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องค์ประกอบทางเคมีและฤทธิ์ทางชีวภาพของเถาวัลย์เปรียง

Chemical Constituents and Biological Activities of *Derris scandens* Benth.

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บทคัดย่อ

เถาวัลย์เปรียง (*Derris scandens* Benth.) เป็นพืชสมุนไพรทางยาที่รู้จักกันดีในแถบเอเชียและเป็นแหล่งผลิตสารสำคัญที่มีฤทธิ์ทางชีวภาพหลากหลาย บทความนี้เป็นการทบทวนเอกสารของโครงสร้างสารและฤทธิ์ทางชีวภาพของสารที่แยกได้จากเถาวัลย์เปรียง จากปี ค.ศ. 1966-2016 จากฐานข้อมูล ScienceDirect และ SciFinder สารองค์ประกอบทางเคมีที่พบในลำต้น ได้แก่ สารในกลุ่มอนุพันธ์เบนซิล คูมาริน ฟลาโวน ไอโซฟลาโวน ไอโซฟลาโวนไกลโคไซด์ พีเทอโรคาเพน สเตอรอยด์ และเทอร์พีน รายงานการวิจัยสารองค์ประกอบจากพืชชนิดนี้พบว่ามีสารจำนวน 66 สาร โดยเป็นสารใหม่จำนวน 20 สาร และสารที่แยกได้จากเถาวัลย์เปรียงเป็นครั้งแรกจำนวน 3 สาร พบว่าหลายสารที่มีความหลากหลายของฤทธิ์ทางเภสัชวิทยาที่น่าสนใจ

ABSTRACT

Derris scandens Benth. is well-known as an Asian medicinal plant and an important source of bioactive compounds. This review focuses on the isolated chemical structures and biological activities of the phytochemicals isolated from *D. scandens* from 1966-2016, according to the literature from ScienceDirect and SciFinder. Phytochemical investigation of the stems afforded a number of secondary metabolites, providing benzil derivatives, coumarins, flavones, isoflavones, isoflavone glycosides, pterocarpans, steroids, and terpenes. Sixty-six of these compounds have been reported from the plant. Twenty compounds are the new isolated compounds and three compounds are the firstly isolated from *D. scandens*. Several compounds have interesting pharmacological activities.

คำสำคัญ: เถาวัลย์เปรียง คูมาริน ฟลาโวน ไอโซฟลาโวน ไอโซฟลาโวนไกลโคไซด์
Keywords: *Derris scandens*, Coumarins, Flavones, Isoflavones, Isoflavone glycosides

1. INTRODUCTION

The Genus *Derris* belonging to the Family Leguminosae has been widely investigated in terms of their bioactive ingredients. About 40 species are abundant in tropical countries in the world (Merril, 1968). Twenty species have been observed in Thailand: *D. amazonica*, *D. araripensis*, *D. brevipes*, *D. elliptica*, *D. ferruginea*, *D. floribunda*, *D. glabrescens*, *D. laxiflora*, *D. malaccensis*, *D. mollis*, *D. nicou*, *D. oblonga*, *D. obtusa*, *D. rariflora*, *D. reticulata*, *D. robusta*, *D. scandens*, *D. sericea*, *D. spruceana*, and *D. trifoliata*.

Derris scandens Benth. locally Thai called “Tao-Wan-Priang”, is a climbing shrub and is widely distributed throughout Southeast Asia, including India, Malaysia, China, Thailand (Muanwongyathi and Supatwanich, 1981; Sriwanthana and Chavalittumrong, 2001; Sreelatha et al., 2010). *D. scandens* is a woody vine. The leaves are odd pinanately compound, about 15 cm long. Flowers are papilionaceous form. Fruit is flattened pod, lanceolate, narrow, spindled at both ends, about 4-6 cm long, and 1-2 cm wide; seeds 1-3, round flat, 3x4 mm (Faculty of Pharmacy Mahidol University, 1986). *D. scandens* has been used in traditional folk medicine in the form of decoction. For example, its dried stems are used as an expectorant, antitussive, diuretic, antidysentery agent, anti-inflammation and treatment of muscle aches and pains as well as arthritis symptoms (Chavalittumrong et al., 1999; Sekine et al., 1999; Rukachaisirikul et al., 2002; Laupattarakasem et al., 2004). A hydroalcoholic extract of the stem has been reported to have both antimicrobial and immunostimulating activities (Dhawan et al., 1977; Chuthaputti and Chavalittumrong, 1998). In addition, dried stem extract of *D. scandens* has been reported to show efficacious and safe for the treatment of knee osteoarthritis (Kuptniratsaikul et al., 2011).

Currently, 66 compounds have been isolated from the roots (Johnson et al., 1966; Palter and Stainton, 1966; Falshaw et al., 1969; Sengupta et al., 1971; Sreelatha et al., 2010; Hussain et al., 2015), stems (Rao et al., 1994; Dianpeng et al., 1999; Sekine et al., 1999; Suwannaroj et al., 2000; Rukachaisirikul et al., 2002; Laupattarakasem et al., 2004; Mahabusarakam et al., 2004; Hussain et al., 2015), and whole plant (Rao et al., 2007) of *D. scandens*. The major compounds were coumarins, isoflavones, and isoflavone glycosides. In this review, the isolated compounds from *D. scandens* and their

biological activities were mainly focused up to June 2016.

2. STRUCTURES AND BIOLOGICAL ACTIVITIES

The biological activities of *D. scandens* extracts have been reported, including the benzene-soluble fraction obtained from the EtOH extracts exhibited a weak activity against *Trichophyton mentagrophytes* with minimal inhibitory concentration (MIC) 500 μg/mL (the MIC of the standard agent lanoconazole, LNCZ was 6 ng/mL). The hexane and chloroform ($CHCl_3$) extracts of the whole plant of *D. scandens* have displayed potent α-glucosidase inhibitory activity with IC_{50} values of 10.63±0.319 and 6.28±1.02 μg/mL, respectively, whereas the $CHCl_3$ extract was observed moderate free radical scavenging activity with SC_{50} value of 7.15±0.118 μg/mL (Rao et al., 2007). The butanol (BuOH) extract of an aqueous extract of the stems had hypotensive activity in rats (Jansakul et al., 1997; Rukachaisirikul et al., 2002) and antibacterial activity against *Escherichia coli* (Sittiwet and Puangpronpitag, 2009). In addition, the aqueous extracts of *D. scandens* significantly reduced myeloperoxide release and eicosanoid production, showed potent inhibitory activity against generation of leukotriene B4, and also displayed antioxidant activity (Laupattarakasem et al., 2003). In the rat hind paw edema test, *D. scandens* extract showed significant activity when given intraperitoneally but did not produce a significant reduction when given orally. The results therefore supported to some extent the traditional use of *D. scandens* for arthritic conditions (Laupattarakasem et al., 2003).

A summary of the chemical structures and biological activities of the phytochemicals isolated from different parts of *D. scandens* is shown in Table 1.

Table 1 Phytochemicals isolated from *D. scandens*

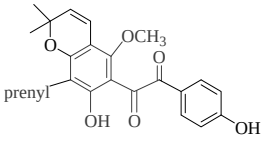
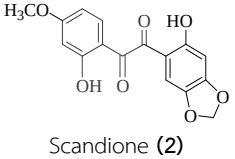
Type, Structure, name (code)	Part (reference)	Biological activity
Benzil derivative		
 Derrisdione A **(1)**	Root (Sreelatha et al., 2010)*	Antifeedant activity against *A. janata* larvae ED_{50} 7.18 μg/cm^2 Toxicity against *A. janata* larvae (Sreelatha et al., 2010)
 Scandione **(2)**	Stem (Mahabusarakam et al., 2004)*	-

Table 1 Phytochemicals isolated from *D. scandens* (continued)

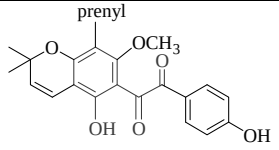
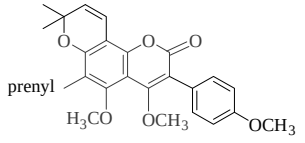
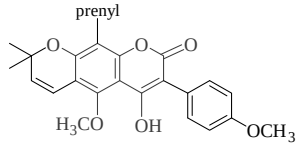
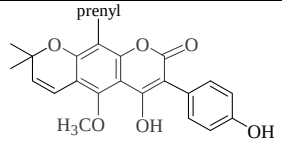
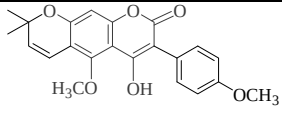
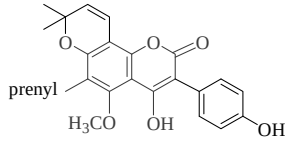
Type, Structure, name (code)	Part (reference)	Biological activity
Benzil derivative (continued)		
 **(3)**	Root (Sreelatha et al., 2010)	Antifeedant activity against *A. janata* larvae: ED_{50} 3.31 μg/cm^2 Toxicity against *A. janata* larvae LD_{50} 3.56 μg/cm^2 (Sreelatha et al., 2010)
Coumarin		
 4,4′-Di-*O*-methyl scandenin **(4)**	stems (Rao et al., 1994)* whole plant (Rao et al., 2007)	-
 Lonchocarpenin **(5)**	Root (Falshaw et al., 1969)	-
 Lonchocarpic acid **(6)**	Root (Johnson et al., 1966)	-
 Robustic acid **(7)**	Stem (Rao et al., 1994)	-
 Scandenin **(8)**	Root (Johnson et al., 1966; Sengupta et al., 1971; Sreelatha et al., 2010; Hussain et al., 2015) Stem (Laupattarakasem et al., 2004) whole plant (Rao et al., 2007)	Eicosanoid synthesis inhibition: COX inhibition: IC_{50} 8 μM, 5-LOX inhibition: IC_{50} 1.6 μM Inhibition of MPO release: IC_{50} 0.14 μM Antioxidation activity: IC_{50} 0.026 μM (Laupattarakasem et al., 2004) Antifeedant and toxicity against *A. janata* larvae: ED_{50} 3.85 μg/cm^2 and

Table 1 Phytochemicals isolated from *D. scandens* (continued)

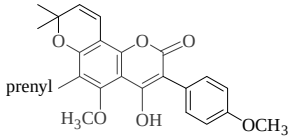
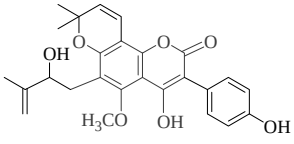
Type, Structure, name (code)	Part (reference)	Biological activity
Coumarin (continued)		
Scandenin **(8)**		LD_{50} 5.28 μg/cm^2, respectively (Sreelatha et al., 2010) Antibacterial activity: *B. megaterium* (IZ 14 + PI 16 mm) *E. coli* (IZ 8 + PI 10 mm) (Hussain et al., 2015) Antifungal activity: *M. violaceum* (PI 9 mm) (Hussain et al., 2015) Antialgal activity: *B. megaterium* (IZ 8.5 mm) (Hussain et al., 2015) (IZ = inhibition zone, PI = partial inhibition)
 Scandenin A **(9)**	whole plant (Rao et al., 2007)* Root (Sreelatha et al., 2010; Hussain et al., 2015)	Intestinal α–glucosidase enzyme inhibition: IC_{50} 25.17 μg/mL (Rao et al., 2007) Antioxidation activity: (DPPH assay) SC_{50} 4.98 μg/mL (Rao et al., 2007) Antibacterial activity: *B. megaterium* (PI 8 mm) *E. coli* (IZ 9 + PI 11 mm) (Hussain et al., 2015) Antifungal activity: *M. violaceum* (PI 8 mm) (Hussain et al., 2015) Antialgal activity: *B. megaterium* (IZ 7 mm) (Hussain et al., 2015) (IZ = inhibition zone, PI = partial inhibition)
 Scandenin B **(10)**	Stem (Rao et al., 2007)*	Antioxidation activity: (DPPH assay) SC_{50} 6.18 μg/mL (Rao et al., 2007)

Table 1 Phytochemicals isolated from *D. scandens* (continued)

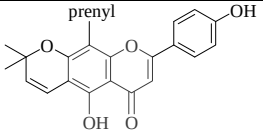
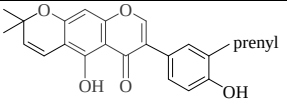
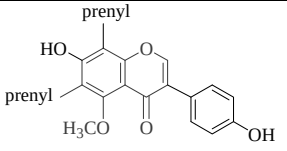
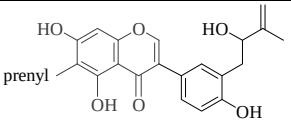
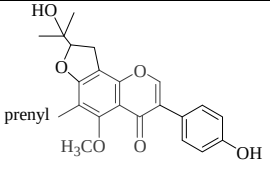
Type, Structure, name (code)	Part (reference)	Biological activity
Flavone		
 Laxifolin **(11)**	Root (Sreelatha et al., 2010)	Antifeedant activity and toxicity against *A. janata* larvae (Sreelatha et al., 2010)
Isoflavone		
 Chandalone **(12)**	Root (Falshaw et al., 1969) Stem (Mahabusarakam et al., 2004)	Radical scavenging activity: 18.42% scavenging of DPPH Antibacterial activity: *S. aureus* 128 μg/mL, MRSA 16 μg/mL Hypertensive activity: increase in MAP (at 4.0 mg/kg) 11.67 mmHg (Mahabusarakam et al., 2004)
 Derrisisoflavone A **(13)**	Stem (Sekine et al., 1999*; Mahabusarakam et al., 2004) whole plant (Rao et al., 2007)	Antidermatophyte activity against *T. mentagrophytes* MIC 500-1000 μg/mL (Sekine et al., 1999) Radical scavenging activity: 81.58% scavenging of DPPH Antibacterial activity: *S. aureus* 16 μg/mL, MRSA 4 μg/mL Hypertensive activity: increase in MAP (at 4.0 mg/kg) 7.5 mmHg (Mahabusarakam et al., 2004)
 Derrisisoflavone B **(14)**	Stem (Sekine et al., 1999)*	Antidermatophyte activity against *T. mentagrophytes*: MIC 500-1000 μg/mL (Sekine et al., 1999)
 Derrisisoflavone C **(15)**	Stem (Sekine et al., 1999)* whole plant (Rao et al., 2007)	Antidermatophyte activity against *T. mentagrophytes*: MIC 250 μg/mL (Sekine et al., 1999)

Table 1 Phytochemicals isolated from *D. scandens* (continued)

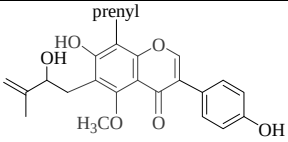
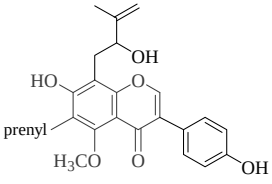
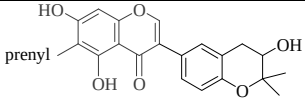
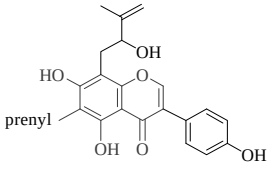
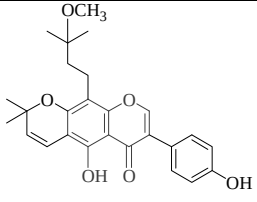
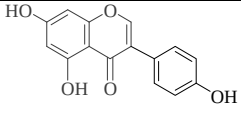
Type, Structure, name (code)	Part (reference)	Biological activity
Isoflavone (continued)		
 Derrisisoflavone D **(16)**	Stem (Sekine et al., 1999)*	Antidermatophyte activity against *T. mentagrophytes*: MIC 500-1000 μg/mL (Sekine et al., 1999)
 Derrisisoflavone E **(17)**	Stem (Sekine et al., 1999)*	Antidermatophyte activity against *T. mentagrophytes:* MIC 500-1000 μg/mL (Sekine et al., 1999)
 Derrisisoflavone F **(18)**	Stem (Sekine et al., 1999)*	Antidermatophyte activity against *T. mentagrophytes*: MIC 500-1000 μg/mL (Sekine et al., 1999)
 Erysenegalensein E **(19)**	Stem (Sekine et al., 1999)**	Antidermatophyte activity against *T. mentagrophytes:* MIC 500-1000 μg/mL (Sekine et al., 1999)
 Eturunagarone **(20)**	Stem (Rao et al., 1994)*	-
 Genistein **(21)**	Root (Sreelatha et al., 2010) Stem (Laupattarakasem et al., 2004; Mahabusarakam et al., 2004)	Eicosanoid synthesis inhibition: COX inhibition: IC_{50} 100 μM 5-LOX inhibition: IC_{50} 80 μM Inhibition of MPO release: IC_{50} 0.22 μM (Laupattarakasem et al., 2004) Antifeedant and Toxicity activities against *A. janata* larvae: ED_{50} 3.22 μg/cm^2, LD_{50} 3.29 μg/cm^2 (Sreelatha et al., 2010)

Table 1 Phytochemicals isolated from *D. scandens* (continued)

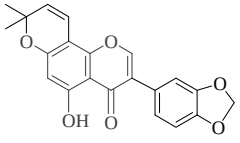
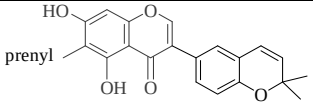
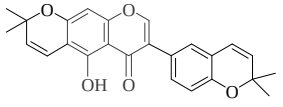
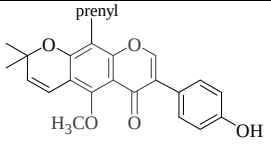
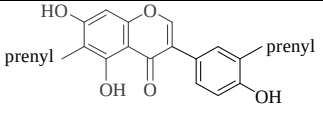
Type, Structure, name (code)	Part (reference)	Biological activity
Isoflavone (continued)		
 5-Hydroxy-2″,2″-dimethylchromeno -[6,7:5″,6″]-2‴,2‴dimethylchromeno [3′,4′:5‴,6‴]isoflavone **(22)**	Stem (Mahabusarakam et al., 2004)	-
 Isochandalone **(23)**	Stem (Mahabusarakam et al., 2004)	DPPH Radical scavenging activity: 10.53% Antibacterial activity: *S. aureus* >256 μg/mL, MRSA >256 μg/mL (Mahabusarakam et al., 2004)
 Isorobustone **(24)**	Stem (Mahabusarakam et al., 2004)	DPPH Radical scavenging activity: 13.16% Antibacterial activity: *S. aureus* >128 μg/mL, MRSA >128 μg/mL (Mahabusarakam et al., 2004)
 Isoscandinone **(25)**	whole plant (Rao et al., 2007)*	-
 Lupalbigenin or 3′-γ,γ-Dimethylallylwighteone **(26)**	Root (Sreelatha et al., 2010) Stem (Rao et al., 1994; Sekine et al., 1999; Laupattarakasem et al., 2004; Mahabusarakam et al., 2004; Rao et al., 2007)	Antidermatophyte activity against *T. mentagrophytes*: MIC 250 μg/mL (Sekine et al., 1999) Eicosanoid synthesis inhibition: COX inhibition: IC_{50} 3 μM 5-LOX inhibition: IC_{50} 6 μM Antioxidation activity: IC_{50} 0.06 μM (Laupattarakasem et al., 2004) DPPH Radical scavenging activity: 26.32% Antibacterial activity: *S. aureus* 2 μg/mL, MRSA 4 μg/mL (Mahabusarakam et al., 2004)

Table 1 Phytochemicals isolated from *D. scandens* (continued)

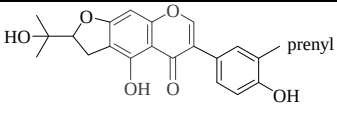
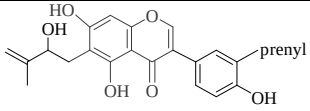
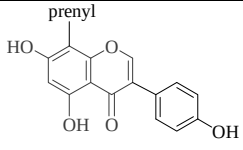
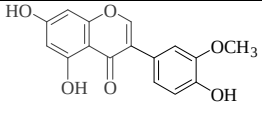
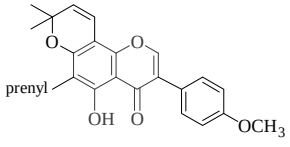
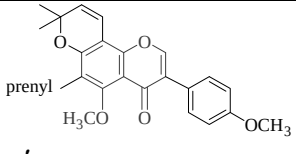
Type, Structure, name (code)	Part (reference)	Biological activity
Isoflavone (continued)		
		Cytotoxicity against breast cancer cells: MCF-7 (IC_{50} 12.553±2.751 μM), MDA-MB-231 (IC_{50} 11.630±2.156 μM), MDA-MB-468 (IC_{50} 15.163±3.621 μM) Cytotoxicity against colon cancer cells: SW-620 (IC_{50} 26.510±4.852 μM) Cytotoxicity against mouse fibroblast cells: L-929 (IC_{50} 37.712±9.802 μM) (Tedasen et al., 2016)
 Lupinisoflavone G **(27)**	Stem (Sekine et al., 1999)**	Antidermatophyte activity against *T. mentagrophytes*: MIC 500-1000 μg/mL (Sekine et al., 1999)
 Lupinisol A **(28)**	Stem (Sekine et al., 1999)**	Antidermatophyte activity against *T. mentagrophytes* MIC 500-1000 μg/mL (Sekine et al., 1999)
 Lupiwighteone **(29)**	Stem (Mahabusarakam et al., 2004)	DPPH Radical scavenging activity: 15.79% (Mahabusarakam et al., 2004)
 3′-Methylorobol **(30)**	Stem (Mahabusarakam et al., 2004)	-
 4′-*O*-Methylosajin **(31)**	whole plant (Rao et al., 2007)	-
 4′-*O*-Methylscandinone **(32)**	whole plant (Rao et al., 2007)	-

Table 1 Phytochemicals isolated from *D. scandens* (continued)

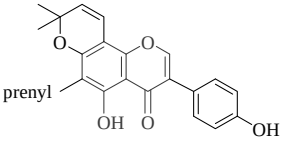
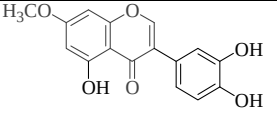
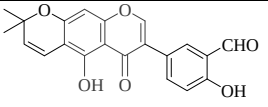
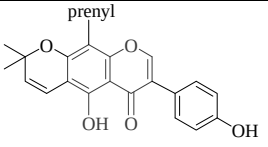
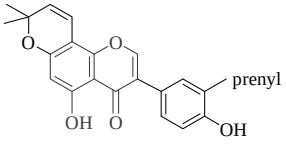
Type, Structure, name (code)	Part (reference)	Biological activity
Isoflavone (continued)		
 Osajin **(33)**	Root (Palter and Stainton, 1966; Sreelatha et al., 2010) whole plant (Rao et al., 2007)	Antifeedant activity against *A. janata* larvae: ED_{50} 3.18 μg/cm^2 Toxicity against *A. janata* larvae: LD_{50} 3.54 μg/cm^2 (Sreelatha et al., 2010)
 Santal **(34)**	Stem (Mahabusarakam et al., 2004)	DPPH Radical scavenging activity: 86.84% Antibacterial activity: *S. aureus* 128 μg/mL, MRSA 2 μg/mL Hypertensive activity: increase in MAP (at 4.0 mg/kg) 21.7 mmHg (Mahabusarakam et al., 2004)
 Scandenal **(35)**	Stem (Mahabusarakam et al., 2004)*	Hypertensive activity: increase in MAP (at 0.4 mg/kg) 11.67 mmHg (Mahabusarakam et al., 2004)
 Scandenone or Warangalone **(36)**	Root (Sreelatha et al., 2010; Palter and Stainton, 1966) Stem (Rao et al., 1994) whole plant (Rao et al., 2007)	Intestinal α–glucosidase enzyme inhibition: IC_{50} 34.74±0.60 μg/mL (Rao et al., 2007)
 Scanderone **(37)**	Stem (Mahabusarakam et al., 2004)*	Hypertensive activity: increase in MAP (at 4.0 mg/kg) 20.0 mmHg (Mahabusarakam et al., 2004)

Table 1 Phytochemicals isolated from *D. scandens* (continued)

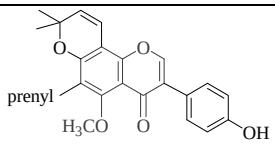
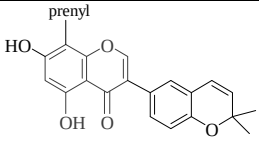
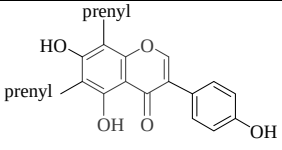
Type, Structure, name (code)	Part (reference)	Biological activity
Isoflavone (continued)		
 Scandinone **(38)**	Roots (Palter and Stainton, 1966; Sreelatha et al., 2010) Stem (Rao et al., 1994; Sekine et al., 1999; Mahabusarakam et al., 2004) whole plant (Rao et al., 2007)	Antidermatophyte activity against *T. mentagrophytes*: MIC 500-1000 μg/mL (Sekine et al., 1999) Antioxidation activity: 63.16% scavenging DPPH Antibacterial activity: *S. aureus* >256 μg/mL, MRSA >256 μg/mL (Mahabusarakam et al., 2004) Intestinal α–glucosidase enzyme inhibition: IC_{50} 33.83±1.32 μg/mL (Rao et al., 2007)
 Ulexone A **(39)**	Stem (Mahabusarakam et al., 2004)	-
 5,7,4′-Trihydroxy-6,8-diprenylisoflavone or 8-γ,γ-Dimethylallylwighteone **(40)**	Stem (Rao et al., 1994; Sekine et al., 1999) whole plant (Rao et al., 2007)	Antidermatophyte activity against *T. mentagrophytes*: MIC 250 μg/mL (Sekine et al., 1999) Intestinal α–glucosidase enzyme inhibition: IC_{50} 45.14±1.13 μg/mL Antioxidation activity (DPPH assay): SC_{50} 9.21 μg/mL (Rao et al., 2007) Cytotoxicity against breast cancer cells: MCF-7 (IC_{50} 11.667±0.626 μM), MDA-MB-231 (IC_{50} 11.767±0.608 μM), MDA-MB-468 (IC_{50} 12.914±3.809 μM) Cytotoxicity against colon cancer cells: SW-620 (IC_{50} 18.331±1.536 μM) Cytotoxicity against mouse fibroblast cells: L-929 (IC_{50} 34.425±6.456 μM) (Tedasen et al., 2016)

Table 1 Phytochemicals isolated from *D. scandens* (continued)

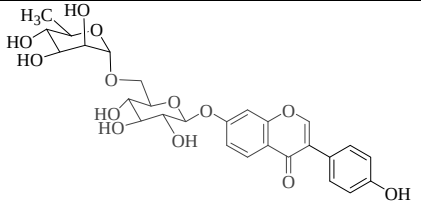
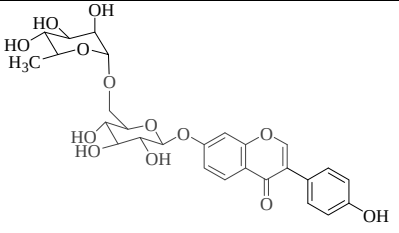
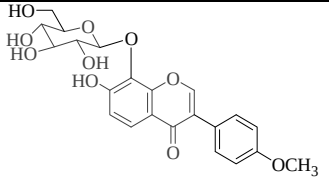
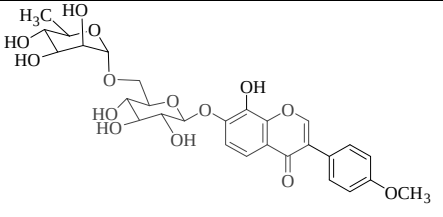
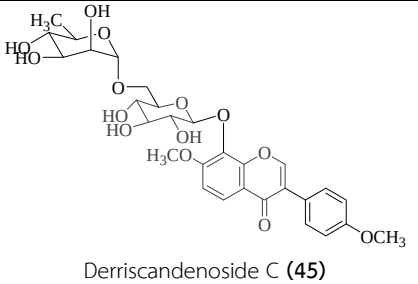
Type, Structure, name (code)	Part (reference)	Biological activity
Isoflavone glycoside		
 Diadzein 7-*O*-[α-rhamnopyranosyl-(1→*6*)]-β-glucopyranoside **(41)**	Stem (Rukachaisirikul et al., 2002)	-
 Daidzein 7-*O*-rhamnosyl(1→6)glucoside **(42)**	Stems (Suwannaroj et al., 2000)	-
 Derriscandenoside A **(43)**	Stem (Rukachaisirikul et al., 2002)*	-
 Derriscandenoside B **(44)**	Stem (Rukachaisirikul et al., 2002)*	-
 Derriscandenoside C **(45)**	Stem (Rukachaisirikul et al., 2002)*	-

Table 1 Phytochemicals isolated from *D. scandens* (continued)

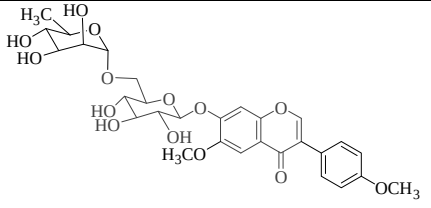
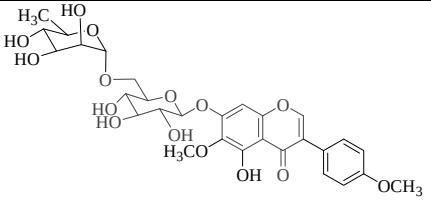
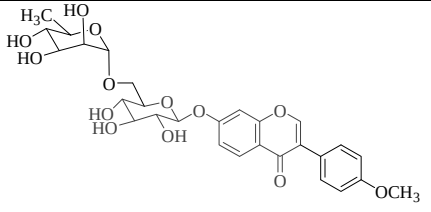
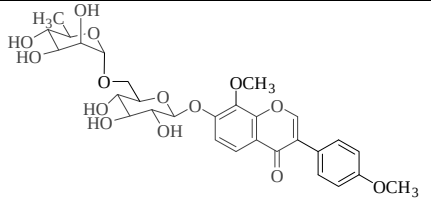
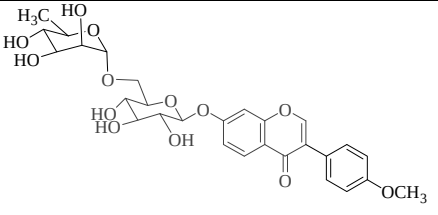
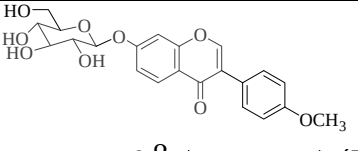
Type, Structure, name (code)	Part (reference)	Biological activity
Isoflavone glycoside (continued)		
 Derriscandenoside D **(46)**	Stem (Rukachaisirikul et al., 2002)*	-
 Derriscandenoside E **(47)**	Stem (Rukachaisirikul et al., 2002)*	-
 Derriscanoside A **(48)**	Stem (Dianpeng et al., 1999; Rukachaisirikul et al., 2002)	-
 Derriscanoside B **(49)**	Stem (Dianpeng et al., 1999; Rukachaisirikul et al., 2002)	Hypertensive activity: increase in MAP (at 4.0 mg/kg) 26.7 mmHg (Rukachaisirikul et al., 2002)
 Formononetin 7-*O*-[α-rhamnopyranosyl-(1→6)]-β-glucopyranoside **(50)**	Stem (Rukachaisirikul et al., 2002)	-
 Formononetin 7-*O*-β-glucopyranoside **(51)**	Stem (Rukachaisirikul et al., 2002)	-

Table 1 Phytochemicals isolated from *D. scandens* (continued)

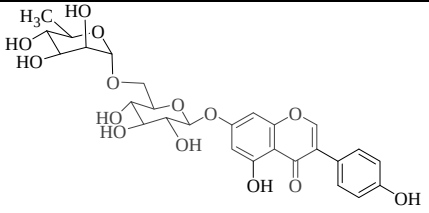
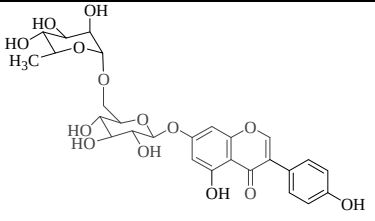
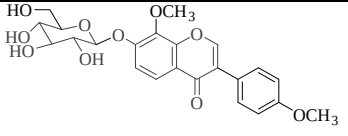
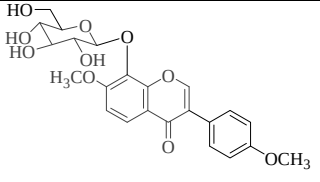
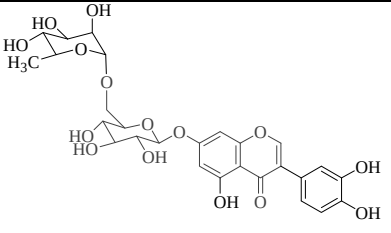
Type, Structure, name (code)	Part (reference)	Biological activity
Isoflavone glycoside (continued)		
 Genistein 7-*O*-[α-rhamnopyranosyl-(1→6)]-β-glucopyranoside **(52)**	Stem (Rukachaisirikul et al., 2002; Laupattarakasem et al., 2004)	Hypertensive activity: increase in MAP (at 4.0 mg/kg) 5 mmHg (Rukachaisirikul et al., 2002) Eicosanoid synthesis inhibition: COX inhibition: IC_{50} 1500 μM 5-LOX inhibition: IC_{50} 2500 μM (Laupattarakasem et al., 2004)
 Genistein 7-*O*-rhamnosyl(1→6)glucoside **(53)**	Stem (Suwannaroj et al., 2000)	-
 7-Hydroxy-4′,8-dimethoxyisoflavone 7-*O*-β-glucopyranoside **(54)**	Stem (Rukachaisirikul et al., 2002)	-
 8-Hydroxy-4′,7-dimethoxyisoflavone-8-*O*-β-glucopyranoside **(55)**	Stem (Rukachaisirikul et al., 2002)	-
 Orobol 7-*O*-rhamnosyl(1→6)glucoside **(56)**	Stem (Suwannaroj et al., 2000)	-

Table 1 Phytochemicals isolated from *D. scandens* (continued)

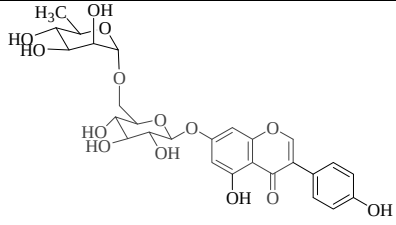
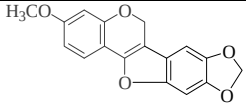
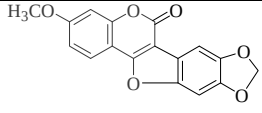
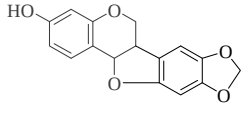
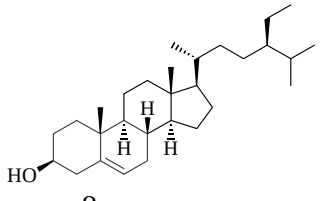
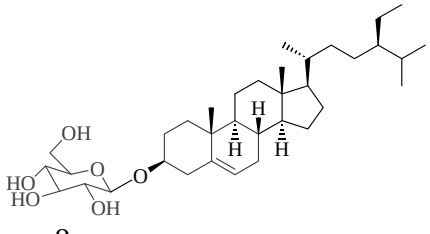
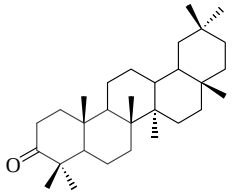
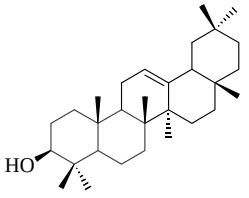
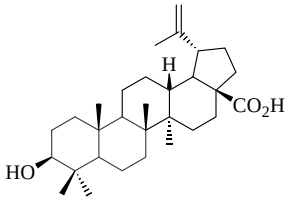
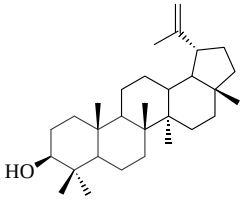
Type, Structure, name (code)	Part (reference)	Biological activity
Isoflavone glycoside (continued)		
 Sphaerobioside **(57)**	Root (Sreelatha et al., 2010)	Antifeedant activity against *Achaea janata* larvae: ED_{50} 3.37 μg/cm^2 Toxicity against *A. janata* Larvae: LD_{50} 3.87 μg/cm^2 (Sreelatha et al., 2010)
Pterocarpan		
 Flemichapparin B **(58)**	Stem (Mahabusarakam et al., 2004)	DPPH Radical scavenging activity: 5.26% Antibacterial activity: S. aureus >512 μg/mL, MRSA >512 μg/mL Hypertensive activity: increase in MAP (at 0.4 mg/kg) 8.9 mmHg (Mahabusarakam et al., 2004)
 Flemichapparin C **(59)**	Stem (Mahabusarakam et al., 2004)	DPPH radical scavenging activity: 21.05% scavenging (Mahabusarakam et al., 2004)
 Maackiain **(60)**	Stem (Mahabusarakam et al., 2004)	Antibacterial activity: *S. aureus* >512 μg/mL, MRSA >512 μg/mL Hypertensive activity: increase in MAP (at 0.4 mg/kg) 8.3 mmHg (Mahabusarakam et al., 2004)
Steroid		
 β-Sitosterol **(61)**	Stem (Hussain et al., 2015)	-
 β-Sitosterol glucopyranoside **(62)**	Stem (Hussain et al., 2015)	-

Table 1 Phytochemicals isolated from *D. scandens* (continued)

Type, Structure, name (code)	Part (reference)	Biological activity
Terpene		
 β-Amyran-3-one **(63)**	Stem (Hussain et al., 2015)	-
 β-Amyrin **(64)**	Root (Hussain et al., 2015)	-
Triterpene (continued)		
 Betulinic acid **(65)**	Root (Hussain et al., 2015)	-
 Lupeol **(66)**	Root (Sengupta et al., 1971; Hussain et al., 2015)	-

Note: *B. megaterium* (*Bacillus megaterium*), *E. coli* (*Escherichia coli*), MRSA (Methicillin resistant *Staphylococcus aureus*), *M. violaceum* (*Microbotryum violaceum*), *S. aureus* (*Staphylococcus aureus*), COX (cyclooxygenase), 5-LOX (5-lipoxygenase), MAP (mean arterial blood pressure), MPO (myeloperoxidase)

* Firstly isolated compound (new compound)

** Firstly isolated compound from *D. scandens*

3. COMPOUNDS ISOLATED FROM *D. scandens*

3.1 Benzil derivative

Three benzil derivatives: derrisdione A **(1)**, scandione **(2)**, and compound **3** were isolated from *D. scandens*. Derrisdione A **(1)** and scandione **(2)** were two new benzil derivatives isolated from the root and stem of *D. scandens*, respectively (Mahabusarakam et al., 2004; Sreelatha et al., 2010). Derrisdione A **(1)** and compound **3** showed antifeedant activity against *Achaea janata* larvae with ED_{50} 7.18 and 3.31 μg/cm^2, respectively and **3** also showed toxicity against *A. janata* larvae with LD_{50} 3.56 μg/cm^2 (Sreelatha et al., 2010).

3.2 Coumarin

Seven coumarins (**4**-**10**) were isolated from *D. scandens* with 4,4′-di-*O*-methyl scandenin **(4)**, scandenin A **(9)**, and scandenin B **(10)** being first reported as new compounds (Rao et al., 1994; Rao et al., 2007). Scandenin **(8)** inhibited the eicosanoid synthesis with IC_{50} values of 8 μM for cyclooxygenase (COX) inhibition and 1.6 μM for 5-lipoxygenase (LOX) inhibition, and also inhibited the myeloperoxidase (MPO) release with IC_{50} value of 0.14 μM (Laupattarakasem et al., 2004). In addition, **8** showed the most effective antifeedant activity and good toxicity against *Achaea janata* larvae with ED_{50} 3.85 μg/cm^2 and LD_{50} 5.28 μg/cm^2, respectively (Sreelatha et al., 2010). Moreover, **9** and **10** displayed potent antioxidation activity by DPPH free radical scavenging assay with SC_{50} 4.98 and 6.18 μg/mL, respectively (Trolox displayed SC_{50} 1.48 μg/mL) (Rao et al., 2007).

3.3 Flavone

Only one flavone compound, laxifolin **(11)**, was isolated from the root extract of *D. scandens* (Sreelatha et al., 2010). However, it did not show either antifeedant nor toxicity activities against *A. janata* larvae (Sreelatha et al., 2010).

3.4 Isoflavone

The isoflavones isolated from *D. scandens* have one or more isoprenoids substituents usually further cyclised with a hydroxyl group. Twenty-nine isoflavones (compounds **12**-**40** in Table 1) were isolated and ten of them were first isolated from *D. scandens*. They are derrisisoflavones A-F **(13-18)**, eturunagarone **(20)**, isoscandinone **(25)**, scandenal **(35)**, and scanderone **(37)** (Rao et al., 1994; Sekine et al., 1999; Mahabusarakam et al., 2004; Rao et al., 2007). Most of these isoflavones showed interesting biological activities.

3.5 Isoflavone glycoside

Seventeen isoflavone glycosides (compounds **41-57** in Table 1) were obtained from *D. scandens* including five new compounds: derriscandenosides A-E (**43**-**47**) (Rukachaisirikul et al., 2002). Derriscanoside B **(49)** and genistein 7-*O*-[α-rhamnopyranosyl-

(1→6)]-β-glucopyranoside **(52)** showed hypertensive activity increase in mean arterial blood pressure (MAP) (at 4.0 mg/kg) 26.7 and 5 mmHg, respectively (Rukachaisirikul et al., 2002). **52** showed eicosanoid synthesis inhibition for COX and 5-LOX inhibition with IC_{50} values of 1500 and 2500 μM, respectively (Laupattarakasem et al., 2004). In addition, sphaerobioside **(57)** showed antifeedant and toxicity activities against *A. janata* larvae with ED_{50} 3.37 μg/cm^2 and LD_{50} 3.87 μg/cm^2, respectively (Sreelatha et al., 2010).

3.6 Pterocarpan

Three pterocarpans were isolated from the stem of *D. scandens*: flemichapparin B **(58)**, flemichapparin C **(59)**, and maackiain **(60)** (Mahabusarakam et al., 2004). Compounds **58** and **59** showed radical scavenging activity 5.26 and 21.05% of DPPH, respectively (Mahabusarakam et al., 2004). Whereas, **58** and **60** exhibited no antibacterial activity against *Staphylococcus aureus* ATCC 25923 and methicillin-resistant *S. aureus* (MRSA) SK1 (MIC >512 μg/mL) and showed hypertensive activity increase in MAP at 0.4 mg/kg in 8.9 and 8.3 mmHg, respectively (Mahabusarakam et al., 2004).

3.7 Steroid and Terpene

Steroid and terpene are two large classes of natural products, but only two steroids: β-sitosterol **(61)**, β-sitosterol glucopyranoside **(62)** and four terpenes: β-amyran-3-one **(63)**, β-amyrin **(64)**, betulinic acid **(65),** lupeol **(66)** were isolated from *D. scandens* (Hussain et al., 2015). None of these compounds were studied for their biological activities. Nevertheless, among of these compounds were isolated from other plants had been determined for their biological activities. β-Sitosterol **(61)** from petroleum ether extract of *Piper galeatum* significantly inhibits the TNF α-induced expression of VCAM-1 and E-Selectin (IC_{50} 30 and 28 μM), inhibited the adhesion of neutrophils to the endothelium in a concentration dependent manner (IC_{50} 22 μM), and also blocked the translocation of NF-kB p65 (Gupta et al., 2010). β-Sitosterol **(61)** in the extract of *Bambusa bambos* was not cytotoxic to MCF-7 cells in any of the dilutions (Sriraman et al., 2015), while **61** from the bark of *Grewia tiliaefolia* at 1 μg/mL showed antibacterial activity against *Klebsiella pneumonia* (MTCC 618) *and Pseudomonas aeruginosa* (ATCC 20852) with 15 and 18 mm of clear zones, respectively (Ahamed et al., 2007). β-Amyrin **(64)** from *Symplocos cochinchinensis* leaves showed very good scavenging effects on DPPH, hydroxyl, nitric oxide, and superoxide (IC_{50} 89.63±1.31, 76.41±1.65, 87.03±0.85, and 81.28±1.79 μg/mL, respectively) radicals and strong suppressive effect on lipid peroxidation (Sunil et al., 2014). β-Amyrin **(64)** isolated from *Laurencia microcladia* showed

antibacterial activity against *Salmonella typhi* and *S. aureus* and with an MIC of 2.5 mg/mL (Abdel-Raouf et al., 2015). Betulinic acid **(65)** isolated from *Vitis amurensis* root inhibited IBMX-induced melanin production in B16F10 cells by suppressing tyrosinase, TRP-1 and TRP-2 (Jin et al., 2014). Lupeol **(66)** has been found in various plants including Shea butter plant, licorice, *Tamarindus indica*, *Celastrus paniculatus*, *Allanblackia monticola*, *Zanthoxylum riedelianum*, *Himatanthus sucuuba*, *Leptadenia hastata*, *Crataeva nurvala*, *Bombax ceiba*, *Sebastiania adenophora*, *Aegle marmelos*, and *Emblica officinalis*. Currently, its anti-inflammatory and anticancer activities have been reported (Saleem, 2009; Siddigue and Saleem, 2011).

4. BIOLOGICAL ACTIVITY OF COMPOUNDS ISOLATED FROM *D. scandens*

4.1 Radical scavenging activity

Eight isoflavones: **12**, **13**, **23**, **24**, **26**, **29**, **34**, and **38** showed radical scavenging activity 18.42, 81.58, 10.53, 13.16, 26.32, 15.79, 86.84, and 63.16% scavenging of DPPH, respectively (Mahabusarakam et al., 2004). Isoflavone **26** displayed antioxidation activity with IC_{50} 0.06 μM by thiobarbituric acid (TBA) test (Laupattarakasem et al., 2004).

4.2 Antimicrobial activity

Seven isoflavones exhibited antibacterial activity against *S. aureus* ATCC 25923 and MRSA SK1 (**12**: MICs 128 and 16 μg/mL, **13**: MICs 16 and 4 μg/mL, **23** and **38**: MICs >256 and >256 μg/mL, **24**: MICs >128 and >128 μg/mL, **26**: MICs 2 and 4 μg/mL, **34**: MICs 128 and 2 μg/mL) (Mahabusarakam et al., 2004). Two coumarins, **8** and **9** showed antibacterial activity against *Bacillus megaterium* (IZ 14+PI 16 and PI 8 mm) and *Escherichia coli* (IZ 8+PI 10 and IZ 9+PI 11 mm), antifungal against *Microbotryum violaceum* (PI 9 and PI 8 mm), and antialgal against *B. megaterium* (IZ 8.5 and IZ 7 mm) (Hussain et al., 2015).

4.3 Hypertensive activity

Five compounds: **12**, **13**, **34**, **37**, and **38** showed hypertensive activity increase in MAP at 4.0 mg/kg in 11.67, 7.5, 21.7, 20.0, and 9.17 mmHg, respectively. Whereas, **35** showed hypertensive activity increase in MAP at 0.4 mg/kg in 11.67 mmHg (Mahabusarakam et al., 2004).

4.4 Antidermatophyte activity

Compounds **13**, **14**, **16**, **17**, **18**, **19**, **27**, **28**, and **38** displayed antidermatophyte activity against *Tricophyton mentagrophytes* with same MIC in range of 500-1000 μg/mL except **15**, **26**, and **40** displayed with MICs 250 μg/mL (Sekine et al., 1999).

4.5 Eicosanoid synthesis inhibition

Compounds **21** and **26** showed eicosanoid synthesis inhibition for COX and 5-LOX inhibition with IC_{50} values of 100, 80 μM and 3, 6 μM, respectively (Laupattarakasem et al., 2004). Moreover, **21** showed inhibition of MPO release with IC_{50} value of 0.22 μM (Laupattarakasem et al., 2004), antifeedant and toxicity activities against *A. janata* larvae with ED_{50} 3.22 μg/cm^2 and LD_{50} 3.29 μg/cm^2, respectively (Sreelatha et al., 2010). **33** showed antifeedant and toxicity activities against *A. janata* larvae with ED_{50} 3.18 μg/cm^2 and LD_{50} 3.54 μg/cm^2, respectively (Sreelatha et al., 2010). **36**, **38**, and **40** showed intestinal α–glucosidase enzyme inhibition with IC_{50} values of 34.74±0.60, 33.83±1.32, and 45.14±1.13 μg/mL, respectively (Rao et al., 2007).

4.6 Anti-tumor activity

Isoflavone **26** sensitizes detachment-induced cell death in human lung cancer cells of pro-survival proteins: protein kinase B (pAKT/AKT), extracellular signal-regulated kinase (pERK/ERK), and antiapoptotic protein B-cell lymphoma 2 (BCL-2) (Ausawasamrit et al., 2015). Compounds **26** and **40** exhibited weak effect on normal mouse fibroblast cell lines L-929 (IC_{50} 37.712±9.802, 34.425±6.456 μM) but significant anti-cancer effects against human breast cancer cell lines: MCF-7 (IC_{50} 12.553±2.751, 11.667±0.626 μM), MDA-MB-231 (IC_{50} 11.630±2.156, 11.767±0.608 μM), and MDA-MB-468 (IC_{50} 15.163±3.621, 12.914±3.809 μM) via cell cycle arrest when compared to colon cancer cell lines SW-620 (IC_{50} 26.510±4.852, 18.331±1.536 μM) (Tedasen et al., 2016). Moreover, Both **26** and **40** showed the induction of apoptosis in breast cancer cell lines (Tedasen et al., 2016).

5. SUMMARY

D. scandens Benth. is one of the medicinal plants and an important source of bioactive compounds. Root and stem are the best source of secondary metabolites. Thirty-four compounds, two benzils, three coumarins, one flavone, 22 isoflavones, three isoflavone glycosides, and three pterocarpans have been isolated and showed interesting pharmacological activities.

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7. REFERENCES

Abdel-Raouf, N., Al-Enazi, N.M., Al-Homaidan, A.A., Ibraheem, I.B.M., Al-Othman, M.R. and Hatamleh, A.A. (2015). Antibacterial β-

amyrin isolated from *Laurencia microcladia*. Arabian Journal of Chemistry 8: 32-37.

Ahamed, B.M.K., Krishna, V., Gowdru, H.B., Rajanaika, H., Kumaraswamy, H.M., Rajshekarappa, S., Dandin, C.J. and Mahadevan, K.M. (2007). Isolation of bactericidal constituents from the stem bark extract of Grewia tiliaefolia Vahl. Res J Med Plant. 1: 72-82.

Ausawasamrit, A., Itthiwarapornkul, N., Chaotham, C., Sukrong, S. and Chanvorachote, P. (2015). Lupalbigenin from *Derris scandens* sensitizes detachment-induced cell death in human lung cancer cells. Anticancer Res. 35: 2827-2834.

Chavalittumrong, P., Chivapat, S., Chuthaputti, A., Rattanajarasroj, S. and Punyamong, S. (1999). Chronic toxicity study of crude extract of *Derris scandens* Benth. Songklanakarin J Sci Technol. 21(4): 425-433.

Chuthaputti, A. and Chavalittumrong, P. (1998). Immunomudulating activity of *Derris scandens* Benth. Thai J Pharm Sci. 22(4): 137-148.

Dhawan, B.N., Patnaik, G.K., Rastogi, R.P., Singh, K.K.S. and Tandon, J.S. (1977). Screening of Indian plants for biological activity VI. Indian J Exp Biol. 15: 208-219.

Dianpeng, L.I., Mingan, O., Jansakul, C. and Chongren, Y. (1999). Two isoflavonoid glycosides from *Derris scandens*. Yaoxue Xuebao 34(1): 43-45.

Faculty of Pharmacy Mahidol University. (1986). Specification of Thai madicinal plants. Aksornsampan Press: Bangkok, Thailand. Vol. 1, pp. 64-68.

Falshaw, C.P., Harmer, R.A., Oills, W.D. and Wheeler, R.E. (1969). Natural occurrence of 3-aryl-4-hydroxycoumarins. Part II. Phyto-chemical examination of *Derris scandens* (Roxb.) Benth. J Chem Soc C. 3: 374-382.

Gupta, P., Balwani, S., Kumar, S., Aggarwal, N., Rossi, M., Paumier, S., Caruso, F., Bovicelli, P., Saso, L., DePass, A.L., Prasad, A.K., Parmar, V.S. and Ghosh, B. (2010). β-Sitosterol among other secondary metabolites of *Piper galeatum* shows inhibition of TNFα-induced cell adhesion molecule expression on human endothelial cells. Biochimie 92: 1213-1221.

Hussain, H., Al-Harrasi, A., Krohn, K., Kouam, S.F., Abbas, G., Shah, A., Raees, M.A., Ullah, R., Aziz, S. and Schulz, B. (2015). Phytochemical investigation and antimicrobial activity of *Derris scandens*. Journal of King Saud University – Science 27: 375-378.

Jansakul, C., Srichanbarn, A. and Saelee, A. (1997). Some phamacological studies of a hypotensive fraction from *Derris scandens*. J Sci Soc. Thailand. 23: 323-334.

Jin, K.-S., Oh, Y.N., Hyun, S.K., Kwon, H.J. and Kim, B.W. (2014). Betulinic acid isolated from *Vitis amurensis* root inhibits 3-isobutyl-1-methylxanthine induced melanogenesis *via* the regulation of MEK/ERK and PI3K/Akt pathways in B16F10 cells. Food and Chemical Toxicology 68: 38-43.

Johnson, A.P., Pelter, A. and Stainton, P. (1966). Extractives from *Derris scandens*. Part I. The structure of scandenin and loncho-carpic acid. J Chem Soc C. 2: 192-203.

Kuptniratsaikul, V., Pinthong, T., Bunjob, M., Thanakhumtorn, S., Chinswangwatanakul, P. and Thamlikitkul, V. (2011). Efficacy and safety

of *Derris scandens* Benth. extracts in patients with knee osteoarthritis. The Journal of Alternative and Complementary Medicine 17(2): 147-153.

Laupattarakasem, P., Houghton, P.J. and Hoult, J.R. S. (2004). Anti-inflammatory isoflavonoids from the stems of *Derris scandens*. Planta Med. 70: 496-501.

Laupattarakasem, P., Houghton, P.J., Hoult, J.R.S. and Itharat, A. (2003). An evaluation of the activity related to inflammation of four plants used in Thailand to treat arthritis. Journal of Ethnopharmacology 85: 207-215.

Mahabusarakam, W., Deachathai, S., Phongpaichit, S., Jansakul, C. and Taylor, W.C. (2004). A benzil and isoflavone derivatives from *Derris scandens* Benth. Phytochemistry 65: 1185-1191.

Merril, E.D. (1968). A flora of manila. New York: Wheldon & Wesley, Ltd. Vol. LXVI, pp. 248.

Muanwongyathi, P. and Supatwanich, P. (1981). Pharmacognostic study of *Derris scandens* Benth. MU. J Pharm. 8: 57-64.

Palter, A. and Stainton, P. (1966). The extractives from *Derris scandens*. Part II. The isolation of osajin and two new isoflavones, scandenone and scandinone. J Chem Soc C. 7: 701-704.

Rao, M.N., Krupadanam, G.L.D. and Srimannarayana, G. (1994). Four isoflavones and two 3-aryl coumarins from stems of *Derris scandens*. Phytochemistry 37: 267-269.

Rao, S.A., Srinivas, P.V., Tiwari, A.K., Vanka, U.M.S., Rao, R.V.S., Dasari, K.R. and Rao, M.J. (2007). Isolation, characterization and chemobiological quantification of α–glucosidase enzyme inhibitory and free radical scavenging constituents from *Derris scandens*. J Chromatogr B. 855: 166-172.

Rukachaisirikul, V., Sukpondma, Y., Jansakul, C. and Taylor, W.C. (2002). Isoflavone glycosides from *Derris scandens*. Phytochemistry 60: 827-834.

Saleem, M. (2009). Lupeol, a novel anti-inflammatory and anti-cancer dietary triterpene. Cancer Letters 285: 109-115.

Sekine, T., Inagaki, M., Ikegami, F., Fujii, Y. and Ruangrungsi, N. (1999). Six diprenylisoflavones, derrisisoflavones A-F, from *Derris scandens*. Phytochemistry 52: 87-94.

Sengupta, P., Das, P.B. and Saha, S.K. (1971). Triterpenes from *Derris scandens*. J Indian Chem Soc. 48(1): 95-96.

Siddique, H.R. and Saleem, M. (2011). Beneficial health effects of lupeol triterpene: A review of preclinical studies. Life Sciences 88: 285-293.

Sittiwet, C. and Puangpronpitag, D. (2009). Antimicrobial activity of *Derris scandens* aqueous extract. J Biol Sci. 9: 607-611.

Sreelatha, T., Hymavathi, A., Rao, V.R.S., Devanand, P., Rani, P.U., Rao, J.M. and Babu, K.S. (2010). A new benzyl derivative from *Derris scandens*: Structure-insecticidal activity study. Bioorg Med Chem Lett. 20: 549-553.

Sriraman, S., Ramanujam, G.M., Ramasamy, M. and Dubey, G.P. (2015). Identification of beta-sitosterol and stigmasterol in *Bambusa bambos* (L.) Voss leaf extract using HPLC and its estrogenic effect *in vitro*. Journal of Pharmaceutical and Biomedical Analysis 115: 55-61.

Sriwanthana, B. and Chavalittumrong, P. (2001). In vitro effect of *Derris scandens* on normal lymphocyte proliferation and its activities on natural killer cells in normals and HIV-1

infected patients. Journal of Ethnopharmacology 76: 125-129.

Sunil, C., Irudayaraj, S.S., Duraipandiyan, V., Al-Dhabi, N.A., Agastian, P., Ignacimuthu, S. (2014). Antioxidant and free radical scavenging effects of β–amyrin isolated from *S. cochinchinensis* Moore. leaves. Industrial Crops and Products 61: 510-516.

Suwannaroj, N., Karnchanapoom, T., Ryoji, K. and Yamazaki, K. (2000). Isoflavone glycosides from *Derris scandens* Bentham stem. In: The fifth joint seminar natural medicines; 15-17 November 2000. Bangkok, Thailand. 121.

Tedasen, A., Sukrong, S., Sritularak, B., Srisawat, T. and Graidist, P. (2016). 5,7,4′-Trihydroxy-6,8-diprenylisoflavone and lupalbigenin, active components of *Derris scandens*, induce cell death on breast cancer cell lines. Biomedicine & Pharmacotherapy 81: 235-241.

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