and numbness. The medicine is used as dried powder of the

whole powder (https://www.dtm.gov.mm/sites/default/files/MedicinalplantsofMyanmar-Vol(1).pdf).

Aung Kyaw Min (2020) had made biological investigations such as bitterness value and amylase inhibition and their activity on A. paniculata (Burm.f.) Wall. ex Nees. grown in Myanmar and suggested that it is an important medicinal plant for the treatment of diabetic and stress related disease.

Than Than Soe and Khin Soe Soe (2020) also had studied the leaves of A. paniculata (Burm.f.) Wall. ex Nees. (Sega gyi) collected from Yangon Division and applied in vivo screening for anti-diarrheal activity and found that the ethanolic extract showed anti-enteropooling activity.

Ei Mon Mon Hlaing et al. (2018) made experiments on hepatoprotective effect of A. paniculata (Burm.f.) Wall. ex Nees on paracetamol-induced hepatotoxicity in albino rats and showed that ethanolic extract of leaves of A. paniculata (Burm.f.) Wall. ex Nees. had some extent of hepatoprotective effect.

DeFilipps and Krupnick (2018) made a comprehensive compilation of the medicinal plants of Myanmar, a total of 123 families, 367 genera, and 472 species, including A. paniculata (Burm.f.) Wall. ex Nees. with its names, growing range and uses.

Sudhakaran (2012) made a study with the objectives to delineate pharmacognostical profile of stem, root and leaves of A. paniculata (Burm.f.) Wall. ex Nees.. He stated that it was an important medicinal plant and used in traditional medicine as a remedy for the cold, fever and detoxification of the body since time immemorial. It had successfully halted the spread of 1919 Indian Flu pandemic.

In the world trade, some imported plant materials such as vegetables and drugs come in the form of dried powdered plant parts, usually rhizomes, roots or leaves. Sometime it would be easy to introduce useless or sometimes even poisonous. These adulterants might be difficult to detect with the naked eye and anatomical methods are needed to detect the identity of such fragments. The proper authentication of crude drug material is essential for standards of safety and quality to be maintained. For these purposes, accurate anatomical and morphological descriptions of the drugs have been required (Cutler, Botha, and Stevenson, 2007).

Anatomy is particularly useful in taxonomically identifying disassociated plant parts whether those parts be leaves, roots, stems, fruits or seeds of living or fossil plants (Culter, Botha and Stevenson 2007).

Khin Win Myint (1996) described macroscopic, microscopic characters and uses of the leaves of A. paniculata (Burm.f.) Wall. ex Nees. in Myanmar. A few researchers studied and described morphology, biological investigation and uses of A. paniculata (Burm.f.) Wall. ex Nees. in Myanmar, however their morphological, anatomical characteristics and phytochemical tests are still lacking on this medicinal plant according to available literature. In this research, morphological, anatomical characteristics, phytochemical tests and uses of A. paniculata (Burm.f.) Wall. ex Nees. collected from Yezin are studied, described and discussed with relevant photographs and photomicrographs

2. Literature Review

Andrographis paniculata (Burm. f.) Wall. Ex. Nees is herbaceous medicinal plant, native to India, Taiwan and China. It belongs to the family Acanthaceae. All parts of the plant have bitter taste and it is commonly known as ‘Kalmegh or King of Bitters. (Sudhakaran MV,2012).

Okhuarobo et al. (2014) stated that *A. paniculata* (Burm.f.) Wall. ex Nees was an annual, branched, erect handsome herb running half to one meter in height. It was native to peninsular India and Srilanka and was also distributed in different regions of Southeast Asia, China, America, West Indies and Christmas Island.

Sahu (2018) reported that *A. paniculata* (Burm f.) Wall. Ex Nees had been used as a valuable traditional medicinal plant. The *A. paniculata*, commonly known as Kalmegh is an perennial herbs. It possesses many important bioactive compounds.

Dey (2013) mentioned that the synonym of *A. paniculata* (Burm f.) Wall. ex Nees is *Justicia latebrosa* Ross. J and traditionally used in the India and any other countries like Java, Malaysia etc. The whole plant part of this herb is especially applied for the treatment of some disease like carminative, liver stimulant, laxative, anthelmintic, blood purifier, anti-inflammatory, antileprotic, antipyretic and prevent for malaria etc. The medicines of *A. paniculata* is very popular in the market because of the ability of this medicinal value.

Vasu (2012) stated that the surface view of upper epidermis lacking stomata, abaxial (lower epidermis) present diacytic type of stomata, small stomatal index and fairly large; cystoliths was found in both surface of lamina. The transverse section of stem was quadrangular shaped with dense collenchyma strands at the angles. Calcium oxalate deposit in the dermal tissues of the lamina, ground tissues of petiole, stem and secondary xylem of root that are also diagnostic characters of the taxon.

Amri (2018) mentioned that the transverse sections of petioles and midribs occurred cystolith cells and large vascular bundle. Lamina, which occurs hypodermis layers and types of trichomes.

Modishproject (2023) described that the mature stomata of *A. paniculate* (Burm f.) Wall. Ex Nees is paracytic type. Leaves are hypostomatic. Sclerids were distributed on both surfaces.

A total of 135 compounds, including 40 flavonoids, 82 terpenes, 3 steroids, and 10 other compounds were isolated and identified from *A. paniculata* by chromatographic methods. Most have been studies for different biological activities . It has many bioactive compounds like diterpenoids, lactones, diterpenes glycosides, flavonoids, and flavonoid glycosides (Humbal A, et.al., 2021).

A significant chemical andrographolide is a diterpenoid lactone having several pharmacological properties (Sreevani P, 2015). It cures and prevents several diseases such as cold, fever and colic pain, and it is active against inflammatory (Parichatikanond W, et.al., 2010), antidiabetic activity (Subramanian R, et.al., 2008), antioxidant (Zhang XF Zhang XF, et.al., 2000), antifertility (Akbarsha MA, et.al., 2000), cardiovascular (Zhang CY, et.al., 1997), hepatoprotective (Shi MD, et.al., 2008), anti-cancer properties (Wiart C, et.al., 2005) and anti-virus including inhibited HIV (Reddy VLN, et.al., 2005).

Genus andrographis includes 28 species of small herbs basically dispensed in tropical and subtropical Asia. Some species, such as *A. paniculata*, are recognized to have healing properties (Hossain S, et.al., 2014).

It belongs to the Acanthaceae family, a potent herb utilized for the number of Ayurvedic, Siddha and homoeopathic formulations. *A. paniculata* is commonly used in indigenous medicine, especially as a bitter tonic, to treat fevers, diarrhoea and to get rid of intestinal worms. The herb is utilized as a liver tonic, blood purifier, and stomachic (Gan L, et.al. 2019).

All parts of this plant are used to extract the active phytochemical. Active components mainly isolated from ethanol or methanol extract of leaves, stems, roots, and whole plant of *A. paniculata*, which include diterpenes, lactones, flavonoids, and xanthones (Wang GY, et.al., 2017). But the compositions of phytoconstituents widely differ from one part to another.

Akilandeswari (2019) stated that *A. paniculata* include various bio-active compound in the whole parts of plants. Flavonoids mainly isolated from the root and also include in the leaves. In the leaves of *A. paniculata* contain the bitter substance that was lactone andrographolide.

Adiguna (2021) described that the extract of this plant contains biological active compounds against several disease. Most active compounds are extracted from the aerial parts of the plant and some extracts are obtained from the roots.

Xanthan Gum is a long chain polysaccharide, which is made by mixing fermented sugars with a certain kind of bacteria. It is mainly used to thicken and stabilize emulsions, foams, and suspensions. Xanthan gum is widely used as a food and medicine. Xanthan gum is used for lowering blood sugar and total cholesterol in people with diabetes. It is also used as a laxative. Compared with other gums and suspending agents, pharmaceutical grade xanthan gum has high viscosity (especially significant at low concentrations), strong rheology and pseudoplastic, excellent stability, acid and alkali resistance, enzyme resistance, good compatibility and adaptability with various solvents, and safe and non-toxic characteristics.

Xanthan gum is safe when up to 15 grams per day are taken. It can cause some side effects such as intestinal gas (flatulence) and bloating. People who are exposed to xanthan gum powder might experience flu-like symptoms, nose and throat irritation, and lung problems.

3. Materials and Methods

3.1. Sample collection area

The whole plant of *Andrographis paniculata* (Burm.f.) Wall. ex Nees were collected from the forest near Golf Club, Forest Research Institute, Yezin, [19.8436° North Latitude; 96.278° East Longitude (Google Earth)] in the year of 2022 to 2023.

3.2. Morphology and Anatomy

Description of collecting specimens was carried out by using dissecting microscope. Identification of the species was done by referring the literature as Key to the families of flowering plants of KERALA VER 2.0, the international plant names index and world checklist of vascular plant 2024.

Some of the specimens are dried to make herbarium sheets and some of them are killed and fixed in 50% or 70% ethyl alcohol for further study. The leaves, stems, roots, as well as the plants in natural habit in flowering and fruiting seasons, were studied and described, discussed and presented.

The small portions of petioles, leaf blades, stem and tap roots which were previously killed and fixed were washed in the running water for overnight and the specimens were dehydrated through a series of tertiary butyl alcohol solutions. Then the totally dehydrated specimens were infiltrated in a series of paraffin wax of which melting points were 49° C, 55° Cand 60° C respectively. The specimens were then embedded in the 60° C paraffin wax and cut into 16 – 19 µm thick sections by using a rotary microtome, BK 2478.

These thin sections were mounted on a clean glass slide by Mryer's albumen and immersed in xylol solution to remove paraffin. Then they were double-stained in the combination of safranin and fast green solutions according to Johenson (1940). After staining, the sections were permanently mounted under a cover slip by using Canada balsam in xylene and kept dried for a few days on a slide tray in the room temperature. The killing and fixation, dehydration, infiltration, embedding, staining and mounting were made according to Johansen's (1940) Method.

The sections were examined under biological microscope (MT 4300H) attached to a laptop by a camera. The parts of leaves, stems and roots were macerated separately by warming in a mixture of two parts of hydrogen peroxide solution and one part of glacial acetic acid solution according to Franklin's method (modified) (Berlyn and Mikshe 1976). The macerated elements were studied under biological microscope (MT 4300H) and the vessel elements and fibers were measured by an ocular micrometer and recorded by a digital camera.

3.3. Phytochemical tests

They were cleaned firstly, then chopped into tiny pieces, air dried in shade at room temperature for one month and powdered separately. The powdered samples then stored properly before use it for FTIR analysis.

3.3.1 Phytochemical screening

Phytochemical constitutes present in leaf, stem, and root of *Andrographis paniculata* (Burm. f.) Wall. ex Nees, were carried out according to the general methods mentioned in phytochemical methods (Harborne and Baxter, 1993).

3.3.1.1 Test for alkaloids

The powdered sample (2 g) was boiled with 1% hydrochloric acid (10 mL) for about 10 minutes, allowed to cool and then filtered. The filtrate was divided into two portions. One portion was tested with Dragendorff's reagent. The orange precipitates in pulp and seeds indicate the presence of alkaloids and other part was tested with Wagner's reagent. The yellowish-brown precipitate indicates the presence of alkaloids (Harborne and Baxter, 1993).

3.3.1.2 Test for α-amino acids

The powdered sample (2 g) was boiled with 10 mL of distilled water for about 10 muinutes and then filtered. An aliquot portion of the filtrate was transferred to filter paper with the help of capillary tube and allowed to dry and sprayed with Ninhydrin reagent. The filter paper was dried at room temperature and then kept in an oven at 110 ºC for 5 minutes to see if purple or violet color spot appeared which indicated the presence of α-amino acids (Harborne and Baxter, 1993).

3.3.1.3 Test for carbohydrates

The powdered sample (2 g) was boiled with 10 mL of distilled water for about 10 minutes and then filtered. The filtrate was placed in a test tube and 5 drops of freshly prepared 10 % α-naphthol were added followed by shaking. The test tube was inclined at an angle of 45 ºC and about 1 mL of concentrated sulphuric acid was slowly introduced along the side of the test tube to see if red ring formed at the interface of two liquids indicating the presence of carbohydrates (Harborne and Baxter,1993).

3.3.1.4 Test for cyanogenic glycosides

The powdered sample (2 g) was mixed with distilled water in a conical flask. About 5 drops of concentrated sulphuric acid was added. Sodium picrate paper was trapped in a neck of the conical flask by means of a cork. The mixture in the flask was heated by a spirit burner. If sodium picrate paper did not give a brick red colour it indicated the absence of cyanogenic glycosides (Harborne and Baxter,1993).

3.3.1.5 Test for flavonoids

The powdered sample (2 g) was boiled with ethanol for about 10 minutes and then cooled and filtered. The filtrate was treated with 5-10 (0.5 mL) drops of concentrated hydrochloric acid and a small piece of magnesium was added in a test tube and boiled for a few minutes. The appearance of pink colour solution indicated the presence of flavonoids (Harborne and Baxter,1993).

3.3.1.6 Test for glycosides

The powdered sample (2 g) was boiled with 10 mL of distilled water for 10 minutes and then allowed to cool and filtered. The filtrate was treated with 10 % lead acetate solution. Appearance of white precipitate indicated the presence of glycosides (Harborne and Baxter, 1993).

3.3.1.7 Test for phenolic compounds

The powdered sample (2 g) was boiled with 10 mL of distilled water for about 10minute. It was cooled and filtered. The filtrate was tested with 5-10 drops of 10 % $FeCl_3$ solution. The formation of pale greenish blue color solution indicated the presence of phenolic compounds (Harborne and Baxter,1993).

3.3.1.8 Test for reducing sugars

The sample (2 g) was boiled with 10 mL of distilled water for 10 minutes and then filtered. To this filtrate, a mixture of Benedict's solution was added and boiled for a few minutes. The appearance of brick red precipitate or red precipitate was indicative of reducing sugars (Harborne and Baxter, 1993).

3.3.1.9 Test for saponins

About (2 g) of the powdered sample was boiled with 10 mL of distilled water for about 10 minutes and shaken vigorously. The formation of the froth was indicative of saponins (Harborne and Baxter, 1993).

3.3.1.10 Test for starch

The powdered sample (2 g) was boiled with distilled water (10 mL) for 30 minutes and filtered. Two drops of 1% iodine solution (w/v) were added to the filtrate and an observation was made to see the formation of a deep blue precipitate which indicated the presence of starch (Harborne and Baxter, 1993).

3.3.1.11 Test for steroids

Sample (2 g) was extracted with 10 mL of petroleum ether for 10 minutes. The ethanol extract was treated with acetic anhydride solution (2 mL), followed by 1 mL of concentrated sulphuric acid. The reddish brown colour solution or red color solution was not observed indicated that absence of steroids (Harborne and Baxter, 1993).

3.3.1.12 Test for tannins

The sample about (2 g) was boiled with 10 mL of distilled water for 10 minutes and filtered. The filtrate was treated with 0.5 mL of 10 % $FeCl_3$ and then the clear solution from the filtrate was added into a few drops of dilute H_2SO_4. The yellowish-brown precipitates indicated the presence of tannins (Harborne and Baxter,1993).

3.3.1.13 Test for terpenoids

A small amount of sample was extracted with 10 mL of ethanol on water bath for a few minutes. Then, it was filtered and the filtrate was tested with 2 mL of acetic anhydride, few drops (1 mL) of chloroform ($CHCl_3$) and 1 mL of concentrated sulphuric acid solution. Reddish brown or red colour solution indicated the the presence of terpenoids (Harborne and Baxter, 1993).

3.3.2 FT-IR (Fourier-Transform InfraRed) Spectroscopic Determination

The FT-IR Spectra of the leaf, stem and root samples were measured at the National Analytical Laboratory (NAL), Department of Research and Innovation, Ministry of Science and Technology, Yangon.

Figure 3.1 Location map of collection site of *Andrographic paniculata* (Burm. f.) Wall. Ex Nees species.

4. Results

4.1 Morphology

Andrographis paniculata (Burm.f.) Wall. ex Nees is an annual herb and 30 – 85 cm height. The stem is quadrangular with wing-like structure at each angle when young and pubescent. Leaves are opposite and decussate, exstipulate, petiolate, lanceolate, base acute, margin entire, tip acuminate, glabrous, deep green, paler beneath, odourless and tasteless.

Inflorescences are panicles with secondary, tertiary and quaternary peduncles, pubescent, leafy bracts usually found at the base of secondary and tertiary peduncle. Flowers are born on only upper side of tertiary or quaternary peduncles and upright.

Flowers are bone on secondary, tertiary and quaternary peduncles, irregular and zygomorphic, cyclic, pentamerous, hypogynous, white. Calyxes are united and 5-lobed, campanulate, sepaloid (green), hairs simple and glandular. Corolla 5-lobed, tubular, valvate, anterior 3 lobes united and larger than two posterior ones, middle one of anterior lobes with long purple blotches, the lateral ones with two purple streaks.

Stamen are apostemonous, epipetalous (connate at the base), filaments pale yellow, some glandular, anthers dithecous, brown, dehiscence longitudinal, curved, dorsifixed.

Pistils are bicarpellary, bilocular, placentation axile, with one row of ovules on a single placenta. Ovary is superior, pubescent, style slender, stigma simple.

Pods or legumes are brown, brown, discoid.

4.1.1 Taxonomic description of *Andrographis paniculata* (Burm.f.) Wall. ex Nees

Andrographis paniculata (Burm.f.) Wall. ex Nees, Pl. Asiat. Rar. 3: 116. 1832

Synonym:	*Justicia paniculata* Burm.f.
	Andrographis paniculata var. glandulosa Trimen
	Andrographis subspathulata C. B. Clarke
	*Justicia latebrosa*Russell ex Wall.
	Justicia stricta Lam. Ex Steud.
Common Name:	Bitterweed, King of Bitters, Creat, Green Chireta, Indian Echinachea,
Local name:	Sega-gyi, Shan- Segar, Ngayoke kha
Family:	Acanthaceae
Locality:	Forest Research Institute campus, Yezin
Specimen examined:	Kyi Kyi Khaing & Aye Nyein Chan, 29-8-2022.

Flowering and fruiting period: July - March, ripe fruits observed round the year.

Annual herb, 30 – 85 cm in height; stem quadrangular with wing-like structure at each angle, stem dark green, 30 – 85 cm long and 0.2– 0.7 cm wide, glabrous, slightly enlarged at the nodes.

Leaves simple, 3.5 – 8.6 cm long and 1.0 – 2.7 cm wide, opposite and decussate, exstupulate, lanceolate, base acute, margin entire, tip acuminate, glabrous, deep green, venation reticulate; petiolate, petiole very short, terete, quadrangular, 0.1 – 0.5 cm long and 0.1 – 0.2 cm wide, pubescent.

Inflorescences racemes or panicles, cylindrical in shape, panicle terminal and upper axillary, primary rachis 23 – 35 cm long, quadrangular, pubescent, 18 – 33 pairs of secondary rachae per primary rachis; secondary rachis 6 – 21 cm long, pubescent, 1 – 19 pairs of inflorescences.

Flowers bone on secondary, tertiary and quaternary peduncles, 1.6 – 2.0 cm long and 1.0 – 1.3 cm wide, pedicels 0.3 – 0.4 cm long, irregular and zygomorphic, cyclic, pentamerous, hypogynous, white with purple streaks.

Calyxes united and 5-lobed, 0.3 – 0.4 cm long, campanulate, sepaloid (green), hairs simple and glandular, pubescent.

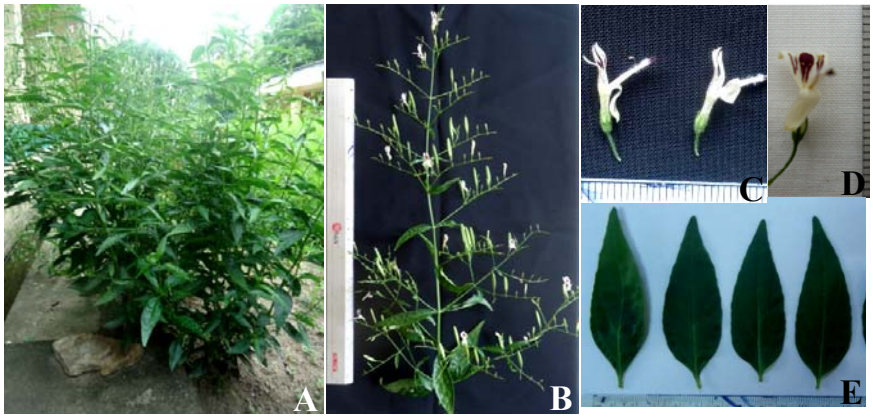
Corolla 5-lobed, tubular, tube 1.2 – 1.5cm long, valvate, anterior 3 lobes, united and larger than two posterior ones, middle anterior lobe with purple streaks, pubescent.

Stamen 2, filaments 0.34 cm long, pale yellow, glandular hairs present at the base; anthers dithecous, brown, curved, dehiscence longitudinal.

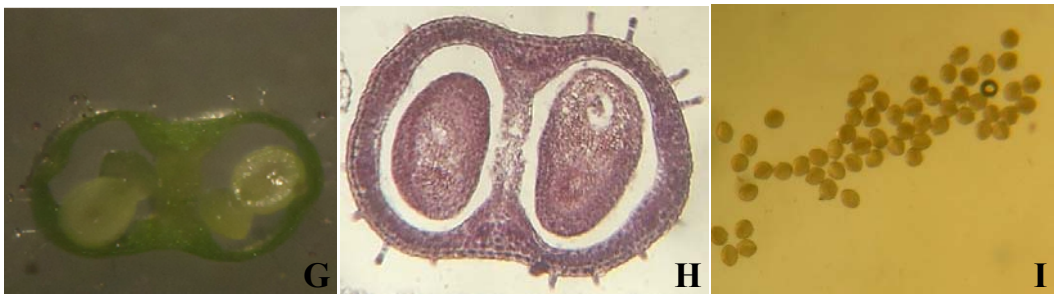
Pistil bicarpellary, bilocular, placentation axile, with one row of ovules on a single placenta. Ovary superior, pubescent, style slender, stigma simple.

Pods or legumes 2.2 – 2.5 cm long and 0.2 – 0.3 cm wide, 9 – 12 seeded; seeds 1 – 2 mm long and 0.1 – 0.15 cm wide, brown, discoid.

Floral formula: $\oplus\ \mathrm{K}_{(5)}\ \mathrm{C}_{(5)}\ \mathrm{A}_{2}\ \underline{\mathrm{G}_{(2)}}$



A. A plant grown in natural habit. B. Inflorescence on a branchlet. C. Flowers as seen. D. Corolla lobe showing purple streaks on the crorlla lobe. E. Leaves.



G. T. S of an ovary. & H. T. S of ovary as shown under microscope. I. Seeds.

Figure 4.1 Habit of *Andrographis paniculata* (Burm.f.) Wall. ex Nees

Table 4.1 Qualitative Morphological Characteristics of *Andrographis paniculata* (Burm. f.) Wall. ex Nees

No.	Parts of plant	Characters	*Andrographis paniculata* (Burm.f.) Wall. ex Nees
1.	Plant	Habit	Annual herb
2.	Leaves	Types of leaves	Simple, opposite decussate
		Shapes of leaf-blades	lanceolate
		Sizes of leaf-blades	3. 5 – 3.6 cm by 1.0 – 2.7cm
		Texture of leaf-surfaces	glabrous on both surfaces
3.	Inflorescences	Types of inflorescences	Racemose or panicles
		Types of flowers	Zygomorphic
		Colours of flowers	White with purple streaks
		Sizes of primary rachis	23.0 – 35.0 cm long
		Sizes of secondary rachis	6.0 – 21.0 cm long
		Sizes of flowers	1.6 – 2.0 cm by 1.0 – 1.3 cm
4.	Calyx	Sizes of calyx	3 – 4 mm long
		Number of sepal	5-lobed
		Texture of sepal	Glandular hairy, pubescent
5.	Corolla	Type of corolla	valvate
		Shapes of corolla lobes	Triangular, anterior
		Number of petal	5-lobed
		Shapes of petal	Tubular
6.	Androecium	Number of stamens	2
		Types of stamens	Apostemonous, apipetalous
		Colours of filaments	Plae yellow
		Types of anthers	Dithecous
		Colours of anthers	Brown
7.	Gynoecium	Types of Pistils	Bicarpellary
		Shapes of style	Slender
		Shapes of stigma	Simple

4.2 Anatomy

4.2.1 Internal structure of laminar of *Andrographis paniculata* (Burm.f.) Wall. ex Nees

In transverse section (Figure 4.2 C&D) the lamina of *Andrographis paniculata* (Burm.f.) Wall. ex Nees studied was 240 – 255 µm in thickness, typical dosiventral. Distinguishable into dermal, ground and vascular tissue system.

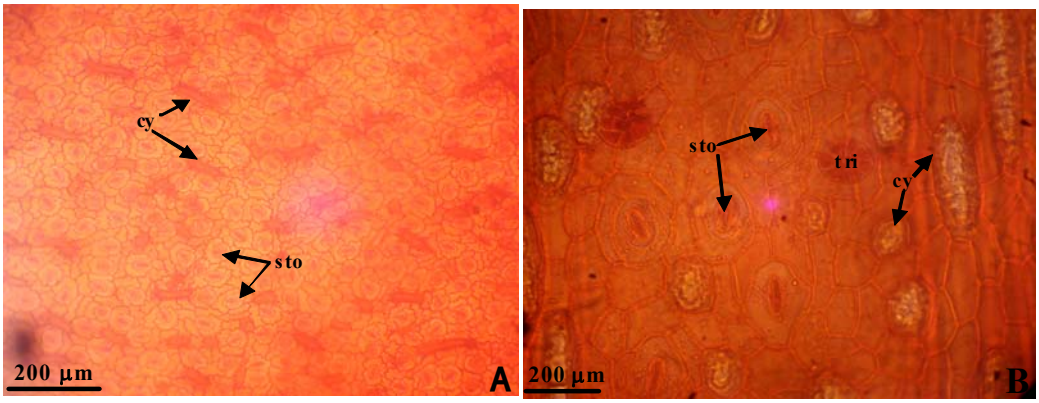
Dermal tissue system: Composed of epidermal cells, guard cells of the stomata and trichome. In surface view (Figure 4.20 A&B) the upper epidermal cells polygonal, thin-walled and compactly arranged. Cystolith numerous, solitary rounded, elongated and double elongated shape, 28 – 115 µm long and 13 – 20 µm wide. Minute sandy crystals present in the epidermal cells. Stomata 18.75 – 25 µm long and 5.5 – 7.5 µm wide, glabrous.

The lower epidermal cells polygonal, thin-walled, compactly arranged. Cystoliths various shape like upper epidermal cell 32.5 – 90 µm long and 13 – 20.5 µm wide, stomata diacytic type, 18.75 – 25 µm long and 12.5 – 15 µm wide, multicellular trichome present.

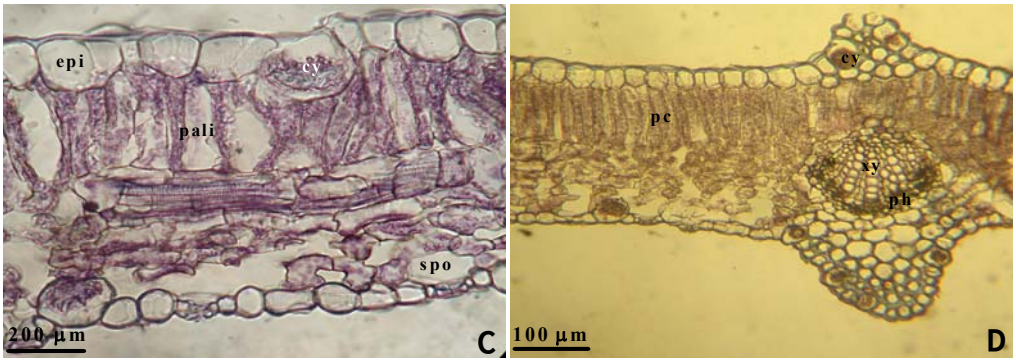
In transverse section, epidermal cells one-layered on both surfaces, cell rectangular in shape, anticlinal walls straight, outer and inner walls slightly convex, cuticle thick. The upper epidermal cells 25.5 – 56.25 µm long and 15.0 – 31.25 µm wide; the lower epidermal cells 25.0 – 65.0 µm length and 10.0 – 42.5 µm width; cuticle thick.

Ground tissue system: Mesophyll composed of palisade and spongy parenchyma; palisade parenchyma lying internal to the adaxial epidermal cells, 1-layered, the layers 45 – 90 µm thick, the cells elongated in shape, chloroplast present; spongy parenchyma lying internal to the abaxial epidermal cells, 3 - or 4- layered, the layers 80 – 130 µm thick, the cells oval or rounded in shape, thin-walled, 16.25 – 42.5µm length and 12.5 – 27.5µm width, intercellular spaces present, chloroplast present.

Vascular tissue system: The vascular bundle embedded in ground tissue, oval in shape, 56.25 – 125.0 µm in tangential diameter, 50 – 150 µm in radial diameter, bundle sheath 1-layered, close collateral type; phloem towards the abaxial side, 3 – 6 tiered, the cells oval or polygonal in shape, 3 – 5 µm length and 2 – 7 µm width, phloem composed of sieve tube and companion cell; xylem at the adaxial side containing 1 or 5 cells, xylem composed of vessel, tracheids, xylem fibers and xylem parenchyma; vessel elements thick walled, lateral walls straight, end walls transverse, tailed at one ends or tailless, perforation plate simple, thickening spiral and pitted, 125 – 320 µm length and 8 – 25 µm width(Figure 4.2 E); tracheids thick-walled, lateral walls straight, end walls acute, thickening spiral, 152 – 300 µm length and 5 – 10 µm width (Figure 4.2 F); fibers thick-walled, lumen narrow, lateral walls straight, end walls acute to acuminate, 180 – 400 µm length and 1 – 5 µm width (Figure 4.2 G).

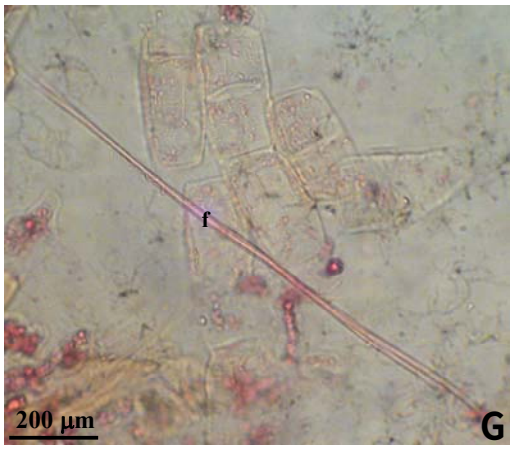


A. Surface view of adaxial sides howing stomata and cystoliths B. Surface view of abaxial side showing stomata and cystoliths (cy – cystoliths, sto – stomata, tri – trichone)



C. T.S of a portion of lamina D. T.S of a portion of lateral veinlet of lamina showing vascular bundle (epi – epidermist, cy – cystoliths, pali – palisade, spo – spongy, xy – xylem, ph – phloem, pc – parenchyma)

E. Vessel element with spiral thickening F. Tracheid and vessel with spiral thickening (ve – vessel, tra – trachied)



G. Fiber (f – fiber)

Figure 4.2 Internal structure and macerated elements of lamina of *Andrographis paniculata* (Burm.f.) Wall. ex Nees

4.2.2 Internal structure of midrib of *Andrographis paniculata* (Burm.f.) Wall. ex Nees

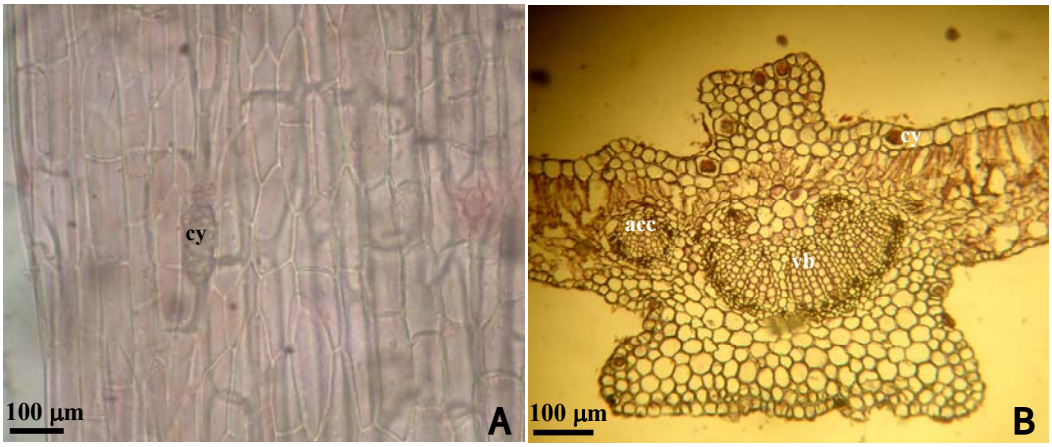
In transverse section (Figure 4.3 B), the midrib of *Andrographis paniculata* (Burm.f.) Wall. ex Nees studied is semicircular shaped in outline, 655 – 800 µmin tangential diameter, 450 – 790 µm in radial diameter with slightly wavy margin and slightly concave at the flattened surface. Distinguishable into dermal, ground and vascular tissue systems.

Dermal tissue system: Composed of epidermal cells and cystoliths containing in cells, trichome absent. In surface view, the epidermal cells parenchymatous, rectangular or polygonal, cell walls thin, anticlinal walls straight, cells 16.25 – 85.0 µm in tangential diameter, 15.0 – 30.5 µm in radial diameter; cystolith present, oval shape, rare double, 40 – 80.5 µm long and 25.5 – 38.75 µm wide.

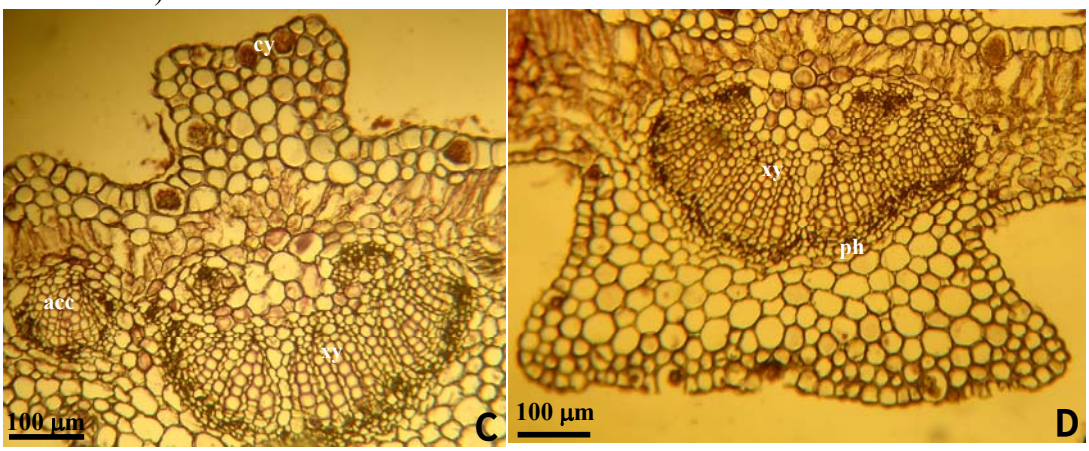
In transverse section (Figure 4.3 A), epidermis one-layered on both surfaces, oval or barrel-shaped 15 – 30 µm in tangential diameter, 7.5 – 26.25 µm in radial diameter, thin-walled, compact, continuous, anticlinal walls straight, outer and inner walls slightly convex; cuticle smooth and thin.

Ground tissue system: Differentiated into collenchymatous and parenchymatous tissue, collenchymatous cells internal to the adaxial epidermis 1 – 2 layered, 11.25 – 45.0 µm in thick, cells internal to the abaxial epidermis 1 – 2 layered, 11.25 – 40.0 µm in thick, cells rounded or oval in shape, 7.5 – 33.75 µm in tangential diameter, 7.5 – 40.0 µm in radial diameter; parenchymatous cells between the adaxial epidermis and vascular stand 2 – 8 layered, 28.0 – 285.0 µm in thick, cells between the abaxial epidermis and vascular stand 2 – 8 layered, 47.5 – 285.0 µm in thick, cells rounded or oval in shape, 11.25 – 46.25 µm in tangential diameter, 15.0 – 52.5 µm in radial diameter, thin-walled, intercellular spaces small.

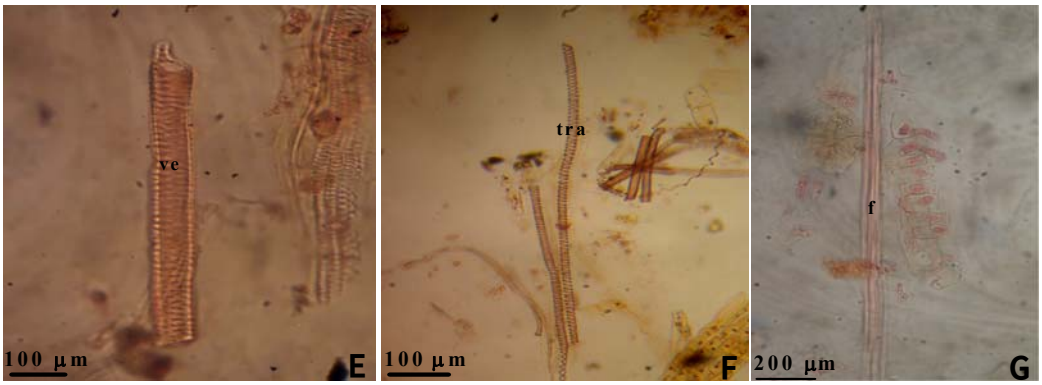
Vascular tissue system: A large vascular bundle lying in the middle and two small accessory strands at the adaxial side, rounded shaped, closed collateral type, large vascular bundle 126.25 – 183.75 µm in tangential diameter, 280 – 450 µm in radial diameter; xylem lying in the center, 1 –7 tiered, 20 – 115 µm thick, arranged in vertical row, composed of vessel elements, tracheids, xylem fibers and xylem parenchyma; vessel elements 90 – 400 µm length and 15 – 25 µm width(Figure 4.3 E), perforation plate simple, tailless, one tail or both; fibers 180 – 390 µm length and 2 – 10 µm width, thick-walled, lumen narrow, lateral walls straight, end walls acute to acuminate(Figure 4.3 F); phloem towards the abaxial side, 3 – 6 tiered, 13.75 – 36.25 µm thick, composed of sieve-tubes, companion cells, phloem parenchyma.



A. Surface view of midrib showing epidermal cell and cystoliths B. T.S of a portion of midrib showing tissue systems (cy - cystoliths, acc - accessory bundle, vb – vascular bundle)



C. T.S of a portion of midrib showing adaxial side D. T.S of a portin of midrib showing abaxial side(cy – cystoliths, acc – accessory bundle, xy – xylem, ph – phloem)



E. Vessel element with spiral thickening F. trachied G. Fiber

Figure 4.3 Internal structure and macerated elements of midrib of *Andrographis paniculata* (Burm.f.) Wall. ex Nees

4.2.3 Internal structure of petiole of *Andrographis paniculata* (Burm.f.) Wall. ex Nees

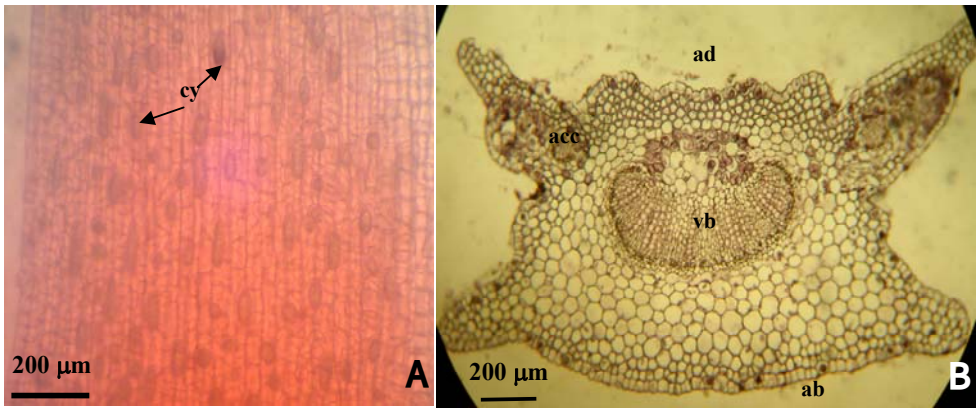
In transverse section (Figure 4.4 B), the petioles of *Andrographis paniculata* (Burm.f.) Wall. ex Nees studied was 865 – 1000 µmin tangential diameter, 1760 – 2685 µm in radial diameter with slightly wavy margin and slightly concave at the flattened surface. Distinguishable into dermal, ground and vascular tissue systems.

Dermal tissue system: Composed of epidermal cells and cystoliths containing in cells, trichome absent (Figure 4.4 A). In surface view, the epidermal cells parenchymatous, rectangular or polygonal, cell walls thin, anticlinal walls straight, cells 12.5 – 42.5 µm in tangential diameter, 11.25 – 30.0 µm in radial diameter.

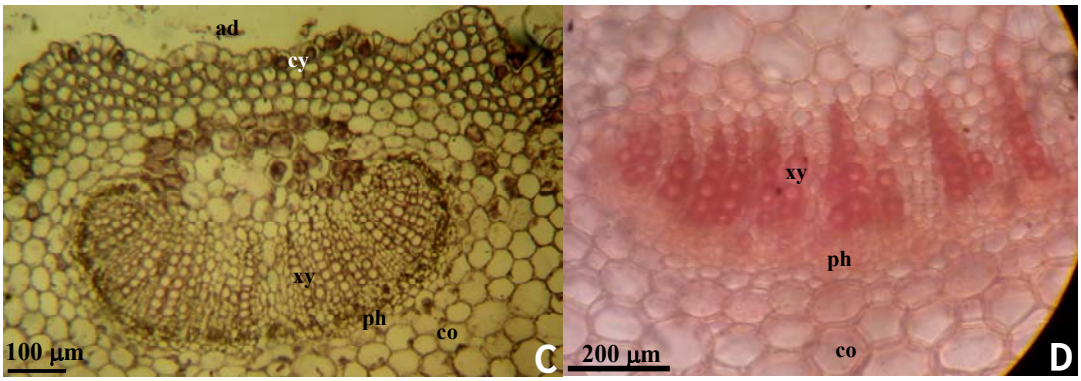
In transverse section (Figure 4.4 B), epidermis one-layered on both surfaces, cell oval or barrel-shaped 16.25 – 30.0 µm in tangential diameter, 12.5 – 25.0 µm in radial diameter, thin-walled, compact, continuous, anticlinal walls straight, outer and inner walls slightly convex, cystoliths containing cells in both side; cuticle smooth and thin.

Ground tissue system: Differentiated into collenchymatous and parenchymatous tissue, collenchymatous cells internal to the adaxial epidermis 1 – 6 layered, 11.25 – 162.5 µm in thick, cells internal to the abaxial epidermis 1 – 2 layered, 15.0 – 38.75 µm in thick, cells rounded or oval in shape, 11.25 – 25.0 µm in tangential diameter, 16.25 – 27.5 µm in radial diameter; parenchymatous cells between the the adaxial epidermis and vascular stand 3 – 6 layered, the layers 95.0 – 245.0 µm in thick, cells between the the abaxial epidermis and vascular stand 6 – 8 layered, the layers 250.0 – 287.5 µm in thick, cells rounded or oval in shape, 13.0 – 73.75 µm in tangential diameter, 15.0 – 83.75 µm in radial diameter, thin-walled, intercellular spaces small.

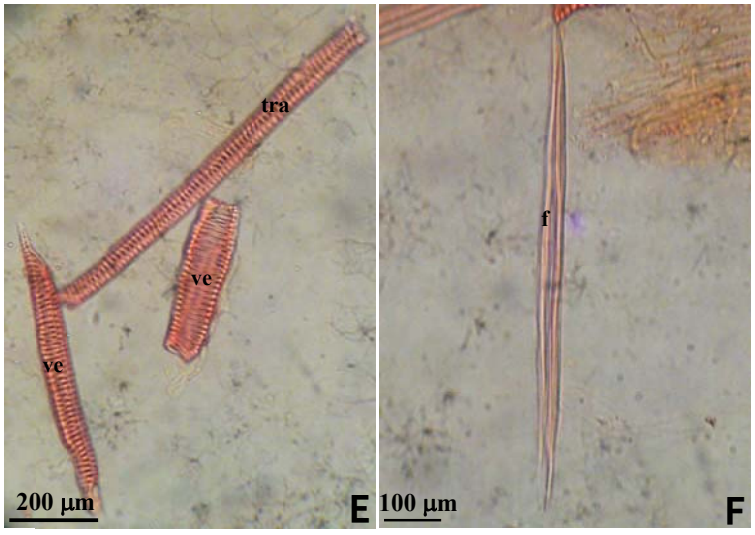
Vascular tissue system: A large vascular bundle crescent-shaped lying in the middle and two small accessory strands (Figure 4.4 C & D) at the adaxial of each side, close collateral type, large vascular bundle 112.5 – 180.0 µm in tangential diameter, 637.0 – 905.0 µm in radial diameter; xylem lying in the center, 1 –9 tiered, 17.5 – 162.5µm thick, arranged in vertical row, xylem composed of vessel elements, tracheids, xylem fibers and xylem parenchyma, vessel elements 90 – 270 µm length and 10 – 21 µm width, (Figure 4.4 E) perforation plate simple, tailless, one tail or both; fibers180 – 390 µm length and 2 – 10 µm width, thick-walled, lumen narrow, lateral walls straight, end walls acute to acuminate(Figure 4.4 F); phloem towards the abaxial side, 2 – 5 tiered, 10.5 – 48.75 µm thick, phloem composed of sieve-tubes, companion cells, phloem parenchyma.



A. Surface view of petiole with cystoliths B. T.S of a portion of petiole showing tissue systems (cy – cystoliths, ad – adaxial, acc – accessory bundle, vb – vascular bundle)



C & D. T.S of a portion of petiole showing adaxial side and vascular bundle (cy – cystoliths, xy – xylem,ph – phloem, co – cortex, en – endodermis)



E. Vessel element & tracheid with spiral thickening G. Fiber (ve – vessel, tra – trachied, f – fiber)

Figure 4.4 Internal structure and macerated elements of petiole of *Andrographis paniculata* (Burm.f.) Wall. ex Nees

4.2.4 Internal structure of stem of *Andrographis paniculata* (Burm.f.) Wall. ex Nees

Primary body in transverse section, the primary stem of *Andrographis paniculata* (Burm.f.) Wall. ex Nees (Figure 4.5 B) studied were 600 – 850 μm in diameter and circular in outline, distinguished into dermal tissue system, ground tissue system and vascular tissue system.

Dermal Tissue System: Composed of epidermal cells, stomata, cystoliths containing in cells and trichome present. In surface view (Figure 4.5 A), the epidermal cells parenchymatous, rectangular or polygonal, cell walls thin, 20.0 – 56.25 μm length and 7.5 – 35.0 μm width; stomata present, diacytic and anomocytic type, 20 – 30 μm length and 15 – 18.75 μm width; cystolith present, solitary rounded and double shape, 37.5 – 125 um length and 22.5 – 35 um width. In transverse section, epidermis one-layered, parenchyma cell, oval or barrel-shaped, 11.25 – 25 μm in tangential diameter, 10 – 32.5 μm in radial diameter, thin-walled, compact; trichomes present; cuticle smooth and thin.

Ground Tissue System: Composed of cortex, endodermis; cortex made up of collenchymatous and parenchymatous tissue, 7 to 14-layered, 130 – 185 μm thick, the cells oval or barrel-shaped, 5.5 – 23 μm in length, 6.25 – 22.5 μm in width, outer collenchyma cell 1 to 3-layered, 5.5 – 32.5 μm thick, cell 7.5 – 17.5 μm length, 5 – 15 μm width, inner parenchyma cell, 2 to 6-layered, 50 – 150 μm thick, 8 –32.5 μm in length, 7.5 – 33.75 μm in width, intercellular space present; ednodermis lying innermost layer of cortex, 1-layered, parenchymatous, the cells barrel-shaped, thin walled.

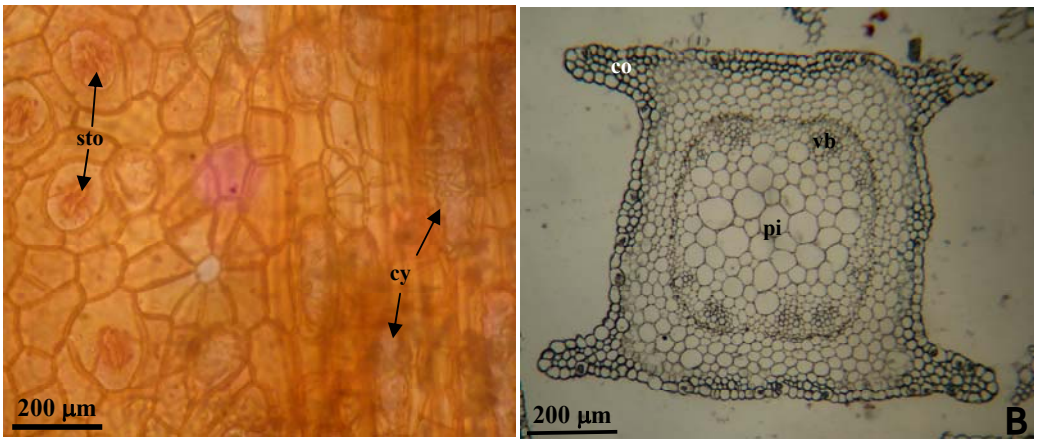
Vascular Tissue System: Vascular tissue embedded in the ground tissues, four vascular bundles, open collateral type, each bundle 50 – 100 μm thick; phloem 8.75 – 23.75 μm thick; primary phloem situated between the cortex and secondary phloem when mature; forming a discontinuous ring of groups of pericyclic fibers; phloem composed of sieve tube, companion cells, phloem parenchyma and phloem fibers; xylem 1 to-7 celled, protoxylem inward and metaxylem outward, metaxylem 13.75 –22.5μm in tangential diameter; xylem composed of vessel elements, tracheids, xylem fiber and xylem parenchyma.

Secondary body in transverse section, the stem of *Andrographis paniculata* (Burm.f.) Wall. ex Nees (Figure 4.5 C & D) studied was circular in outline, 2372 – 3435 μm in diameter; distinguishable into secondary vascular tissue, consists of secondary xylem and secondary phloem. The stem of *A. paniculata* studied show the periderm formation, and vascular cambium formed between phloem and xylem, secondary phloem and secondary xylem were derived from the vascular cambium. Periderm formation occurred at the outer part of the cortex and forming a continuous ring. It consists of phellogen or cork cambium, phelloderm, and phellem or cork. Phellogen or cork cambium 1-layered, parenchymatous, meristematic, tangentially flattened, rectangular, usually with a nucleus, dividing to give rise to phellem or cork cells outward and phelloderm inward. Phellem or cork cells lying external to phellogen, 4 or 5- layered, parenchymatous, cells tangentially flattened, rectangular. Phelloderm lying internal to phellogen, derived from phellogen, 1- layered, parenchymatous, cells tangentially flattened, rectangular.

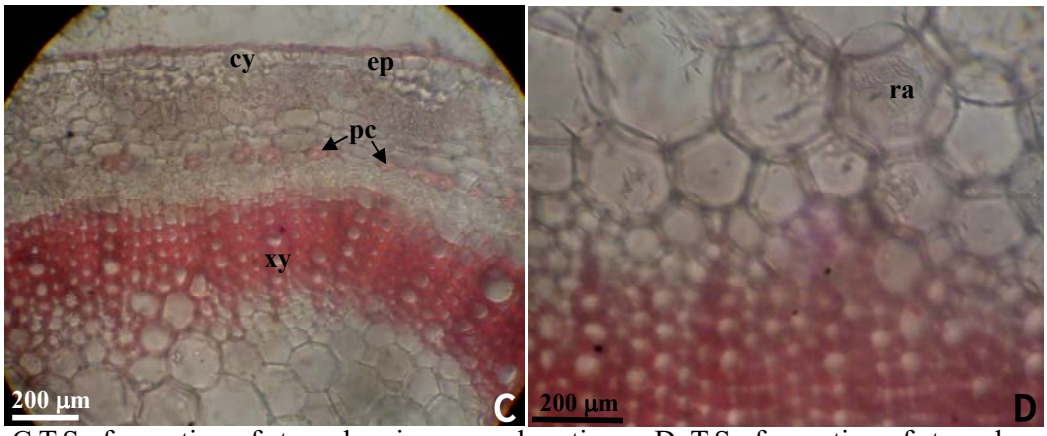
Vascular Cambium: Lying between phloem and xylem forming a continuous ring, 1 or 2- layered with its immediate derivatives, parenchymatous, meristematic, compactly arranged, cells tangentially flattened, rectangular or slightly elongated, colourless, some cells with nucleus, dividing to give rise to secondary phloem outward and secondary xylem inward, distinguishable into fusiform initial and ray initial; fusiform initial gives rise to sieve tube, companion cell, phloem parenchyma and phloem fiber outward, and vessel element,

xylem parenchyma and fiber inward; ray initial gives rise to phloem ray outward and xylem ray inward.

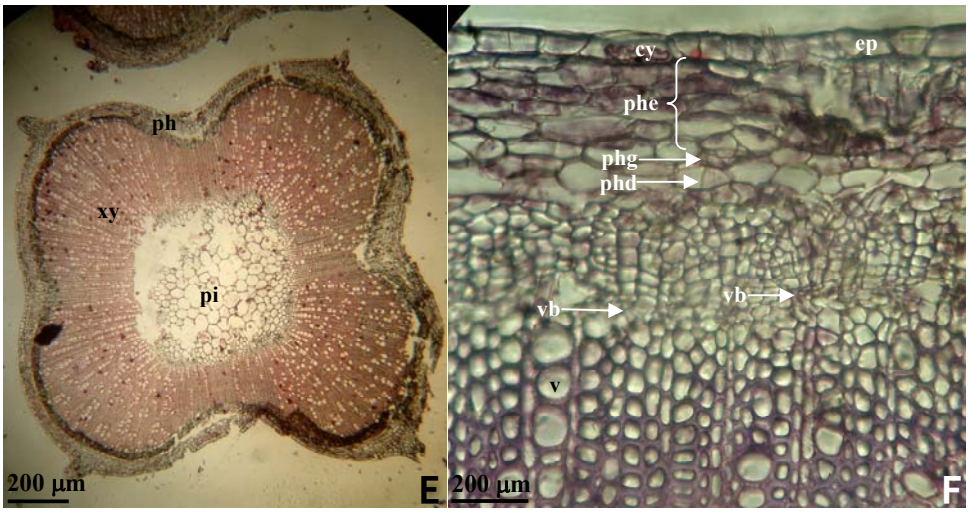
Secondary Vascular Tissues: Secondary phloem lying external to vascular cambium, derived from vascular cambium, consists of sieve tube elements, companion cells, phloem parenchyma and phloem fibers (Figure 4.5 F); phloem cells 50 – 80 µm thick; phloem fibers forming a discontinuous peripheral ring of groups of cells, thick-walled, polygonal in shape. Phloem ray cells large, radially elongated. Secondary xylem lying internal to the vascular cambium, derived from vascular cambium, consists of vessel elements, xylem parenchyma, and fiber. Vessel elements 100 – 640 µm in length, 13.75 – 32.5 µm in width, perforation plate simple, end wall oblique, slightly oblique or transverse, thickening spiral, reticulated or pitted (Figure 4.5 G); tracheids100 – 495 µm in length, 8.75 – 20 µm in width (Figure 4.5 H); wood fibers 128.5 – 1482.5 µm in length, 7.5 – 21.25 µm in width, lumen narrow, lateral walls straight and end walls acute (Figure 4.5 I).



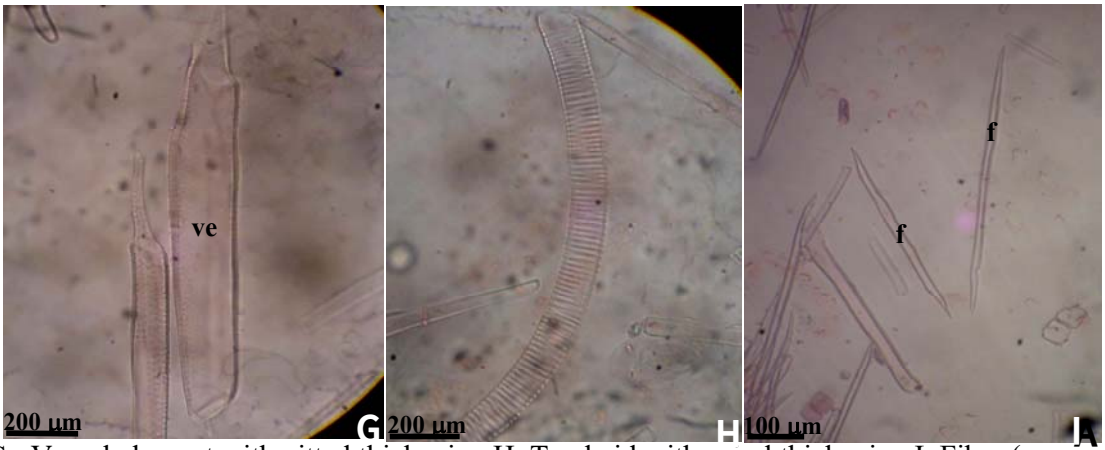
A. Surface view of stem with cystoliths and stomata B. T.S of a portion of young stem showing tissue systems (cy – cystoliths, st – stomata, vb – vascular bundle, co – cortex, pi – pith)



C T.S of a portion of stem showing secondary tissue, D. T.S of a portion of stem showing raphides in pith (cy – cystolith, xy – xylem, pc – pericycle, pi – pith, xr - xylem ray, ph – phloem)



E. T.S of stem showing secondary tissue, F. T. S of stem showing periderm and vascular bundle (phg – phellogen, phd – phelloderm, phe – phellem, vb – vascular bundle, v – vessel)



G. Vessel element with pitted thickening H. Tracheid with spiral thickening I. Fiber (ve – vessel, tra – tracheid, f – fiber)

Figure 4.5 Internal structure and macerated elements of stem of *Andrographis paniculata* (Burm.f.) Wall. ex Nees

4.2.5 Internal structure of root of *Andrographis paniculata* (Burm.f.) Wall. ex Nees

Primary body in transverse section, the primary root of *Andrographis paniculata* (Burm.f.) Wall. ex Nees (Figure 4.6 B) studied were 690 – 1120 µm in diameter and circular in outline, distinguished into dermal tissue system, ground tissue system and vascular tissue system.

Dermal Tissue System: In transverse section (Figure 4.6 A), epiblema one-layered, parenchyma cell, oval or barrel-shaped, thin-walled, compact; trichomes present; cuticle smooth and thin.

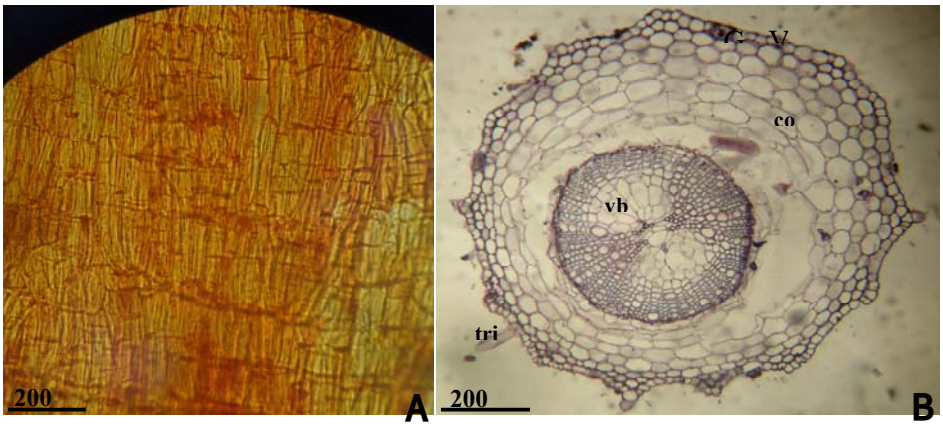
Ground Tissue System: Composed of cortex, endodermis; cortex made up of homogenous parenchymatous tissues; lying internal to the epiblema, 1-layered, 13 – 35 µm thick, the cells oval or barrel-shaped, 12.5 – 37.5 µm in length, 13.0 – 35.0 µmin width ednodermis lying innermost layer of cortex, 1-layered, parenchymatous, the cells barrel-shaped, thin walled.

Vascular Tissue System: Vascular tissue embedded in the ground tissues, two vascular bundle, biarth shape; open collateral type, each bundle 20 – 27 μm thick; phloem 12.5 – 20.0 μm thick; primary phloem situated between the cortex and secondary phloem when mature; forming a discontinuous ring of groups of pericyclic fibers; phloem composed of sieve tube, companion cells, phloem parenchyma and phloem fibers; xylem 10 – 15μm thick, protoxylem inward and metaxylem outward, metaxylem 15 – 23 μm in tangential diameter; xylem composed of vessel elements, tracheids, xylem fiber and xylem parenchyma.

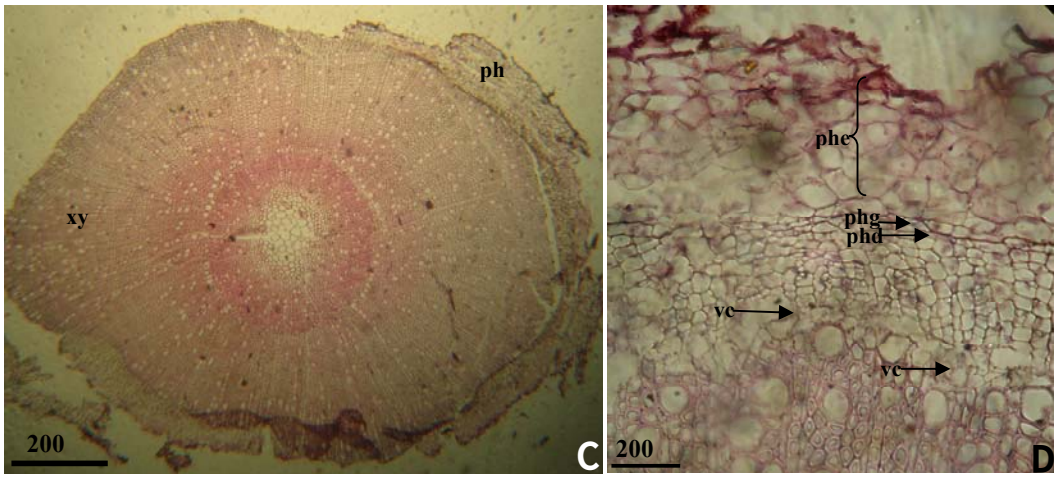
Secondary body in transverse section, the root of *Andrographis paniculata* (Burm.f.) Wall. ex Nees (Figure 4.6 C &D) studied was circular in outline, 2000 – 2400 μm in diameter; distinguishable into secondary vascular tissue, consists of secondary xylem and phloem. The root of *A. paniculata* studied show the periderm formation, and vascular cambium formed between phloem and xylem, secondary phloem and secondary xylem were derived from the vascular cambium. Periderm formation occurred at the outer part of the cortex and forming a continuous ring. It consists of phellogen or cork cambium, phelloderm, and phellem or cork. Phellogen or cork cambium 1-layered, parenchymatous, meristematic, tangentially flattened, rectangular, usually with a nucleus, dividing to give rise to phellem or cork cells outward and phelloderm inward. Phellem or cork cells lying external to phellogen, 7 to 8-layered, parenchymatous, cells tangentially flattened, rectangular. Phelloderm lying internal to phellogen, derived from phellogen, 1- layered, parenchymatous, cells tangentially flattened, rectangular.

Vascular Cambium: Lying between phloem and xylem forming a continuous ring, 1 or 2-layered with its immediate derivatives, parenchymatous, meristematic, compactly arranged, cells tangentially flattened, rectangular or slightly elongated, colourless, some cells with nucleus, dividing to give rise to secondary phloem outward and secondary xylem inward, distinguishable into fusiform initial and ray initial; fusiform initial gives rise to sieve tube, companion cell, phloem parenchyma and phloem fiber outward, and vessel element, xylem parenchyma and fiber inward; ray initial gives rise to phloem ray outward and xylem ray inward.

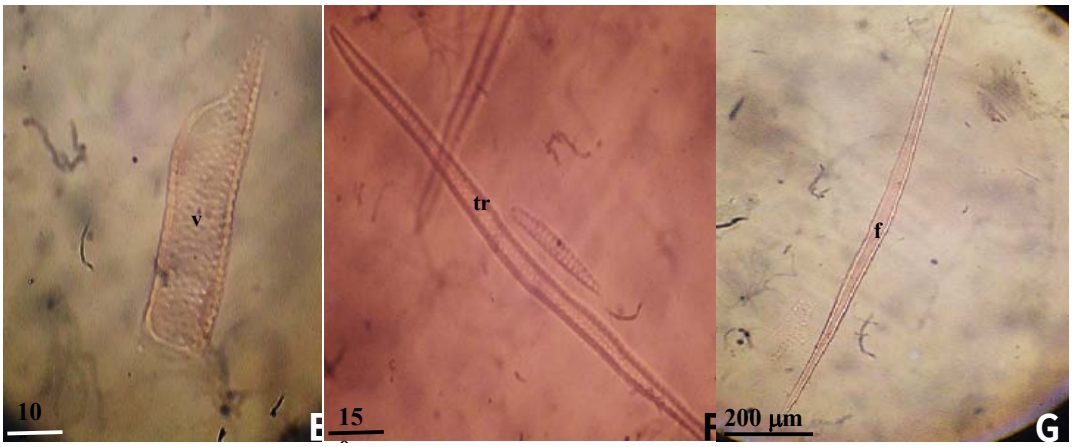
Secondary Vascular Tissues: Secondary phloem lying external to vascular cambium, derived from vascular cambium, (Figure 4.6 D) consists of sieve tube elements, companion cells, phloem parenchyma and phloem fibers; phloem cells 70 – 110 μm thick; phloem fibers forming a discontinuous peripheral ring of groups of cells, thick-walled, polygonal in shape. Phloem ray cells large radially elongated. Secondary xylem lying internal to the vascular cambium, derived from vascular cambium, consists of vessel elements, xylem parenchyma, and fiber. Vessel elements 125 – 432.5 μm in length, 10 – 37.5 μm in width, perforation plate simple, end wall oblique, slightly oblique or transverse, thickening spiral, reticulated or pitted (Figure 4.6 E); tracheids 127.5 – 336 μm in length, 6.25 – 20 μm in width (Figure 4.6 F); wood fibers 212.5 – 705.0 μm in length, 6.25 – 20 μm in width, lumen narrow, lateral walls straight and end walls acute (Table 4.6 G).



A. Surface view of root with cystoliths B. T.S of a portion of young root showing tissue systems (cy – cystoliths, vb – vascular bundle, co – cortex)



C. T.S of root showing secondary tissue, D. T. S of root showing periderm and vascular bundle (phg – phellogen, phd – phelloderm, phe – phellem, vc – vascular cambium, xy – xylem, ph – phloem)



E. Vessel element with pitted thickening F. Tracheid with spiral thickening (ve – vessel, tra – tracheid) G. Fiber (f – fiber)

F. Figure 4.6 Internal structure and macerated elements of root of *Andrographis paniculata* (Burm.f.) Wall. ex Nees

Table 4.2 Quantitative anatomical characteristics of *Andrographis paniculata* (Burm.f.) Wall. ex Nees

No	Name	Shape	Size(µm)	Dermal Tissue System (µm)				Ground Tissue System (µm)				Vascular Tissue System (µm)			
				Trichome	**Stomata L & W**	**Cystolists L & W**	**Epidermal cell L & W**	**Parenchyma cell**		**Collenchyma cell**		**Shape**	**Size**	**Number of xylem cell**	**Phloem tiered**
1.	Laminar (upper)	dosiventral	240–255diameter	-	18.75 –25.0 12.5 –15.0	28 – 115 13 – 20	25.5–56.25 15.0–31.25	Palisade 1 layer	45 – 90 thick	-	-		-		
	Laminar (lower)			-	18.75 – 25.0 12.5 – 15.0	32.5 – 90.0 13.0 –20.5	25.0–65.0 10.0–42.5	Spongy 3 to 4	80 – 130	-	-	oval	56.25 – 125.0 tagential 50 – 150	1 to 5 - celled	3-to 5 tiered
2.	Midrib	Semicircular	655 – 800 tagential 450– 790 radial	-	-	40 – 80.5 25.5 – 30.75	16.25–85.0 15.0–30.5	2 to 8 layer	47.5 – 285.0	ad. 2 to 8 ab. 1 to 2 layered	ad. 28 – 285.0 ab. 11.25 – 40.0thick	crescent-shaped	126 – 183 tagential 280.0 – 450.0 radial	1 to 7 celled	3-to 6 tiered
3.	Petiole	Semicircular shape	865 – 1000 tagential 1760 – 2685 radial	-	-	Present	12.5 – 42.5 11.25 – 30.0	6 to 8 layered	250.0 – 287.5 thick	1 to 2 layered	15.0 – 38.75	crescent-shaped	112.5 – 180.0 tagential 637.0 – 905.0 radial	1 to 9- celled	2-to 5-tiered
4.	Primary body of Stem	Circular	600 – 850 diameter	-	20 – 30 15.0 – 18.75	37.5 – 125.0 22.5 –35	11.25 – 25.0 10.0 – 32.5	7 to14-outer layered 2 to 6inner layer	130 – 185 thick 50 – 150 thick	1 to 3 layered	5.5 – 32.5 thick	discontinuous circular ring	50 – 100	1to 7- celled	2-to 6- tiered
5	Primary body of Root	Circular	960 – 1120 µm in diameter	present	-	present	12.5 – 37.5 µm length 13.0 –	6 to7-layered (only Parenchymatous cells at cortex layer)	150.0 – 187.5 µm thick	-	-	discontinuous circular ring	20 – 27	5 to 7 - celled	3-to 4- tireed

Table 4.3 Quantitative characters of macerated element of *Andrographis paniculata* (Burm.f.) Wall. ex Nees

Name	Vessel		Tracheid		Fiber	
	Length (μm)	Width (μm)	Length (μm)	Width (μm)	Length (μm)	Width (μm)
Laminar	125 – 320	8 – 25	152 – 300	5 – 10	180 – 400	1 – 5
Midrib	90 – 400	15 – 25	-	-	180 – 390	2 – 10
Petiole	90 – 270	10 – 21	-	-	160 – 640	2 – 12
Stem	100 – 640	13.75 – 32.5	100 – 495	8.75 – 20.0	128.5 – 1482.5	7.5 – 21.25
Root	125.0– 432.5	10.0 – 37.5	127.5– 336.0	6.25 – 20.0	212.5 – 705.0	6.25 – 20.0

4.3 Phytochemical Examination

Table 4.4 Phytochemical screening of leaf, stem and root

No	Tests	Extract	Test Reagent	Observation colour/ppt	Leaf	Stem and Root
				reddish brown ppt (leaf) pale brown ppt(stem) yellowish brown ppt(root)	+	+
			Dragendorff's reagent	Orange ppt	+	+
2	α- Amino acid	Distilled water	Ninhydrin reagent	Purple spot	+	+
3	Carbohydrates	Distilled water	10 % α- naphthol, conc: H_2SO_4	Red ring	+	+
4	Cyanogenic glycosides	Distilled water	Picric acid and 5 % Na_2CO_3 solution	No colour change (in paper)	-	-
5	Flavonoids	95 % EtOH	Conc:HCl, Mg ribbon,	Pink coloursolution	+	+
6	Glycoside	Distilled water	10 % lead acetate	White ppt	+	+
7	Phenolic compounds	Distilled water	10 % $FeCl_3$ solution	Greenish blue color solution	+	+
8	Reducing sugars	Distilled water	Benedict's solution	Brick red ppt	+	+
9	Saponins	Distilled water	Distilled Water	Froth formation	+	+
10	Starch	Distilled water	1 % I_2 solution	Deep blue colour solution	+	+
11	Steroids	Petroleum ether	Acetic anhydride, conc: H_2SO_4	Reddish brown colour solution	-	+
12	Tannins	Distilled water	10 % $FeCl_3$, dil:H_2SO_4,	Yellowish brown ppt	+	+
13	Terpenoids	95 % EtOH	Acetic anhydride, $CHCl_3$, conc: H_2SO_4	Reddish brown colour solution	+	+

(+) = presence (-) = absence (ppt) = precipitate

According to the above data, the crude extract of the leaf of *Andrographis paniculata* (Burm. f.) Wall ex Nees, shown positive test for Alkaloids, α- Amino acid, Carbohydrates, Flavonoids, Glycosides, phenolic compounds, reducing sugars, Saponins, Starch,Tannin and Terpenoids. The stem and root crude extract of the leaf of *A. paniculata* (Burm. f.) Wall. ex Nees, also gave positive test for Flavonoids, Glycosides, phenolic compounds, reducing sugars, Saponins, Starch, steroid, Tannin and Terpenoids respectively.

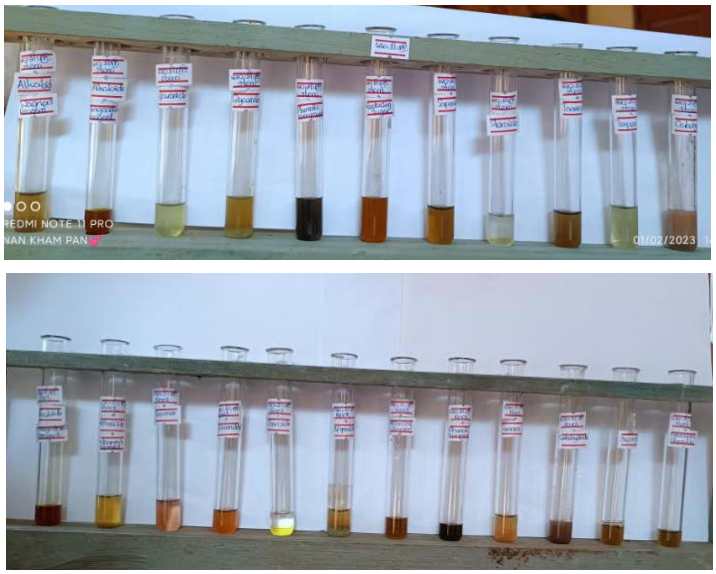


Figure 4.7 Phytochemical screening of leaf, stem and root

4.3.1 FT-IR Assignments of compound isolated from the powdered leaf sample

FT-IR spectra of the compounds isolated from the powdered leaf, stem, and root samples *Andrographis paniculata* (Burm. f.) Wall. ex Nees were measured at the National Analytical Laboratory (NAL), Department of Research and Innovation, Ministry of Science and Technology.

FT-IR spectrum of compound isolated from the leaf sample of *A. paniculata* (Burm. f.) Wall. ex Nees is shown in (Figure 4.9). In the spectrum of compound, the broad band at 3276 cm^{-1} indicates the O-H- stretching vibration of alcohol or phenolic group. The peaks at 2919 cm^{-1} and 2850 cm^{-1} are due to unsymmetrical and symmetrical C- H stretching vibration of sp^3 hydrocarbon group. The C=O stretching vibration of carbonyl group could be observed at 1591 cm^{-1}. Moreover, the bands which appear at 1403 and 1023 cm^{-1} indicates the C=C ring skeleton stretching vibration of aromatic benzene ring. Hence, the FT-IR spectrum represents the existence of the following functional groups.

- Alcohol or phenolic group
- sp^3 hydrocarbon group
- Carbonyl group
- Aromatic benzene ring respectively.

Table 4.5 FT-IR Assignments of compound isolated from the leaf sample

Absorption band (cm^{-1})	Assignments
3276	OH- stretching vibration of alcohol or phenolic group
2919, 2850	unsymmetrical and symmetrical C- H stretching vibration of sp^3 hydrocarbon
1591	C=O stretching vibration of carbonyl group
1403, 1023	C=C ring skeleton stretching vibration of aromatic benzene ring

These results were in accordance not only with the characteristics of the Xanthan Gum mentioned in Perkin Elmer Spectrum Version 10.03.02 but also with the library spectrum in A07187.SP A07187 286028. DX. Therefore, the isolated compound from the leaf sample is confirmed to be Xanthan Gum. According to FT-IR result, the amount of Xanthan Gum content in the leaf sample is 76 %. Moreover, this leaf sample also contains copper, iron, sodium and potassium elements. The elements found from the leaf were not health concern.

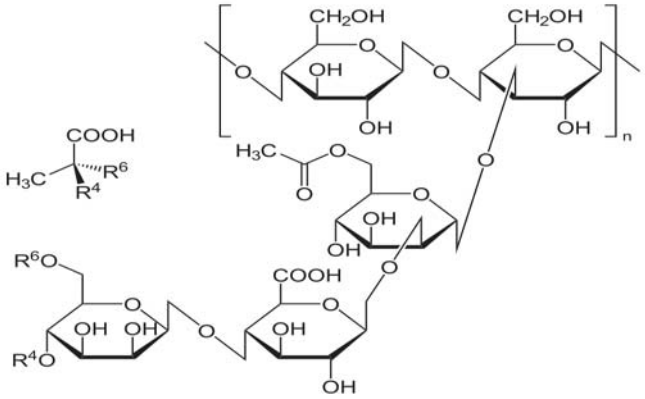


Figure 4.8 Structure of Xanthan Gum

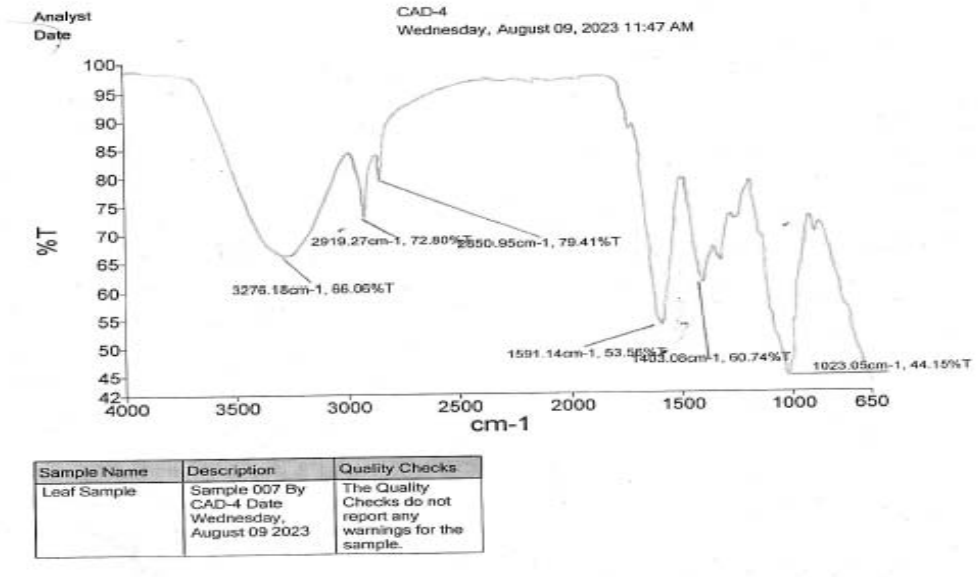


Figure 4.9 FT-IR spectrum of leaf sample

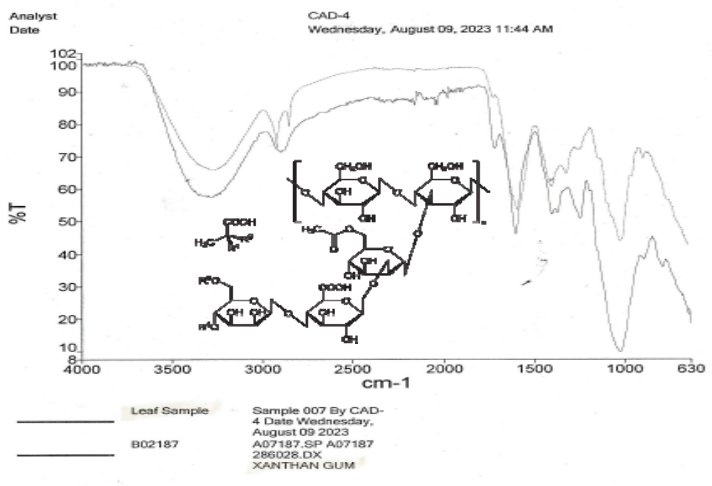


Figure (4.10) Comparison of FT-IR Spectrum of leaf Sample with Library Spectrum

4.3.2 FT-IR assignments of compound isolated from the stem sample

Based on Figure 4.11 and Table 4.6, major compound that has been found contained in the *Andrographis paniculata* (Burm. f.) Wall. ex Nees powdered stem sample are some specific functional groups which are alcohol, sp^3 hydrocarbon, carbonyl and aromatic benzene ring. At wavenumber 3282 cm^{-1} which is the broadest peak produced represent a strong absorption of alcohol group with stretching vibration. The appearance peak at 2919, 2850 cm^{-1} represent unsymmetrical and symmetrical C- H stretching vibration of sp^3hydrocarbon while strong band at 1591 cm^{-1} wavenumber was reveals a C=O stretching vibration of carbonyl group. According to peak values 1372, 1023 cm^{-1} these represent C=C stretching which are called as thearomatic groups.

The assignments of the FT-IR Spectrum are tabulated in table (4.6).

Table 4.6 FT-IR assignments of isolated stem compound

Absorption band (cm^{-1})	Assignments
3282	OH- stretching vibration of alcohol or phenolic group
2919, 2851	unsymmetrical and symmetrical C- H stretching vibration of sp^3 hydrocarbon
1591	C=O stretching vibration of carbonyl group
1398, 1018	C=C stretching vibration of aromatic benzene ring

According to the FT-IR spectrum, the selected powdered stem sample was confirmed as a type of Xanthan Gum compound. All of the absorption maxima of the individual peaks are consistent with that of library spectrum of Xanthan Gum. FT-IR result show that the amount of Xanthan Gum content in the stem sample is 86 %.

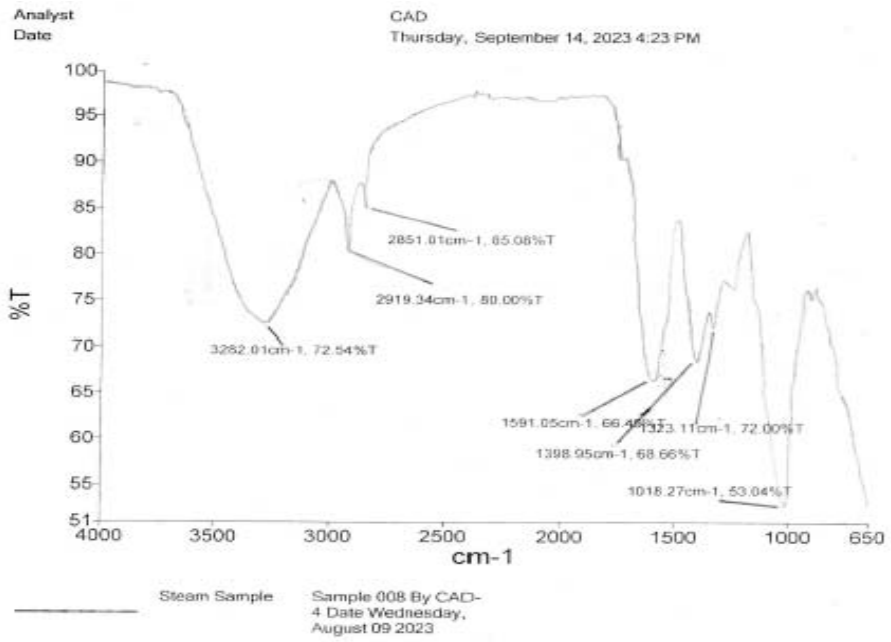


Figure 4.11 Comparison of FT-IR spectrum of stem sample with library spectrum

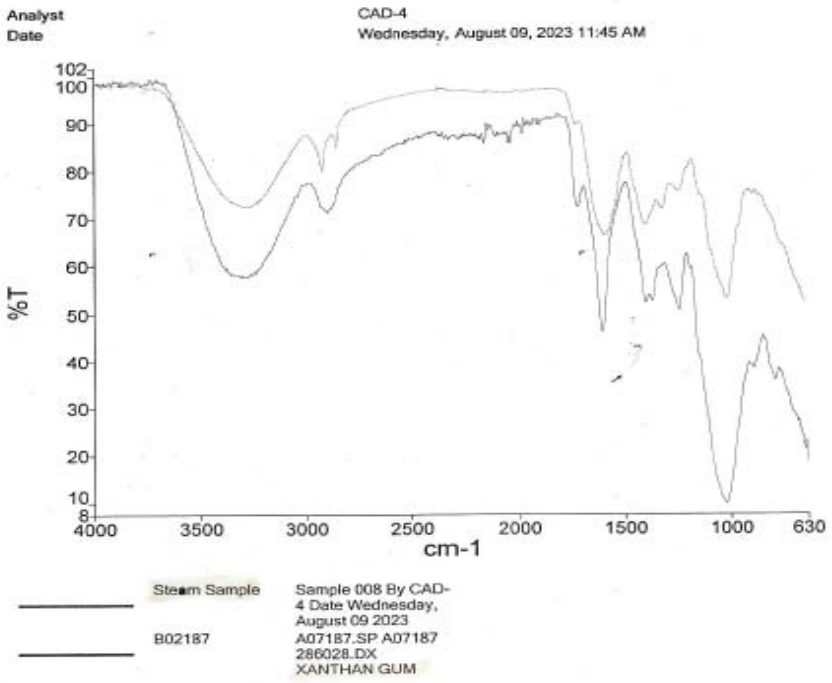


Figure 4.12 Comparison of FT-IR spectrum of stem sample with library spectrum

4.3.3FT-IR Assignments of Compound Isolated from the Root Sample

FT-IR spectrum of isolated compound from the root sample of *Andrographis paniculata* (Burm. f.) Wall. ex Nees is also shown in Figure (4.7).According to the FT-IR

4.3.3 FT-IR assignments of compound isolated from the root sample

FT-IR spectrum of isolated compound from the root sample of *Andrographis paniculata* (Burm. f.) Wall. ex Nees is also shown in Figure (4.13). According to the FT-IR Spectrum, the compound that isolated from the powdered root sample contains OH group, sp^3 hydrocarbon, carbonyl group and aromatic benzene ring, respectively.

The assignments of the FT-IR Spectrum are tabulated in table (4.7).

Table 4.7 FT-IR assignments of compound isolated from root sample

Absorption band (cm^{-1})	**Assignments**
3282	OH- stretching vibration of alcohol or phenolic group
2919, 2851	unsymmetrical and symmetrical C- H stretching vibration of sp^3 hydrocarbon
1591	C=O stretching vibration of carbonyl group
1398, 1323,1018	C=C stretching vibration of aromatic benzene ring

The result from the FT-IR indicated that the percentage of Xanthan Gum content in the root sample is 76 %.

The above results were in accordance with the characteristics of Xanthan Gum compound. All of the bands of the isolated compound from the powdered root sample are consistent with that of library spectrum of Xanthan Gum. Therefore, the type of the compound isolated from the root sample is confirmed to be Xanthan Gum. The elements such as iron (Fe) and lead (Pb) found from the isolated compound were not health concern except pb. This Pb heavy metal element is a health concern substance due to its accumulative effect on long-term use.

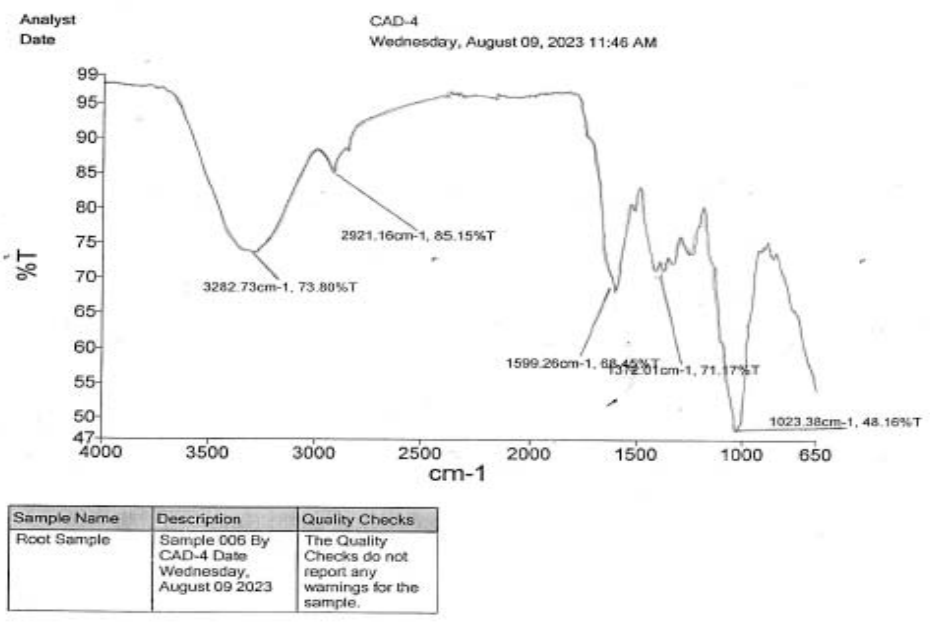


Figure 4.13 FT-IR spectrum of root sample

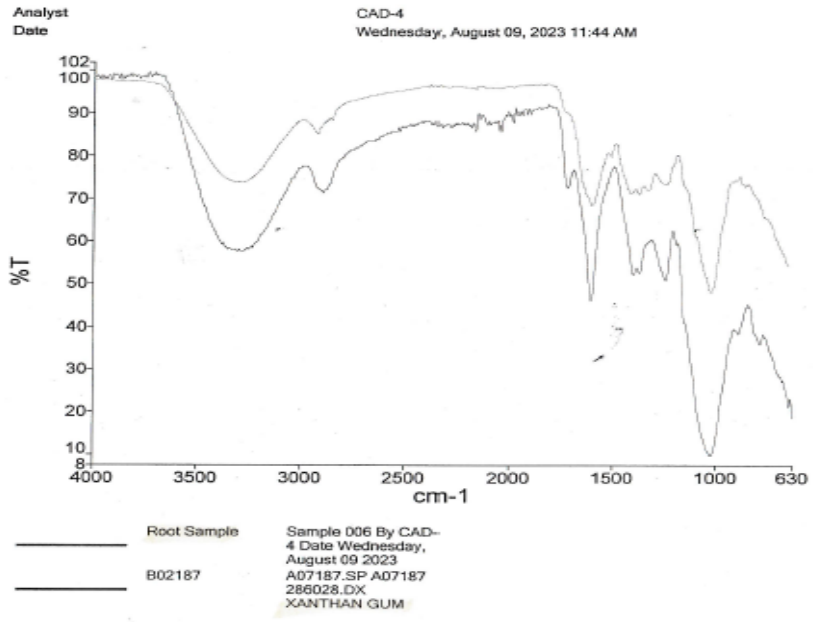


Figure 4.14 Comparison of FT-IR spectrum of root sample with library spectrum

5. Discussion and conclusion

Andrographis paniculata (Burm.f.) Wall. ex Nees, Bitterweed or King of Bitters, Sega-gyi in Myanmar, belongs to the family Acanthaceae, was collected in Yezin area, Nay Pyi TawDistrict, studied and identified. Their morphological and anatomical characteristics, phytoconstituents and isolation of bioactive compound from the leaf, stem and root samples and their uses were described, discussed and their phtotographs and photomicrographs were presented.

Macroscopic and microscopic studies of the genuine parts were referred to a few publications in Myanmar. The microscopic characters of the leaves, stem and root were found to be in agreement with Metcalfe and Chalk (1953) whereas some are not.

A. paniculata (Burm.f.) Wall. ex Nees is annual herb with glabrous, opposite and decussate leaves. Inflorescences are panicles with secondary, tertiary and quaternary peduncles which are pubescent. Flowers are born on only upper side of tertiary or quaternary peduncles, and upright. Flowers are zygomorphic and hypogynous. Corolla are 5-lobed, anterior 3 lobes united and larger than two posterior ones, middle one with long purple blotches, the lateral two with two purple streaks. Fruits are capsules.

The morphological characteristics of *A. paniculata* (Burm.f.) Wall. ex Nees have previously been reported by Khin Win Myint (1996), Thazin Phyu (2017) and Hossain et al.(2014). The morphological characteristics observed in this study are generally agreed with those described by Khin Win Myint (1996), Thazin Phyu (2017) and Hossain et. al.(2014).

In this paper, leaves are simple, 3.5 – 8.6 cm long and 1.0 – 2.7 cm wide, petiole very short, flowers 1.6 – 2.0 cm long and 1.0 – 1.3 cm wide, calyx 5-lobed, campanulate, corolla 5-lobed, corolla lobes triangular, anterior 3 lobes united and larger than posterior ones, anterior corolla lobe with purple streaks, pubescent; stamen 2, pistil bicarpellary, bilocular,

placentation axile, with one row of ovules on a single placenta, style slender, stigma simple. Pods or legumes, 2.2 – 2.5 cm long and 0.2 – 0.3 cm wide, 9 – 12 seeded; seeds 0.1 – 0.2 cm long and wide, brown, discoid.

But, Thazin Phyu (2017) stated that leaves were simple, 3.5 – 5.5 cm long and 2 – 3 cm, wide, peduncle 4 – 6 cm long, glabrous, flowers 0.5 – 0.7 cm in diameter, calyx tubular, 5-partite, tubes 0.2 – 0. 4cm long, lanceolate, corolla bilabiate, narrow, 0.3 – 0.4 cm long; 2-lipped, upper lips oblong, bifid, erect, lower lips oblong-lanceloate, 3- lobed, 0.3 – 0.5 cm long; style filiform; fruits capsular, linear oblong, 1.5 – 2.0 cm long, seeds ovate.

Akilandeswari (2019) stated that the plants were annual, branched, erect, about 1 m high; leaves simple, opposite, lanceolate, glabrous, dark green, entire along the margin, acute at the apex; calyx 5-partite, tube narrow, white corolla with violet spots; stamens 2, inserted in the throat; ovary superior.

In this study, palisade mesophyll is one-layered in lamina, cystoliths and stomata present on both surfaces, stomata diacytic; midribs irregularly quadrangular in outline in transverse section with convex surface at adaxial side, cystolith present in epidermial cells, vascular bundle large with two accessory bundles; petiole irregularly quadrangular-oblong in outline in transverse section with convex surface at adaxial side, vascular bundle large with two accessory bundles; stem quadrangular in outline in transverse section with wing-like structures at four angles, cystolith present in epidermal cells, vascular bundles in groups forming a quadrangular ring.

The anatomical characteristics observed in this study are generally agreed with those described by Khin Win Myint (1996). In this research, in the surface view of upper and lower epidermis, stomata diacytic. Vasu (2012) stated that the surface view of upper epidermis is lacking stomata, stomata present in lower epidermis, stomata diacytic. In this study, cystoliths were numerous, solitary, rounded or elongated, sometime 2 cystolyths present in one cell. Minute sandy crystals were present in the epidermal cells. But, Khin Win Myint (1996) described that cystoliths were numerous of various shapes and sizes.

In this paper, the transverse section of petioles and midribs showed cystoliths and this characteristics was in agreement with those described by Amriche et al. (2018).

In this paper, collenchymatous cells were lying internal to the epidermis of the midrib, 1 or 2 layered, cells rounded or oval in shape; parenchymatous cells lying internal to the collenchymatous cells, 2 – 8 layered, cells rounded or oval in shape.

But, Khin Win Myint (1996) described that collenchymatous of midrib cells of the upper side 2 or 3 layered; 1or 2 layers at the lower side, cells of both sides oval to rounded. The remaining tissue was parenchymatous cells at both sides, about 6 layered, cells large, rounded and compact; cystoliths occur in some cells of the adaxial side.

In this study, in the midrib, vascular bundle is large, closed and collateral; xylem lying at the adaxial side, each row of xylem 1 –7 tiered, phloem lying at the abaxial side, 3 – 6 tiered. But, Khin Win Myint (1996) described that vascular bundle was collateral, crescent shaped in outline; xylem strands about 18, protoxylem pointing towards the adaxial surface, 3 or 4 celled per strand.

In Myanmar, *A. paniculata* (Burm.f.) Wall. ex Nees is used in traditional medicine for a lon g time. *Andrographis paniculata* (Burm.f.) Wall. ex Nees is an important medicinal plant and it is being used in traditional medicine, as a remedy for the cold, fever and detoxification of the body since time immemorial. This medicinal plant (Kalmegh) has successfully halted the spread of 1919 Indian Flue (Influenza) pandemic. Drug has immense

therapeutic potentials such as immunomodulatory, antibacterial and anti-inflammatory, laxative, depurative, prophylactic, hepatoprotective and cardiovascular effects (Sudhakaran 2012).

A. paniculata (Burm.f.) Wall. ex Nees, has been extensively used as a traditional medicine. Phytochemical test of leaf powder showed the presence of alkaloids, α- amino acid, carbohydrates, flavonoids, glycosides, phenolic compounds, reducing sugars, saponins, starch, tannin and terpenoids; stem and root powder showed flavonoids, glycosides, phenolic compounds, reducing sugars, saponins, starch, steroid, tannin and terpenoids.

The functional groups of isolated compounds from the leaves, stems and roots could be assigned as xanthan gum. The xanthan gum is used for lowering blood sugar and total cholesterol in people with diabetes and other medicinal purposes. Moreover, leaf powder contained copper, iron, sodium and potassium elements and the iron and lead elements have been isolated from the roots.

In this study, preliminary screening confirmed the presence of the four functional groups in the powdered leaves, stems and roots sample of *A. paniculata* (Burm. f.) Wall. ex Nees. Wang et al. (2017) stated that active components mainly isolated from ethanol or methanol extract of leaves, stems, roots, and whole plant of *A. paniculata* (Burm. f.) Wall. ex Nees, which include diterpenes, lactones, flavonoids, and xanthones.

The morphological and anatomical characteristics of A. paniculata (Burm.f.) Wall. ex Nees are found to be useful in identification of the medicinal plant. Phytochemical test are also useful to know the active compounds present in the plants. The isolated compound, xanthan gum is found to be useful for lowering the blood sugar and total cholesterol in people with diabetes.

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