ANALYSIS OF ESSENTIAL OILS AND PHYTOCHEMICALS FROM SELECTED ANNONACEAE FAMILY AND CYCLOOXYGENASE-2 INHIBITORY ACTIVITY

NATASA MOHD SHAKRI

UNIVERSITI PENDIDIKAN SULTAN IDRIS

2021

ANALYSIS OF ESSENTIAL OILS AND PHYTOCHEMICALS FROM SELECTED ANNONACEAE FAMILY AND CYCLOOXYGENASE-2 INHIBITORY ACTIVITY

NATASA MOHD SHAKRI

DISSERTATION PRESENTED TO QUALIFY FOR A
MASTERS IN SCIENCE
(RESEARCH MODE)

FACULTY OF SCIENCE AND MATHEMATICS
UNIVERSITI PENDIDIKAN SULTAN IDRIS

2021

UNIVERSITI PENDIDIKAN SULTAN IDRIS
SULTAN IDRIS EDUCATION UNIVERSITY

Please tick (√)
Project Paper
Masters by Research
Master by Mixed Mode
PhD

√

INSTITUTE OF GRADUATE STUDIES

DECLARATION OF ORIGINAL WORK

This declaration is made on the ..MARCH..day of..22..20..21..

i. Student's Declaration:

I, NATASA MOHD SHAKRI, M20191000775 (PLEASE INDICATE STUDENT'S NAME, MATRIC NO. AND FACULTY) hereby declare that the work entitled ANALYSIS OF ESSENTIAL OILS AND PHYTOCHEMICALS FROM SELECTED ANNONACEAE FAMILY AND CYCLOOXYGENASE-2 INHIBITORY ACTIVITY is my original work. I have not copied from any other students' work or from any other sources except where due reference or acknowledgement is made explicitly in the text, nor has any part been written for me by another person.

Signature of the student

ii. Supervisor's Declaration:

I DR. WAN MOHD NUZUL HAKIMI W SALLEH (SUPERVISOR'S NAME) hereby certifies that the work entitled ANALYSIS OF ESSENTIAL OILS AND PHYTOCHEMICALS FROM SELECTED ANNONACEAE FAMILY AND CYCLOOXYGENASE-2 INHIBITORY ACTIVITY (TITLE) was prepared by the above named student, and was submitted to the Institute of Graduate Studies as a * partial/full fulfillment for the conferment of MASTER OF SCIENCE (NATURAL PRODUCTS) (PLEASE INDICATE THE DEGREE), and the aforementioned work, to the best of my knowledge, is the said student's work.

22 MARCH 2021
Date

Signature of the Supervisor

INSTITUT PENGAJIAN SISWAZAH /
INSTITUTE OF GRADUATE STUDIES

BORANG PENGESAHAN PENYERAHAN TESIS/DISERTASI/LAPORAN KERTAS PROJEK
DECLARATION OF THESIS/DISSERTATION/PROJECT PAPER FORM

Tajuk / *Title*: **ANALYSIS OF ESSENTIAL OILS AND PHYTOCHEMICALS FROM SELECTED ANNONACEAE FAMILY AND CYCLOOXYGENASE-2 INHIBITORY ACTIVITY**

No. Matrik /*Matric's No.*: **M20191000775**

Saya / *I* : **NATASA MOHD SHAKRI**

(Nama pelajar / *Student's Name*)

mengaku membenarkan Tesis/Disertasi/Laporan Kertas Projek (Kedoktoran/Sarjana)* ini disimpan di Universiti Pendidikan Sultan Idris (Perpustakaan Tuanku Bainun) dengan syarat-syarat kegunaan seperti berikut:-
acknowledged that Universiti Pendidikan Sultan Idris (Tuanku Bainun Library) reserves the right as follows:-

1. Tesis/Disertasi/Laporan Kertas Projek ini adalah hak milik UPSI.
   The thesis is the property of Universiti Pendidikan Sultan Idris
2. Perpustakaan Tuanku Bainun dibenarkan membuat salinan untuk tujuan rujukan dan penyelidikan.
   Tuanku Bainun Library has the right to make copies for the purpose of reference and research.
3. Perpustakaan dibenarkan membuat salinan Tesis/Disertasi ini sebagai bahan pertukaran antara Institusi Pengajian Tinggi.
   The Library has the right to make copies of the thesis for academic exchange.
4. Sila tandakan (√) bagi pilihan kategori di bawah */ Please tick (√) for category below:-*

☐	**SULIT/*CONFIDENTIAL***	Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub dalam Akta Rahsia Rasmi 1972. / *Contains confidential information under the Official Secret Act 1972*
☐	**TERHAD/*RESTRICTED***	Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan ini dijalankan. / *Contains restircted information as specified by the organization where research was done.*
☑	**TIDAK TERHAD / *OPEN ACCESS***	

(Tandatangan Pelajar/ Signature)

(Tandatangan Penyelia / *Signature of Supervisor*)
& (Nama & Cop Rasmi / *Name & Official Stamp*)

Tarikh: **22 MARCH 2021**

Catatan: Jika Tesis/Disertasi ini **SULIT** @ **TERHAD**, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan ini perlu dikelaskan sebagai **SULIT** dan **TERHAD**.

Notes: If the thesis is CONFIDENTAL or RESTRICTED, please attach with the letter from the organization with period and reasons for confidentiality or restriction.

This dissertation is dedicated to;

The memory of my parents, **Mohd Shakri Khatib** *and* **Sariah Jamil**. *Even though you both are no longer here with me, but your love and affection is the reason I am still standing strong here today.*

To my brother and sister, **Mohammad Shahril Iqmal** *and* **Shikin Nabilah**, *who have been my sources of inspiration and strongest support system.*

To my **close family and friends**, *who always shared their word of advice and encourage me to complete this study.*

This humble work is a sign of my love to all of you.

ACKNOWLEDGEMENT

First and foremost, Alhamdulillah, praises and thanks to Allah, the Almighty, for his countless blessings, throughout my research work to successfully completed the research.

I would like to express my deep and sincere gratitude to Dr. Wan Mohd Nuzul Hakimi Wan Salleh, my research supervisor, for giving me the opportunity to do this research under his supervision and providing me with valuable guidance and support throughout this research. I was truly inspired by his hard work and passion. It was a great privilege and honor to work and study under his supervision.

I would also like to thank Dr. Nor Azah Mohamad Ali and Mrs. Mailina Jamil from Natural Product Division, Forest Research Institute Malaysia for the services and access for GC and GC-MS instruments. Sincerely thanks to the Department of Chemistry, Faculty of Science and Mathematics, UPSI for the access of laboratory and instruments.

Last but not least, special thanks to my lab mates and friends; Ammar, Basri, Siddiq, Juliana, Suffiya, Maya, Ainol, Farhana, Hajar, Auni, Ida, Nabila, Helena, Auni, Fadriz, Fikri, Izzul, and Ridhwan for their moral support, advice and guidance throughout my research.

ABSTRACT

The aims of this study were to analyse the essential oils, phytochemistry and cyclooxygenase-2 inhibitory activity of selected species of the genus *Polyalthia* (*P. stenopetalla*, *P. sumatrana*, *P. cauliflora* and *P. rumphii*), *Xylopia* (*X. magna*, *X. ferruginea* and *X. frutescens*) and *Goniothalamus* (*G. macrophyllus* and *G. malayanus*) from Annonaceae family. The essential oils were obtained via hydrodistillation technique and their chemical compositions were determined by gas chromatography (GC-FID) and gas chromatography-mass spectrometry (GC-MS). The phytochemicals were obtained using chromatography techniques and their structures were confirmed by spectroscopic data and comparison with literatures. The bioactivity of the essential oils and extracts was investigated using cyclooxygenase-2 (COX-2) inhibitory activity. The study showed the essential oils of *P. sumatrana*, *P. stenopetalla*, *P. cauliflora* and *P. rumphii* were made up of bicyclogermacrene (18.8%), α-cadinol (13.0%), δ-elemene (38.1%) and germacrene D (33.3%), respectively. The major components of essential oil from *X. frutescens* was bicyclogermacrene (22.8%), whereas *X. magna* gave germacrene D (35.9%) and *X. ferruginea* was dominated by bicyclogermacrene (23.6%). As for *G. malayanus* and *G. macrophyllus*, the essential oils consisted mainly of bicyclogermacrene (43.9%) and germacrene D (25.1%), respectively. The dichloromethane and methanol leaf extracts of *P. rumphii* yielded seven phytochemicals identified as 5,7-dimethoxyflavone, 4′,5,7-trimethoxyflavone, 5-hydroxy-7-methoxyflavone, 4′-hydroxy-5,7-dimethoxyflavone, β-sitosterol, lupeol and taraxerol. The essential oil of *G. macrophyllus* and methanolic extracts of *X. magna* and *X. frutescens* displayed the best results in COX-2 inhibitory activity with percentage of 18.6%, 13.8% and 21.9%, respectively. In conclusion, the composition of the essential oils from nine species of Annonaceae family have shown that sesquiterpene hydrocarbons as their major components, meanwhile phytochemical studies had yielded flavonoids and terpenes compounds. The implication of this study demonstrate the essential oils and extracts of the genus *Xylopia* and *Goniothalamus* can be useful for rheumatism treatment.

ANALISIS MINYAK PATI DAN FITOKIMIA DARI KELUARGA ANNONACEAE TERPILIH DAN AKTIVITI PERENCATAN SIKLOOKSIGENASE

ABSTRAK

Tujuan kajian untuk menganalisis minyak pati, fitokimia dan aktiviti perencatan siklooksigenase-2 bagi tumbuhan terpilih daripada genus *Polyalthia* (*P. stenopetalla*, *P. sumatrana*, *P. cauliflora* dan *P. rumphii*), *Xylopia* (*X. magna*, *X. ferruginea* dan *X. frutescens*) dan *Goniothalamus* (*G. macrophyllus* dan *G. malayanus*) daripada keluarga Annonaceae. Minyak pati diperoleh melalui penyulingan hidro dan kandungan kimianya ditentukan melalui kromatografi gas (GC-FID) dan kromatografi gas-spektrometri jisim (GC-MC). Sebatian fitokimia diperolehi menggunakan teknik kromatografi dan strukturnya disahkan melalui data spektroskopi dan perbandingan dengan data literatur. Bioaktiviti minyak pati dan ekstrak dikaji menggunakan aktiviti perencatan siklooksigenase-2 (COX-2). Kajian menunjukkan minyak pati daripada *P. sumatrana*, *P. stenopetalla*, *P. cauliflora* and *P. rumphii* masing-masing terdiri daripada bisiklogermakren (18.8%), α-kadinol (13.0%), δ-elemen (38.1%) dan germakren D (33.3%). Komponen utama minyak pati daripada *X. frutescens* adalah bisiklogermakren (22.8%), manakala *X. magna* memberikan germakren D (35.9%) dan *X. ferruginea* didominasi oleh bisiklogermakren (23.6%). Bagi *G. malayanus* dan *G. macrophyllus*, minyak pati masing-masing terdiri terutamanya bisiklogermakren (43.9%) dan germakren D (25.1%). Ekstrak diklorometana dan metanol daripada daun *P. rumphii* menghasilkan tujuh sebatian fitokimia yang dikenalpasti sebagai 5,7-dimetoksiflavon, 4′,5,7-trimetoksiflavon, 5-hidroksi-7-metoksiflavon, 4′-hidroksi-5,7-dimetoksiflavon, β-sitosterol, lupeol dan taraxerol. Minyak pati *G. macrophyllus* dan ekstrak metanol *X. magna* dan *X. frutescens* menunjukkan hasil terbaik dalam aktiviti perencatan COX-2 dengan peratusan masing-masing 18.6%, 13.8% dan 21.9%. Kesimpulannya, komposisi minyak pati daripada sembilan spesies famili Annonaceae menunjukkan hidrokarbon seskuiterpena adalah komponen utamanya, manakala kajian fitokimia telah menghasilkan sebatian flavon dan terpena. Implikasi kajian ini menunjukkan minyak pati dan ekstrak daripada genus *Xylopia* dan *Goniothalamus* boleh digunakan dalam rawatan reumatisme.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

α	Alpha
Abs	Absorbance
β	Beta
br	broad
^{13}C	Carbon-13
CC	Column Chromatography
$CDCl_3$	Deuterated chloroform
$CHCl_3$	Chloroform
cm	Centimeter
cm^{-1}	Per centimeter
COSY	Correlation spectroscopy
COX-2	Cyclooxygenase-2
1D	1 Dimension
2D	2 Dimension
δ	chemical shift
d	doublet
dd	doublet of doublets
DEPT	Distortionless Enhancement by Polarization Transfer
EIMS	Electron Impact Mass Spectrometry
Et_2O	Diethyl ether
EtOAc	Ethyl acetate
GC	Gas Chromatography
GC-MS	Gas Chromatography-Mass Spectrometry

h	Hour(s)
n-Hex	Hexane
^{1}H	Proton
H_2SO_4	Sulfuric acid
HCl	Hydrochloric acid
HMBC	Heteronuclear Multiple Bond Correlation
HMQC	Heteronuclear Multiple Quantum Coherence
Hz	Hertz
IR	Infrared
J	Coupling constant
KBr	Potassium bromide
KI	Kovats Index
L	Liter
m	multiplet
M^+	Molecular ion
MeOH	Methanol
MHz	Megahertz
min	Minute(s)
m/z	Mass to charge ion
mg	milligram
m.p	Melting point
$MgSO_4$	Magnesium sulphate
mL	milliliter
mm	millimeter
MS	Mass Spectrometer

NMR	Nuclear Magnetic Resonance
nm	nanometer
PTLC	Preparative Thin Layer Chromatography
R_f	Retention factor
s	singlet
SiO_2	Silica gel
t	triplet
TLC	Thin Layer Chromatography
UV	Ultraviolet

CHAPTER 1

INTRODUCTION

1.1 General Introduction

Nature can be very beneficial to human who can support the basic needs such as source of foods, tools for shelter, and even traditional medicine. Natural products have been the backbone of traditional medicine ever since antiquity. Medicinal plants are great value to mankind. They are the gift of nature to human beings to lead a disease-free and healthy life. They have a crucial role to play in preserving our health (Oladeji, 2016). Although synthetic products or medicines are more popular at the moment due to its affordability of production, time savings and convenient quality control, their safety and effectiveness will always be questionable. As a result, more than 80% of the total population in the developing world depend on natural products because of its time effectiveness and reliability (Veeresham, 2012).

As a source of medicinal agents for the treatment of human diseases, natural products derived from plants have long been, and will continue to be, incredibly important. Mythology records of diverse cultures have provided lists of plants with beneficial medicinal properties (Salleh et al., 2016). However, despite these many important past contributions from the plant kingdom, many species of plants still haven't been characterised and remain undiscovered. In addition, only several plants species have been described for biologically active chemical components. It is therefore reasonable to assume that new plant sources of important and pharmaceutically amusing components would then remain to be discovered (Newman, Cragg & Snader, 2000).

Medicinal uses have been reported and described for a total of 6,000 floral species in the tropical regions. Based on the records, a significant number of 1,230 species were already identified in Malaysia as medicinal plants used in alternative medicine (Zakaria & Mohd, 1994). Alternative medicine is an indispensable part of the Malaysian cultural heritage and has been practiced in the country by different ethnic groups even before modern medicine system was implemented into the country. *Eurycoma longifolia* (tongkat ali), *Labisia pumila* (kacip fatimah), *Ficus deltoidea* (mas cotek) and *Cymbopogon nardus* (serai wangi) are the most common traditional Malaysian medicinal plants (Wiart, 2002; Wiart, 2006).

Currently, numerous researchers are currently striving to discover more plants which have medicinal qualities and have the capability to be marketed as herbal remedies. Annonaceae is one of the families of plants that are considered to have elevated therapeutic benefits due to its extensive used in various alternative medicines.

1.2 Annonaceae Family

The Annonaceae family, consisting of about 135 genera and over 2500 species, is the largest family in the order Magnoliales (Anary, Brandão, Déborah & Santos, 2016). The family has a source of edible fruit that can be considered to have an economic importance. Nielsen (1993) stated that the prickly soursop (*Annona muricata*), the sugar apple (*Annona squamosal*), cherimoya (*Annona cherimola*), and custard apple (*Annona reticulate*) are among the most important source of edible fruit which is broadly used in the production of pulp, juice and consumed in nature. Some species of the family have their own medicinal uses. For example, the seeds of *Annona dioica* are used to treat diarrhea while the leaves are used to treat rheumatism (Nielsen, 1993). From 135 genus in Annonaceae family, three genus were analysed which are *Polyalthia, Goniothalamus,* and *Xylopia*.

1.2.1 The Genus *Polyalthia*

Based on the report by International Plant Names Index, with approximately 346 species recorded, the *Polyalthia* genus has become one of the largest genera in the Annonaceae family (IPNI, 2012). *Polyalthia* trees and shrubs are reported to occur primarily in tropical and subtropical regions, particularly in Southeast Asia, widening from Southern India and Sri Lanka through continental Southeast Asia to Northern Australia and Melanesia, with some occurrences occurring in the lowland wetlands of East Africa and Madagascar (Bakker, 2000). *Polyalthia* species have also been widely

used in numerous treatments in alternative medicine. Table 1.1 demonstrates the medicinal uses of several *Polyalthia* species.

Table 1.1

Medicinal uses of several Polyalthia species

Species	**Part**	**Medicinal Uses**
P. beccarii	Leaf	Used to treat skin diseases (Burkill & Haniff, 1930)
P. cerasoides	Stem	Used to treat postpartum recovery (Lamxay, de Boer & Björk, 2011)
	Root	Used as tonic and febrifuge (Treeratana et al., 2011)
P. debilis	Root	Used to treat abdominal Pain (Kanokmedhakul, Kanokmedhakul, Yodbuddee & Phonkerd, 2003)
P. evecta	Root	Used for the treatment of galactagoguem (Kanokmedhakul, Kanokmedhakul, Ohtani & Isobe, 1998)
P. fragrans	Leaf	Used as an ingredient for cough and anemia (Burkill, 1966)
P. hypoleuca	Root	Used to cure postpartum depression (Burkill, 1966)
P. korinti	Root	Used for the cure of stomachache and also as a good antidote for snake bite (Burkill, 1966)
P. longifolia	Stem bark	Used to treat rheumatic fever, diarrhoea, indigestion, gonorrhoea, uterus aliment (Sinhababu & Banerjee, 2013)
	Leaf	Used to treat bone fracture and to treat postpartum depression (Suneetha, Prasanthi, Ramarao & Reddi, 2011)

(to be continue)

Table 1.1 *(continue)*

Species	Part	Medicinal Uses
P. longifolia	Stem	Used to treat skin diseases, diabetes, urinary tract infection and reducing blood pressure (Pallathupatti & Nadu, 2018)
	Root	Used to treat skin infections (Burkill, 1966)
P. oliveri	Leaf	Used as a cure for blackwater fever, to treat yellow fever. (Burkill & Haniff, 1930)
	Bark	Used as a vermifuge (Burkill & Haniff, 1930)
P. rumphii	Root	Prevention of rheumatic fever, hypertension, and inhibition of cancer cells (Yuan et al., 2011)
P. suberosa	Root	The decoction is used as abortifacient (Burkill, 1966)

Polyalthia has several general features. The flowers have six petals, the amount of sepals varying from three to six, and the amount of ovules per carpel may be one or three (Li & Gilbert, 2011). Few numbers of studies on the phytochemicals of *Polyalthia* species have been done and showed that the species are rich in alkaloids, tannins, saponins and glycosides (Lui, Jalil, Attiq, Chiew & Zakaria, 2018). Four species have been selected for this study which are *P. stenopetalla*, *P. sumatrana*, *P. cauliflora*, and *P. rumphii*. The descriptions for each species are shown in Table 1.2.

Table 1.2

The selected species of the genus Polyalthia

Species	Image	Description
P. stenopetalla		**Local name:** *Jambul cicit* **Distribution:** Peninsular Malaysia, Borneo **Medicinal uses:** Used to treat rheumatic fever and diarrhoea (Burkill & Haniff, 1930; Burkill, 1966).
P. sumatrana		**Local name:** *Karai puteh* **Distribution:** Asian tropics, South-East Asia **Medicinal uses:** Used to treat cough and anemia (Burkill & Haniff, 1930; Burkill, 1966).
P. cauliflora		**Local name:** *Lia padang, Semukau* **Distribution:** Thailand, Peninsular Malaysia, Sumatra and Borneo **Medicinal uses:** Used for birth control and skin disease (Burkill & Haniff, 1930; Burkill, 1966).
P. rumphii		**Local name:** *Merpadi* (Malaysia) **Distribution:** Asian tropics **Medicinal uses:** Used to treat skin disease (Burkill & Haniff, 1930; Burkill, 1966).

1.2.2 The Genus *Xylopia*

The second largest genus of the Annonaceae family is *Xylopia*, approximately 180 species worldwide. It has been found largely in West African countries such as Nigeria, Ghana, and Cameroon (David & Nancy, 2018). *Xylopia* are canopy trees with 50 m tall. The leaves are distichous, exstipulate, simple, entire and the leaf blades are commonly narrow oval shape, elliptic, or oblong, and papery to leathery. The flowers has a single spiral of three sepals, a spiral of three outer petals, and a spiral of three inner petals borne on a flat or slightly concave receptacle. The fruits usually follows Annonaceae summative pattern, with each carpel developing into a discrete fruitlet called a monocarp (Lamaty, Menut, Bessiere, Zollo & Fekam, 1989; Quintans, 2013; Da Silva et al., 2013; De Souza et al., 2015).

Phytochemical investigations of some *Xylopia* species have indicated the presence of alkaloids, flavonoids, terpenes as well as essential oils. These phytochemicals exhibited several biological activities, such as antifungal, antioxidant, cytotoxic, antinociceptive, and insecticidal (Da Silva et al., 2013). There are many reports of local used of *Xylopia* wood as a material for building and tools (Alolga, Chavez-Leon, Osei-Adjei & Onoja 2019). Table 1.3 shows several *Xylopia* species and their medicinal uses.

Three species from the genus *Xylopia* have been selected which are *X. magna*, *X. ferruginea*, and *X. frutescens.* The descriptions for each species are shown in Table 1.4.

Table 1.3

Medicinal uses of several Xylopia species

Species	**Part**	**Medicinal Uses**
X. aethiopica	Fruit	Used to treat syphilis, boils, malaria, fungal infections, cough, stomachache, hernia, cholera, dizziness, amenorrhea, headache, neuralgia, carminative, rheumatism, haemorrhoids, dysentery, flatulence, bronchitis, uterine fibroid and female infertility (Ghana Herbal Pharmacopoeia, 2007)
	Roots	Orally administered to eliminate worms (Irvine, 1961)
	Leaves	Decoctions of the leaves are used against rheumatism, headaches and as an emetic (Yapi et al., 2012)
	Seed	Used to treat scabies, asthma, stomach pains, rheumatism, malaria, cough, bronchitis, dysentery, female sterility and abdominal pains (Kama Niamayou, Binaki, Enzonga Yoca, Loumouamou, Myoula Tsiéri & Silou, 2014)
X. aromatica	Flowers	Use in folk medicine as a stimulant, diuretic, and treatment of digestive diseases (Do Nascimento et al., 2018)
X. ferruginea	Bark	Used to stop vomiting (Flora Fauna Web, 2019)
X. frutescens	Seeds	Used to treat inflammation, antidiarrheal, and digestion (De Souza et al., 2015)

(to be continue)

Table 1.3 *(continue)*

Species	Part	Medicinal Uses
X. laevigata	Leaves	To treat heart diseases, treating tumors and inflammatory conditions (Queiroz et al., 2014)
X. malayana	Leaves	Used for treatment after childbirth (Kamarudin, 1988)
X. parviflora	Roots	Used as chewing stick and anti-bacterial components which keep the teeth healthy (Babarinde, Pitan, Olatunde & Ajala, 2015)
X. sericea	Seeds	Analgesic, anti-inflammatory and to treat gastrointestinal disorders (Mendes et al., 2017)
	Fruits	Used as a carminative remedy, and are often used as a condiment in cuisine as a replacement for 'black pepper' (Lorenzi, 2002)

Table 1.4

The selected species of the genus Xylopia

Species	Image	Description
X. magna		**Local name:** *Jangkang* **Distribution:** Southeast Asia **Medicinal uses:** No information
X. ferruginea		**Local name:** *Jangkang Bukit* **Distribution:** Southeast Asia **Medicinal uses:** A decoction of the bark is to treat antispasmodic (Burkill, 1966).

(to be continue)

Table 1.4 *(continue)*

Species	Image	Description
X. frutescens		**Local name:** *Jangkang Betina* **Distribution:** Southeast Asia, Australia and Malaysia, South and Central America **Medicinal uses:** Seeds are used to treat rheumatism, inflammation, digestion and as antidiarrheal (Burkill, 1966).

1.2.3 The Genus *Goniothalamus*

Goniothalamus is a trees and shrubs, comprising about 160 species and mostly found occurring across Indochina and Malaysia in tropical Southeast Asia. Around 44 species of *Goniothalamus* have been identified and recorded in Malaysia. The botanical characteristics of *Goniothalamus* species are simple, strongly aromatic bark, having few leaves that are simple, alternate, and exstipulate. In addition, axillary and characteristically woody, fusiform and sometimes dark green are the flowers (Wiart, 2006).

Phytochemical studies of this species have led in the discovery of derivatives of styryl-lactone and also have been proved to produce embryotoxic properties (Sam, Chew, Sabirin, Gan, Dzulkifli & Mohamed, 1987). Previous studies have described the biological activities of various *Goniothalamus* species such as antibacterial, antimicrobial, antifungal, antioxidant, and cytotoxicity activities (Aslam, Ahmad,

Mamat, Ahmad & Salam, 2016). Table 1.5 shows several *Goniothalamus* species and their medicinal uses.

Table 1.5

Medicinal uses of several Goniothalamus species

Species	**Part**	**Medicinal Uses**
G. amuyon	Seed	Used to treat scabies, rheumatism and tympanites (Ahmad, 1991)
	Fruit	Used to treat stomachache (Quisumbing, 1951)
G. dolichocharpus	Root	It is boiled and taken orally by the Kelabit community to ease stomachache (Quisumbing, 1951)
G. giganteus	Root	Used in abortion and treatment of colds (Wiart, 2006)
	Leaf	Heated leaves are applied onto swellings (Wiart, 2006)
G. laoticus	Stem bark	Used traditionally as a tonic and a febrifuge by the local people (Wu, 1991)
G. macrophyllus	Leaf	Used to allay fever (Alkofahi et al., 1988)
	Root	Used as a postpartum remedy and to cause abortion, antiaging purposes, rheumatisms, skin complaints, and used to treat body pains (Alkofahi et al., 1988)
G. malayanus	Root	Treatment of rheumatism and fever (Ahmad, 1991)
	Bark	Treat measles and as insect repellents (Ahmad, 1991)
G. scortechinii	Leaf	Used as a postpartum protective remedy and were used to improve blood circulation (Burkill, 1966)

(to be continue)

Table 1.5 *(continue)*

Species	Part	Medicinal Uses
G. tapis	Root	Used to treat typhoid fever (Inayat-Hussain, 1999)
G. uvaroides	Roots	Used as postpartum protective remedies, abortifacients, typhoid fever, rheumatism (Moharam et al., 2012)
G. velutinus	Leaf	Used as a traditional medicine for treating headache, food poisoning, snake bite remedies, induce abortion and as a post-partum remedy (Inayat-Hussain, 1999)

Meanwhile, two species from the genus of *Goniothalamus* have been selected which are *G. macrophyllus* and *G. malayanus*. The descriptions for each species are shown in Table 1.6.

Table 1.6

The selected species of the genus Goniothalamus

Species	Image	Description
G. macrophyllus		**Local name:** *Gajah Beranak* **Distribution:** Peninsular Malaysia, Sumatra **Medicinal uses:** Fever and for postpartum remedy (Burkill & Haniff, 1930).
G. malayanus		**Local name:** *Kenanga Paya* **Distribution:** Peninsular Malaysia, Sumatra **Medicinal uses:** Effective as a mosquito repellent (Burkill, 1966).

1.3 Problem Statement

Due to their range of phytochemicals and biological properties that have been documented, medicinal plants from the Annonaceae family seem to be of considerable significance. However, several Malaysian species of Annonaceae have not been extensively studied, both chemically and biologically. Nine species from Annonaceae family have been selected for this study. Taking into account the importance of the medicinal uses of this genus in the treatment of several diseases, it is clear that there is a need to explore a wider range of studies. Consequently, studies have been investigated concerning the extraction of essential oils, the isolation of phytochemicals and the biological activity of the species selected. The research findings will make a positive contribution in the future to the enhancement of human wellbeing and also to the field of pharmaceutical products.

1.4 Objectives of Study

The objectives of the study are:

1. To investigate the chemical compositions of the essential oils from Annonaceae family
2. To isolate and characterize the phytochemicals from *Polyalthia rumphii* and identified spectroscopically.
3. To determine the cyclooxygenase-2 inhibitory activity of the essential oils and crude extracts.

1.5 Scopes of Study

The study was separated into three parts. The first part was on the extraction of the essential oils by hydrodistillation method from the leaves of *P. stenopetalla, P. sumatrana, P. cauliflora, P. rumphii, X. magna, X. ferruginea, X. frutescens, G. macrophyllus,* and *G. malayanus.* The chemical compositions of the essential oils were analysed using GC, GC-MS and Kovats Indices. The second part was to isolate the major phytochemicals from *P. rumphii* extracts using various chromatographic methods. The structures of the isolated phytochemicals were analysed spectroscopically using IR, UV, 1D and 2D NMR, and MS. Finally, the biological activity of the essential oils and crude extracts were carried out against cyclooxygenase-2 (COX-2) inhibitory activity.