CHAPTER II

HISTORICAL

1. Chemical Constituents of *Pachyrrhizus* spp.

A number of compounds have been isolated from the only one species, *Pachyrrhizus erosus.* Various classes of flavonoids were identified including coumarin, coumaronochromene, coumestan, flavonoid glycoside, isoflavanones, isoflavone, pterocarpan and rotenoids (**Table 1**).

Table 1 Distribution of Chemical Constituents in *Pachyrrhizus erosus*

Chemical constituent	Category	Plant part	Reference
Daidzin [**1**]	Isoflavone glycoside	Seed	Yahara *et al.*, 1994
Dehydroneotenone [**2**]	Isoflavone	Seed	Krishnamurti and Seshadri, 1966
Dehydropachyrrhizone [**3**]	Rotenoid	Seed	Krishnamurti, Sambhy and Seshadri, 1970
(+)-Dolineone [**4**]	Rotenoid	Seed	Krishnamurti and Seshadri, 1966
Erosenone [**5**]	Isoflavanone	Seed	Kalra, Krishnamurti and Nath, 1977
Erosnin [**6**]	Coumestan	Seed	Krishnamurti and Seshadri, 1966
(+)-Erosone [**7**]	Rotenoid	Seed	Krishnamurti and Seshadri, 1966
(+)-12a-Hydroxydolineone[**8**]	Rotenoid	Seed	Krishnamurti, Sambhy and Seshadri, 1970

Table 1 (continued)

Chemical constituent	Category	Plant part	Reference
(+)-12a-Hydroxyerosone [**9**]	Rotenoid	Seed	Kalra, Krishnamurti and Nath, 1977
(+)-12a-Hydroxy-munduserone [**10**]	Rotenoid	Seed	Kalra, Krishnamurti and Nath, 1977
(+)-12a-Hydroxy-pachyrrhizone [**11**]	Rotenoid	Seed	Krishnamurti, Sambhy and Seshadri, 1970
(-)-12a-Hydroxyrotenone [**12**]	Rotenoid	Seed	Kalra, Krishnamurti and Nath, 1977
(+)-Munduserone [**13**]	Rotenoid	Seed	Kardono *et al.*, 1990
Neodulin [**14**]	Pterocarpan	Seed	Crombie and Whiting, 1963
Neotenone [**15**]	Isoflavanone	Seed	Krishnamurti and Seshadri, 1966
Pachyrrhisomene [**16**]	Coumaronochromene	Seed	Kardono *et al.*, 1990
Pachyrrhizin [**17**]	3-Arylcoumarin	Seed	Krishnamurti and Seshadri, 1966
(+)-Pachyrrhizone [**18**]	Rotenoid	Seed	Krishnamurti and Seshadri, 1966
(-)-Rotenone [**19**]	Rotenoid	Seed	Krishnamurti and Seshadri, 1966
(+)-Abrine [**20**]	Miscellany (Amino acid)	Seed	Yahara *et al.*, 1994
Kaikasaponin III [**21**]	Miscellany (Saponin)	Seed	Yahara *et al.*, 1994

2. Chemical Constituents of *Millettia* spp.

A number of chemical constituents of the genus *Millettia* can be classified as flavonoids in various classes and some miscellaneous substances (**Tables 2-3**).

Table 2 Distribution of Flavonoids in *Millettia*

Plant and compound	Class	Plant part	Reference
Millettia auriculata			
Auricularin [**22**]	Isoflavone	Root	Rao, Prasad and Ganapaty, 1992
Auriculasin [**23**]	Isoflavone	Leaf	Minhaj *et al.*, 1976
Auriculatin [**24**]	Isoflavone	Root	Shabbir *et al.*, 1968
Auriculin [**25**]	Isoflavone	Root	Shabbir and Zaman, 1970
Aurmillone [**26**]	Isoflavone	Seed	Raju and Srimannarayana, 1978
2'-Deoxyisoauriculatin [**27**]	Isoflavone	Root	Rao, Prasad and Ganapaty, 1992
Isoauriculasin [**28**]	Isoflavone	Leaf	Minhaj *et al.*, 1976
Isoauriculatin [**29**]	Isoflavone	Root	Shabbir and Zaman, 1970
Isoaurmillone [**30**]	Isoflavone	Pod	Gupta *et al.*, 1983
2'-O-Methylisoauriculatin [**31**]	Isoflavone	Root	Rao, Prasad and Ganapaty, 1992
Millettin [**32**]	Isoflavone	Seed	Raju *et al.*, 1981
Scandenone [**33**]	Isoflavone	Root	Rao, Prasad and Ganapaty, 1992
(-)-Sumatrol [**34**]	Rotenoid	Root	Shabbir *et al.*, 1968
		Seed	Rao, Prasad and Ganapaty, 1992

Table 2 (continued)

Plant and compound	Class	Plant part	Reference
Millettia conraui			
Conrauinone A [**35**]	Isoflavone	Stem bark	Fuendjiep *et al.*, 1998a
Conrauinone B [**36**]	Isoflavone	Stem bark	Fuendjiep *et al.*, 1998a
Conrauinone C [**37**]	Isoflavone	Stem bark	Fuendjiep *et al.*, 1998b
Conrauinone D [**38**]	Isoflavone	Stem bark	Fuendjiep *et al.*, 1998b
7-Hydroxy-6-methoxy-3',4'-methylenedioxyisoflavone [**39**]	Isoflavone	Stem bark	Fuendjiep *et al.*, 1998b
5-Methoxydurmillone [**40**]	Isoflavone	Stem bark	Fuendjiep *et al.*, 1998a
Millettia dura			
Calopogonium isoflavone A [**41**]	Isoflavone	Stem bark	Yenesew, Midiwo and Waterman, 1996
6a,12a-Dehydrodeguelin [**42**]	Rotenoid	Seed	Ollis, Rhodes and Sutherland, 1967
Deguelin [**43**]	Rotenoid	Seed	Dange, Mammo and Bekele, 1991
6-Demethyldurallone [**44**]	Isoflavone	Seed pod	Yenesew, Midiwo and Waterman, 1996
7,2'-Dimeyhoxy-4',5'-methylenedioxyisoflavone [**45**]	Isoflavone	Stem bark Root bark	Dange, Mammo and Bekele, 1991
Durallone [**46**]	Isoflavone	Seed pod	Yenesew, Midiwo and Waterman, 1996
Durlettone [**47**]	Isoflavone	Seed	Ollis, Rhodes and Sutherland, 1967
Durmillone [**48**]	Isoflavone	Seed	Ollis, Rhodes and Sutherland, 1967
		Stem bark	Yenesew, Midiwo and Waterman, 1996
Ferrugone [**49**]	Isoflavone	Seed pod	Yenesew, Midiwo and Waterman, 1997

Table 2 (continued)

Plant and compound	Class	Plant part	Reference
Formononetin [**50**]	Isoflavone	Seed pod	Yenesew, Midiwo and Waterman, 1997
4-Hydroxyderricin [**51**]	Chalcone	Stem bark Root bark	Dange, Mammo and Bekele, 1991
4-Hydroxylonchocarpin [**52**]	Chalcone	Stem bark Root bark	Dange, Mammo and Bekele, 1991
Isoerythrin-A 4'-(3-methylbut -2-enyl) ether [**53**]	Isoflavone	Seed pod	Yenesew, Midiwo and Waterman, 1996
Jamaicin [**54**]	Isoflavone	Seed pod	Yenesew, Midiwo and Waterman, 1997
Maximaisoflavone B [**55**]	Isoflavone	Stem bark Root bark	Dange, Mammo and Bekele, 1991
Maximaisoflavone D [**56**]	Isoflavone	Stem bark	Yenesew, Midiwo and Waterman, 1996
Maximaisoflavone H [**57**]	Isoflavone	Stem bark	Yenesew, Midiwo and Waterman, 1996
6-Methoxycalopogonium isoflavone A [**58**]	Isoflavone	Seed pod	Yenesew, Midiwo and Waterman, 1997
Milldurone [**59**]	Isoflavone	Seed	Ollis, Rhodes and Sutherland, 1967
(-)-Millettone [**60**]	Isoflavone	Seed	Ollis, Rhodes and Sutherland, 1967
		Seed pod	Yenesew, Midiwo and Waterman, 1997
(-)-Millettosin [**61**]	Isoflavone	Seed	Ollis, Rhodes and Sutherland, 1967
Predurallone [**62**]	Isoflavone	Seed pod	Yenesew, Midiwo and Waterman, 1996
(-)-Rotenone [**19**]	Rotenoid	Seed	Ollis, Rhodes and Sutherland, 1967

Table 2 (continued)

Plant and compound	Class	Plant part	Reference
(-)-Tephrosin [**63**]	Rotenoid	Seed Seed pod	Ollis, Rhodes and Sutherland, 1967 Yenesew, Midiwo and Waterman, 1997
Millettia erythrocalyx			
Derricidin [**64**]	Chalcone	Stem bark	Sritularak *et al.*, 2002
7-γ,γ-Dimethylallyloxyflavanone [**65**]	Flavanone	Stem bark	Sritularak *et al.*, 2002
2'-Hydroxy-3,4-methylenedioxy-4'-γ,γ-dimethylallyloxychalcone [**66**]	Chalcone	Stem bark	Sritularak *et al.*, 2002
3',4'-Methylenedioxy-6,7-dimethoxyflavone (Milletenin C) [**67**]	Flavone	Stem bark	Sritularak *et al.*, 2002
3',4'-Methylenedioxy-7-methoxy flavone [**68**]	Flavone	Stem bark	Sritularak *et al.*, 2002
Milletenone [**69**]	Chalcone	Stem bark	Sritularak *et al.*, 2002
Millettocalyxin A [**70**]	Flavone	Stem bark	Sritularak *et al.*, 2002
Millettocalyxin B [**71**]	Flavone	Stem bark	Sritularak *et al.*, 2002
Millettocalyxin C [**72**]	Flavone	Stem bark	Sritularak *et al.*, 2002
Ovalifolin [**73**]	Flavone	Stem bark	Sritularak *et al.*, 2002
Pongaglabrone [**74**]	Flavone	Stem bark	Sritularak *et al.*, 2002
Ponganone I [**75**]	Chalcone	Stem bark	Sritularak *et al.*, 2002
Pongal methyl ether [**76**]	Flavone	Stem bark	Sritularak *et al.*, 2002
Prunetin [**77**]	Isoflavone	Stem bark	Sritularak *et al.*, 2002

Table 2 (continued)

Plant and compound	Class	Plant part	Reference
Millettia ferruginea			
Deguelin [**43**]	Rotenoid	Seed	Highet and Highet, 1967
Durmillone [**48**]	Isoflavone	Seed	Highet and Highet, 1967
Ferrugone [**49**]	Isoflavone	Seed	Highet and Highet, 1967
(-)-Rotenone [**19**]	Rotenoid	Seed	Highet and Highet, 1967
Millettia ferruginea subsp. *darassana*			
Barbigerone [**78**]	Isoflavone	Seed	Dagne and Bekele, 1990
Calopogonium isoflavone A [**41**]	Isoflavone	Seed	Dagne and Bekele, 1990
Durmillone [**48**]	Isoflavone	Seed pod	Dagne, Bekele and Waterman, 1989
		Seed	Dagne and Bekele, 1990
Ferrugone [**49**]	Isoflavone	Stem bark	Dagne, Bekele and Waterman, 1989
		Seed	Dagne and Bekele, 1990
Flemichapparin B [**79**]	Pterocarpene	Stem bark	Dagne, Bekele and Waterman, 1989
7-Hydroxy-5,6-dimethoxy-3',4'-methylenedioxyisoflavone [**80**]	Isoflavone	Stem bark	Dagne, Bekele and Waterman, 1989
(-)-12a-Hydroxyrotenone [**12**]	Rotenoid	Seed	Dagne and Bekele, 1990
Ichthynone [**81**]	Isoflavone	Stem bark	Dagne, Bekele and Waterman, 1989
Jamaicin [**54**]	Isoflavone	Stem bark	Dagne, Bekele and Waterman, 1989
5-Methoxydurmillone [**40**]	Isoflavone	Stem bark	Dagne, Bekele and Waterman, 1989
Predurmillone [**82**]	Isoflavone	Seed	Dagne and Bekele, 1990
Prefurrugone [**83**]	Isoflavone	Seed	Dagne and Bekele, 1990
(-)-Tephrosin [**63**]	Rotenoid	Seed	Dagne and Bekele, 1990

Table 2 (continued)

Plant and compound	Class	Plant part	Reference
Millettia ferruginea			
subsp. Ferruginea			
Barbigerone [**78**]	Isoflavone	Seed	Dagne and Bekele, 1990
Calopogonium isoflavone A [**41**]	Isoflavone	Seed	Dagne and Bekele, 1990
Calopogonium isoflavone B [**84**]	Isoflavone	Stem bark	Dagne and Bekele, 1990
Durmillone [**48**]	Isoflavone	Seed	Dagne and Bekele, 1990
Ferrugone [**49**]	Isoflavone	Seed	Dagne and Bekele, 1990
		Root bark	Dagne *et al.*, 1990
7-*O*-Geranylformononetin [**85**]	Isoflavone	Root bark	Dagne *et al.*, 1990
4'-*O*-Geranylisoliquiritigenin [**86**]	Chalcone	Root bark	Dagne *et al.*, 1990
4'-Hydroxyisolonchocarpin [**87**]	Flavanone	Stem bark	Dagne, Bekele and Waterman, 1989
4-Hydroxylonchocarpin [**52**]	Chalcone	Stem bark	Dagne, Bekele and Waterman, 1989
Isojamaicin [**88**]	Isoflavone	Stem bark	Dagne, Bekele and Waterman, 1989
Jamaicin [**54**]	Isoflavone	Stem bark	Dagne, Bekele and Waterman, 1989
		Root bark	Dagne *et al.*, 1990
5-Methoxydurmillone [**40**]	Isoflavone	Stem bark	Dagne, Bekele and Waterman, 1989
		Root bark	Dagne *et al.*, 1990
Nordurlettone [**89**]	Isoflavone	Seed	Dagne *et al.*, 1990
Prebarbigerone [**90**]	Isoflavone	Seed	Dagne and Bekele, 1990
Pre-5-methoxydurmillone [**91**]	Isoflavone	Root bark	Dagne and Bekele, 1990
(-)-Rotenone [**19**]	Rotenoid	Seed	Dagne and Bekele, 1990

Table 2 (continued)

Plant and compound	Class	Plant part	Reference
Millettia griffoniana			
Calopogonium isoflavone B [**84**]	Isoflavone	Root bark	Yankep, Fomum and Dagne, 1997
3',4'-Dihydroxy-7-*O*-[(*E*)-3,7-dimethyl-2,6-octadienyl]isoflavone [**92**]	Isoflavone	Root bark	Yankep *et al.*, 1998
7,2'-Dimethoxy-4',5'-methylenedioxy isoflavone [**45**]	Isoflavone	Root bark	Yankep, Fomum and Dagne, 1997
Durmillone [**48**]	Isoflavone	Root bark	Yankep, Fomum and Dagne, 1997
7-*O*-Geranylformononetin [**85**]	Isoflavone	Root bark	Yankep, Fomum and Dagne, 1997
4'-*O*-Geranylisoliquiritigenin [**86**]	Chalcone	Root bark	Yankep, Fomum and Dagne, 1997
7-*O*-Geranylpseudobaptigenin [**93**]	Isoflavone	Root bark	Yankep, Fomum and Dagne, 1997
Griffonianone A [**94**]	Rotenoid	Root bark	Yankep *et al.*, 2001
Griffonianone B [**95**]	Isoflavone	Root bark	Yankep *et al.*, 2001
Griffonianone C [**96**]	Isoflavone	Root bark	Yankep *et al.*, 2001
7-Hydroxy-6-methoxy-3',4'-methylenedioxyisoflavone [**39**]	Isoflavone	Root bark	Yankep *et al.*, 2001
4-Hydroxy-5,6,7-trimethoxy-3-(3,4-methylenedioxy)phenylcoumarin [**97**]	3-Aryl coumarin	Root bark	Yankep *et al.*, 1998
Jamaicin [**54**]	Isoflavone	Root bark	Yankep, Fomum and Dagne, 1997
Maximaisoflavone G [**98**]	Isoflavone	Root bark	Yankep *et al.*, 2001
4'-Methoxy-7-*O*-[(*E*)-3-methyl-7-hydroxymethyl-2,6-octadienyl] isoflavone [**99**]	Isoflavone	Root bark	Yankep *et al.*, 1998

Table 2 (continued)

Plant and compound	Class	Plant part	Reference
Odorantin [**100**]	Isoflavone	Root bark	Yankep, Fomum and Dagne, 1997
Millettia hemsleyana			
Dihydroisomilletenone methyl ether [**101**]	Chalcone	Stem bark	Mahmoud and Waterman, 1985
Dihydromilletenone methyl ether [**102**]	Chalcone	Stem bark	Mahmoud and Waterman, 1985
Lanceolatin B [**103**]	Flavone	Stem bark	Mahmoud and Waterman, 1985
3',4'-Methylenedioxy-7-methoxy flavone [**68**]	Flavone	Stem bark	Mahmoud and Waterman, 1985
Milletenone [**69**]	Chalcone	Stem bark	Mahmoud and Waterman, 1985
Pongaflavone [**104**]	Flavone	Stem bark	Mahmoud and Waterman, 1985
Millettia ichthyochtona			
3,6-Dimethoxyfurano[4",5":8,7] flavone [**105**]	Flavone	Leaf	Kamperdick *et al.*, 1998
Jamaicin [**54**]	Isoflavone	Leaf	Kamperdick *et al.*, 1998
2',4',5'-Trimethoxy-2",2"-dimethyl pyrano[5",6":6,7]isoflavone [**106**]	Isoflavone	Leaf	Kamperdick *et al.*, 1998
Millettia laurentii			
Calycosin [**107**]	Isoflavone	Wood	Kamnaing *et al.*, 1999
Glyricidin [**108**]	Isoflavone	Wood	Kamnaing *et al.*, 1999
Laurentinol [**109**]	Flavonol	Wood	Kamnaing *et al.*, 1999
Laurentiquinone [**110**]	Isoflavan	Wood	Kamnaing *et al.*, 1999

Table 2 (continued)

Plant and compound	Class	Plant part	Reference
Millettia ovalifolia			
1-(4-Hydroxy-5-benzofuranyl)-3-phenyl-2-propen-1-one [**111**]	Chalcone	Root	Saxena *et al.*, 1987
7-Hydroxy-6,8-di-C-prenylflavanone (Ovaliflavanone A) [**112**]	Flavanone	Seed	Gupta and Krishnamurti, 1976a
7-Hydroxy-8-C-prenylflavanone (Ovaliflavanone B) [**113**]	Flavanone	Seed	Gupta and Krishnamurti, 1976a
Kanjone[**114**]	Flavone	Seed	Gupta and Krishnamurti, 1976a
Karanjin [**115**]	Flavone	Seed	Gupta and Krishnamurti, 1976a
Lanceolatin B [**103**]	Flavone	Seed	Gupta and Krishnamurti, 1976a
Milletenin A [**116**]	Flavanone	Leaf	Khan and Zaman, 1974
Milletenin B [**117**]	Flavanone	Leaf	Khan and Zaman, 1974
Milletenin C [**67**]	Flavone	Leaf	Khan and Zaman, 1974
Milletenone [**69**]	Chalcone	Leaf	Khan and Zaman, 1974
Ovalichalcone [**118**]	Chalcone	Seed	Gupta and Krishnamurti, 1977a
Ovalichromene [**119**]	Flavanone	Seed	Gupta and Krishnamurti, 1976b
Ovalichromene A [**120**]	Flavanone	Seed	Gupta and Krishnamurti, 1976c
Ovalichromene B [**121**]	Flavanone	Seed	Gupta and Krishnamurti, 1976c
Ovaliflavanone C [**122**]	Flavanone	Seed	Islam, Gupta and Krishnamurti, 1980

Table 2 (continued)

Plant and compound	Class	Plant part	Reference
Ovaliflavanone D [**123**]	Flavanone	Seed	Islam, Gupta and Krishnamurti, 1980
Ovalifolin [**73**]	Flavone	Leaf	Khan and Zaman, 1974
Ovalitenin A [**124**]	Chalcone	Seed	Gupta and Krishnamurti, 1977b
Ovalitenin B [**125**]	Chalcone	Seed	Gupta and Krishnamurti, 1976c
Ovalitenin C [**126**]	Chalcone	Seed	Islam, Gupta and Krishnamurti, 1980
Ovalitenone [**127**]	Dibenzoyl-methane	Seed	Gupta and Krishnamurti, 1977b
Pongachalcone I [**128**]	Chalcone	Seed	Gupta and Krishnamurti, 1976c
Pongaglabrone [**74**]	Flavone	Seed	Gupta and Krishnamurti, 1976a
Pongamol [**129**]	Chalcone	Seed	Gupta and Krishnamurti, 1976b
Pongapin [**130**]	Flavone	Seed	Gupta and Krishnamurti, 1976b
Millettia pachycarpa			
Chalcone [**131**]	Chalcone	Seed	Singhal *et al.*, 1983
5-Hydroxy-4'-methoxy-6",6"-dimethylpyrano(2",3":7,8) isoflavone[**132**]	Isoflavone	Seed	Singhal *et al.*, 1983
(-)-12a-Hydroxyrotenone [**12**]	Rotenoid	Root	Singhal *et al.*, 1982
(+)-12a-Hydroxyrot-2'-enonic acid [**133**]	Rotenoid	Root	Singhal *et al.*, 1982
Isoflavone [**134**]	Isoflavone	Leaf	Singhal *et al.*, 1981
Isoflavone [**135**]	Isoflavone	Leaf	Singhal *et al.*, 1981

Table 2 (continued)

Plant and compound	Class	Plant part	Reference
Isoflavone [**136**]	Isoflavone	Leaf	Singhal *et al.*, 1982
Isoflavone [**137**]	Isoflavone	Leaf	Singhal *et al.*, 1982
Isoflavone [**138**]	Isoflavone	Seed	Singhal *et al.*, 1983
Isolonchocarpin [**139**]	Flavanone	Root	Shao *et al.*, 2001a
Lupinifolol [**140**]	Flavanonol	Aerial part	Singhal *et al.*, 1980
5-Methoxykaranjin [**141**]	Flavone	Root	Lu *et al.*, 1999
Pachycarin A [**142**]	Flavone	Root	Chen *et al.*, 1999
Pachycarin B [**143**]	Flavone	Root	Chen *et al.*, 1999
Pachycarin C [**144**]	Flavone	Root	Shao *et al.*, 2001b
Pachycarin D [**145**]	Flavone	Root	Shao *et al.*, 2001b
Pachycarin E [**146**]	Flavone	Root	Shao *et al.*, 2001b
Pinnatin [**147**]	Flavone	Root	Shao *et al.*, 2001a
Pomiferin [**148**]	Isoflavone	Seed	Singhal *et al.*, 1983
Pongaflavone [**104**]	Flavone	Root	Shao *et al.*, 2001a
(-)-Rotenone [**19**]	Rotenoid	Root	Singhal *et al.*, 1982
Rot-2'-enonic acid [**149**]	Rotenoid	Root	Singhal *et al.*, 1982
5,7,3',4'-Tetrahydroxy-6,8-	Isoflavone	Aerial part	Singhal *et al.*, 1980
diprenylisoflavone [**150**]		Seed	Singhal *et al.*, 1983
5,7,4'-Trihydroxy-6,8-diprenyl	Isoflavone	Aerial part	Singhal *et al.*, 1980
isoflavone [**151**]		Seed	Singhal *et al.*, 1983
5,7,4'-Trihydroxy-6,3'-diprenyl	Isoflavone	Aerial part	Singhal *et al.*, 1980
isoflavone [**152**]			
Millettia peguensis			
Kanjone [**114**]	Flavone	Stem bark	Ganapaty *et al.*, 1998
Lanceolatin B [**103**]	Flavone	Stem bark	Ganapaty *et al.*, 1998
Milletenone [**69**]	Chalcone	Stem bark	Ganapaty *et al.*, 1998
Ovaliflavanone A [**112**]	Flavanone	Srem bark	Ganapaty *et al.*, 1998
Ovalitenone [**127**]	Dibenzoyl	Stem bark	Ganapaty *et al.*, 1998
	Methane		
Pongaglabol [**153**]	Flavone	Leaf	Ganapaty *et al.*, 1998

Table 2 (continued)

Plant and compound	Class	Plant part	Reference
Pongamol [**129**]	Chalcone	Leaf	Ganapaty *et al.*, 1998
Millettia pendura			
Claussequinone [**154**]	Isoflavan	Heart wood	Hayashi *et al.*, 1978
Equol [**155**]	Isoflavan	Heart wood	Hayashi *et al.*, 1978
(-)-Maackiain [**156**]	Pterocarpan	Heart wood	Hayashi *et al.*, 1978
Pendulone [**157**]	Isoflavan	Heart wood	Hayashi *et al.*, 1978
Millettia pervilleana			
3'-*O*-Demthylpervilleanone [**158**]	Isoflavanone	Root bark	Galeffi *et al.*, 1997
Emoroidocarpan [**159**]	Pterocarpan	Root bark	Palazzino *et al.*,2003
3α-Hydroxyrotenone [**160**]	Rotenoid	Root bark	Palazzino *et al.*,2003
Pervilleanine [**161**]	3-Aryl coumarin	Root bark	Palazzino *et al.*,2003
Pervilleanone [**162**]	Isoflavanone	Root bark	Galeffi *et al.*, 1997
Pervilline [**163**]	Pterocarpan	Root bark	Palazzino *et al.*,2003
Pervillinine [**164**]	Pterocarpan	Root bark	Palazzino *et al.*,2003
(-)-Rotenone [**19**]	Rotenoid	Root bark	Palazzino *et al.*,2003
Millettia pulchra			
7,4'-Dihydroxy-8,3',5'-triprenyldihydroflavanol [**165**]	Flavanonol	Aerial part	Baruah *et al.*, 1984
(-)-Maackiain [**156**]	Pterocarpan	Aerial part	Baruah *et al.*, 1984
6α-Methoxyhomopterocarpin [**166**]	Pterocarpan	Aerial part	Baruah *et al.*, 1984
6α-Methoxypterocarpin [**167**]	Pterocarpan	Aerial part	Baruah *et al.*, 1984
5,7,2',4'-Tetrahydroxy-6,3'-diprenylisoflavone [**168**]	Isoflavone	Aerial part	Baruah *et al.*, 1984
5,7,4'-Trihydroxy-2'-methoxy-6,3'-diprenylisoflavone [**169**]	Isoflavone	Aerial part	Baruah *et al.*, 1984

Table 2 (continued)

Plant and compound	Class	Plant part	Reference
5,7,4'-Trihydroxy-8,3',5'-triprenyl flavanone [**170**]	Flavanone	Aerial part	Baruah *et al.*, 1984
(-)-Pterocarpin [**171**]	Pterocarpan	Aerial part	Baruah *et al.*, 1984
(-)-Sophoranone [**172**]	Flavanone	Aerial part	Baruah *et al.*, 1984
Millettia racemosa			
(+)-Cyclomillinol [**173**]	Isoflavan	Stem	Kumar, Krupadanam and Srimannarayana, 1989
Demethylvestitol [**174**]	Isoflavan	Stem	Rao, Prashant and Krupadanam, 1996
(-)-Isomillinol B [**175**]	Isoflavan	Stem	Rao and Krupadanam, 1994
Laxifloran [**176**]	Isoflavan	Stem	Rao and Krupadanam, 1994
(+)-Millinol [**177**]	Isoflavan	Stem	Kumar, Krupadanam and Srimannarayana, 1989
(+)-Millinol B [**178**]	Isoflavan	Stem	Kumar, Krupadanam and Srimannarayana, 1989
Millinolol [**179**]	Isoflavan	Stem	Rao, Prashant and Krupadanam, 1996
Neomillinol [**180**]	Isoflavan	Stem	Rao, Prashant and Krupadanam, 1996
Neovestitol [**181**]	Isoflavan	Stem	Rao, Prashant and Krupadanam, 1996
Vestitol [**182**]	Isoflavan	Stem	Rao and Krupadanam, 1994

Table 2 (continued)

Plant and compound	Class	Plant part	Reference
Millettia rubiginosa			
Durmillone [**48**]	Isoflavone	Root	Desai *et al.*, 1977
Ichthynone [**81**]	Isoflavone	Root	Desai *et al.*, 1977
Millettia sanagana			
Kanjone [**114**]	Flavone	Root bark	Mbafor *et al.*, 1995
Lanceolatin B [**103**]	Flavone	Root bark	Mbafor *et al.*, 1995
5-Methoxyfurano[7,8:4",5"]flavone [**141**]	Flavone	Root bark	Mbafor *et al.*, 1995
Pongamol [**129**]	Chalcone	Root bark	Mbafor *et al.*, 1995
Sanaganone [**183**]	Flavone	Root bark	Mbafor *et al.*, 1995
Millettia thonningii			
Alpinumisoflavone [**184**]	Isoflavone	Seed	Olivares *et al.*, 1982
3',5-Dihydroxy-4'-methoxy-2",2"-dimethylpyrano-(5",6";6,7) isoflavone [**185**]	Isoflavone	Seed	Olivares *et al.*, 1982
Dimethylalpinumisoflavone [**186**]	Isoflavone	Seed	Olivares *et al.*, 1982
		Root bark	Asomaning *et al.*, 1995
		Root, Pod	Asomaning *et al.*, 1999
5-*O*-Methylalpinumisoflavone [**187**]	Isoflavone	Root	Asomaning *et al.*, 1999
4'-Methylalpinumisoflavone [**188**]	Isoflavone	Seed	Olivares *et al.*, 1982
5-*O*-Methyl-4'-*O*-(3-methyl-2-butenyl)alpinumisoflavone [**189**]	Isoflavone	Root bark	Asomaning *et al.*, 1995
		Root	Asomaning *et al.*, 1999
Robustic acid [**190**]	3-Aryl coumarin	Seed	Olivares *et al.*, 1982

Table 2 (continued)

Plant and compound	Class	Plant part	Reference
Robustone [**191**]	Isoflavone	Seed	Khalid and Waterman, 1983
Thonningine A [**192**]	3-Aryl coumarin	Seed	Khalid and Waterman, 1983
Thonningine B [**193**]	3-Aryl coumarin	Seed	Khalid and Waterman, 1983
Thonninginisoflavone [**194**]	Isoflavone	Root bark	Asomaning *et al.*, 1995
Millettia usaramensis Subsp. *usaramensis*			
Barbigerone [**78**]	Isoflavone	Stem bark	Yenesew, Midiwo and Waterman, 1998
(+)-12a-Epimillettosin [**195**]	Rotenoid	Stem bark	Yenesew, Midiwo and Waterman, 1998
4'-*O*-Geranylisoliquiritigenin [**86**]	Chalcone	Stem bark	Yenesew, Midiwo and Waterman, 1998
(+)-12α-Hydroxy-12-dihydro usararotenoid A[**196**]	Rotenoid	Stem bark	Yenesew, Midiwo and Waterman, 1998
Isoliquiritigenin [**197**]	Chalcone	Stem bark	Yenesew, Midiwo and Waterman, 1998
Jamaicin [**54**]	Isoflavone	Stem bark	Yenesew, Midiwo and Waterman, 1998
Maximaisoflavone G [**98**]	Isoflavone	Stem bark	Yenesew, Midiwo and Waterman, 1998
Norisojamaicin [**198**]	Isoflavone	Stembark	Yenesew, Midiwo and Waterman, 1998
α,4,2''-Trihydroxy-4-*O*-geranyl dihydrochalcone [**199**]	Chalcone	Stem bark	Yenesew, Midiwo and Waterman, 1998
(+)-Usararotenoid A [**200**]	Rotenoid	Stem bark	Yenesew, Midiwo and Waterman, 1998

Table 2 (continued)

Plant and compound	Class	Plant part	Reference
(+)-Usararotenoid B [**201**]	Rotenoid	Stem bark	Yenesew, Midiwo and Waterman, 1998
Millettia zechiana			
Cyanidin 3,5-diglucoside [**202**]	Glycoside	Flower	Parvez and Ogbeide, 1990
3-Hydroxy-4'-methoxyflavone [**203**]	Flavonol	Flower	Parvez and Ogbeide, 1990
8-Hydroxyquercetin 7-glucoside [**204**]	Glycoside	Flower	Parvez and Ogbeide, 1990
Kaempferol 3-glucoside [**205**]	Glycoside	Flower	Parvez and Ogbeide, 1990
Kaempferol 3-rhamnoside [**206**]	Glycoside	Flower	Parvez and Ogbeide, 1990
Malvidin 3,5-diglucoside [**207**]	Glycoside	Flower	Parvez and Ogbeide, 1990
Pelargonidin 3-rhamnoside [**208**]	Glycoside	Flower	Parvez and Ogbeide, 1990
Quercetin 3-glucoside [**209**]	Glycoside	Flower	Parvez and Ogbeide, 1990

Table 3 Distribution of miscellaneous compounds in *Millettia*

Compound	Category	Source	Reference
O-Acetylmillaurine [**210**]	Alkaloid	*Millettia laurentii* (Seed)	Ngamga, Fanso Free and Fomum, 1993
β-Amyrin [**211**]	Triterpenoid	*M. pendura* (Stem bark)	Rathore, Nagar and Gupta, 1983
		M. racemosa (Stem)	Rao and Krudapanam, 1994
		M. thonningii (Root bark)	Asomaning *et al.*, 1995
Azulene [**212**]	Monoterpenoid	*M. ovalifolia* (Leaf)	Nigam *et al.*, 1982
Behenic acid [**213**]	Fatty acid	*M. racemosa* (Stem)	Rao and Krudapanam, 1994
α-Boneol [**214**]	Monoterpenoid	*M. ovalifolia* (Leaf)	Nigam, *et al.*, 1982
Canavanine [**215**]	Protein	*M. peguensis* (Seed)	Rao, 1983
1,8-Cineol [**216**]	Monoterpenoid	*M. ovalifolia* (Leaf)	Nigam *et al.*, 1982
5a,9a-Dihydro-5a-hydroxymillaurine [**217**]	Alkaloid	*M. laurentii* (Seed)	Ngamga, Fanso Free and Fomum, 1994
2,6-Dimethoxy-*p*-benzoquinone [**218**]	Quinone	*M. laurentii* (Wood)	Ngamga, Fanso Free and Fomum, 1994
Daucosterol [**219**]	Steroid	*M. pendura* (Seed)	Rathore, Nagar and Gupta, 1983
Ellagic acid [**220**]	Coumarin	*M. pendura* (Stem bark)	Rathore, Nagar and Gupta, 1983
Galactose [**221**]	Carbohydrate	*M. pendura* (Stem bark)	Rathore, Nagar and Gupta, 1983

Table 3 (continued)

Compound	Category	Source	Reference
Gallic acid [**222**]	Benzenoid	*M. pendura* (Stem bark)	Rathore, Nagar and Gupta, 1983
4-*O*-geranyl-cinnamylacetate[**223**]	Cinnamic acid derivative	*M. usaramensis* (Stem bark)	Yenesew, Midiwo and Waterman, 1998
Linelyl acetate [**224**]	Monoterpenoid	*M. ovalifolia* (Leaf)	Nigam, *et al.*, 1982
Methyl chavicol [**225**]	Phenylpropanoid	*M. ovalifolia* (Leaf)	Nigam, *et al.*, 1982
β-Methylgalactoside [**226**]	Carbohydrate	*M. pendura* (Stem bark)	Rathore, Nagar and Gupta, 1983
Millaurine [**227**]	Alkaloid	*M. laurentii* (Seed)	Ngamga, Fanso Free and Fomum, 1993
Millettonine [**228**]	Alkaloid	*M. laurentii* (Stem bark)	Kamnaing *et al.*, 1994
Octacosan-1-ol [**229**]	Alcohol	*M. pendura* (Stem bark)	Rathore, Nagar and Gupta, 1983
Oleanolic acid [**230**]	Triterpenoid	*M. pachycarpa* (Root)	Chen *et al.*, 1999
Ovalin [**231**]	Pipecolic acid	*M. ovalifolia* (Seed)	Gupta and Krishnamurti, 1979
19-Oxo-5α-carda-14,20(22)-dienolide-3-*O*-β-D-gluco-pyranoside [**232**]	Cardenolide	*M. ovalifolia* (Root)	Bose and Chakraborty, 2000
Pi-cymene [**233**]	Monoterpenoid	*M. ovalifolia* (Leaf)	Nigam *et al.*, 1982
α-Pinene [**234**]	Monoterpenoid	*M. ovalifolia* (Leaf)	Nigam *et al.*, 1982
β-Pinene [**235**]	Monoterpenoid	*M. ovalifolia* (Leaf)	Nigam *et al.*, 1982

Table 3 (continued)

Compound	Category	Source	Reference
β-Sitosterol [**236**]	Steroid	*M. ovalifolia* (Seed)	Gupta and Krishnamurti, 1976a
		M. pachycarpa (Root)	Chen *et al.*, 1999
		M. pendura (Stem bark)	Rathore, Nagar and Gupta, 1983
		M. racemosa (Stem)	Rao and Krudapanam, 1994
Stigmasterol [**237**]	Steroid	*M. pendura* (Stem bark)	Rathore, Nagar and Gupta, 1983
		M. racemosa (Root)	Desai *et al.*, 1977
α-Terpinolene [**238**]	Monoterpenoid	*M. ovalifolia* (Leaf)	Nigam *et al.*, 1982
α-Thujene [**239**]	Monoterpenoid	*M. ovalifolia* (Leaf)	Nigam *et al.*, 1982

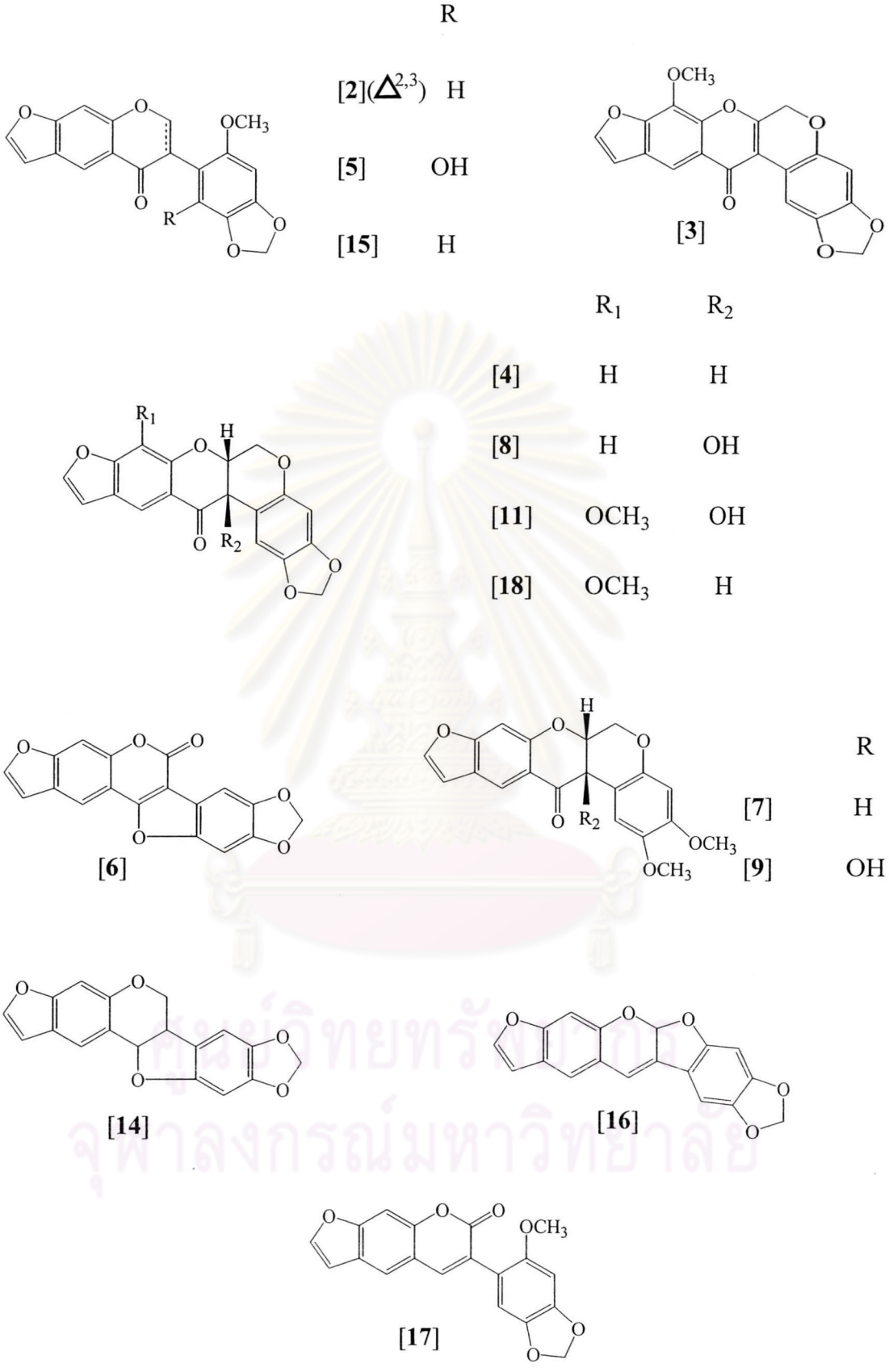
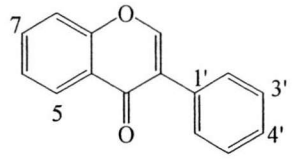


Figure 3 Structures of flavonoids isolated from *Pachyrrhizus erosus*



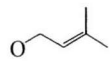
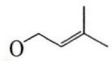
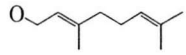
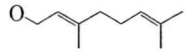
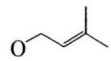
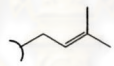
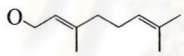
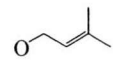
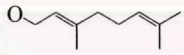
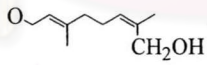
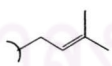
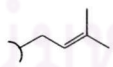
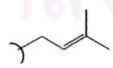
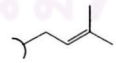
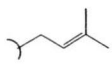
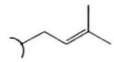
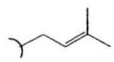
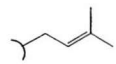
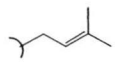
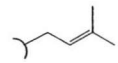
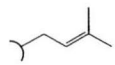
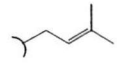
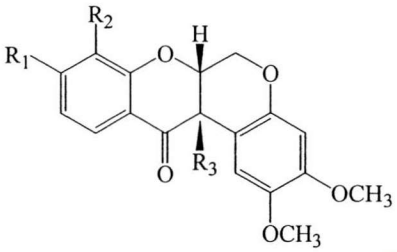
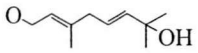
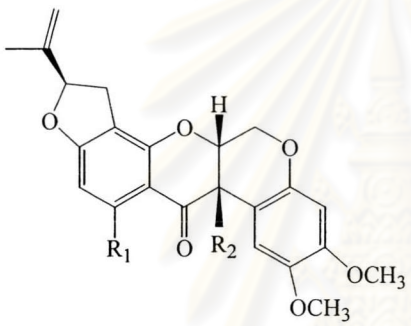
	5	6	7	8	2'	3'	4'	5'
[1]	H	H	O-Glc	H	H	H	OH	H
[26]	OH	H	OH	OCH_3	H	H		H
[30]	OH	OCH_3	OH	H		H	H	H
[37]	OCH_3	H	OH	H	H	H		H
[38]	H	H	OH	H	H	H		H
[47]	H	H	OCH_3	H	H	H		H
[50]	H	H	OH	H	H	H	OCH_3	H
[62]	H	OCH_3	OH		H	OCH_3	OCH_3	H
[77]	OH	H	OCH_3	H	H	H	OH	H
[85]	H	H		H	H	H	OCH_3	H
[89]	H	H	OH	H	H	H		H
[90]	H	H	OCH_3	H	OCH_3	H	OCH_3	OCH_3
[92]	H	H		H	H	OH	OH	H
[99]	H	H		H	H	H	OCH_3	H
[107]	H	H	OH	H	H	OH	OCH_3	H
[108]	H	H	OH	H	H	OH	OCH_3	OH
[138]	OH		OH		H	OH	OCH_3	H
[150]	OH		OH		H	OH	OH	H
[151]	OH		OH		H	H	OH	H
[152]	OH		OH	H	H		OH	H
[168]	OH		OH	H	OH		OH	H
[169]	OH		OH	H	OCH_3		OH	H

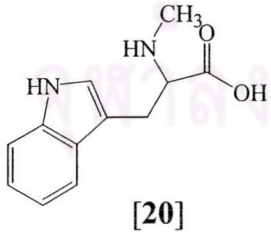
Figure 4 Structures of compounds isolated from *Pachyrrhizus erosus* and *Millettia* spp.



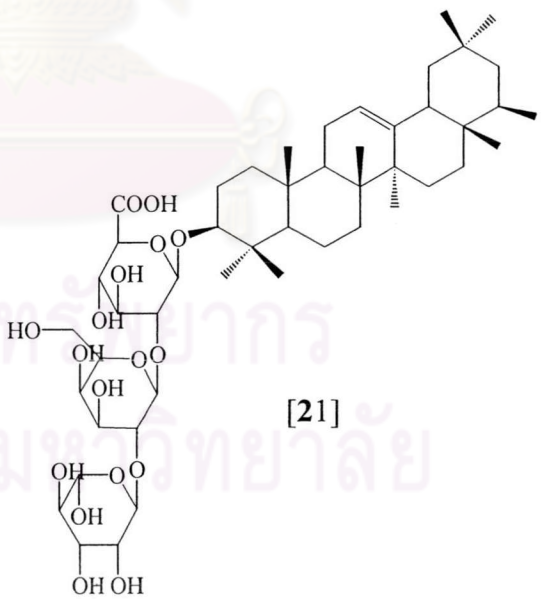
	R_1	R_2	R_3
[**10**]	OCH_3	H	OH
[**13**]	OCH_3	H	H
[**94**]		H	OH
[**133**]	OH		OH
[**149**]	OH		H



	R_1	R_2
[**12**]	H	OH
[**19**]	H	H
[**34**]	OH	H

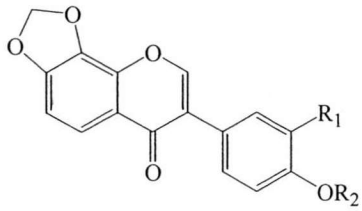


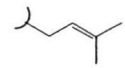
[**20**]

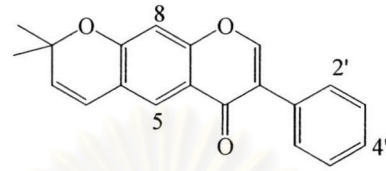


[**21**]

Figure 4 Structures of compounds isolated from *Pachyrrhizus erosus* and *Millettia* spp. (continued)



	R_1	R_2
[22]	H	
[56]	OCH_3	CH_3
[57]	H	CH_3



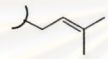
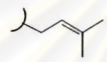
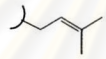
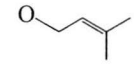
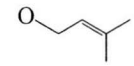
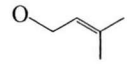
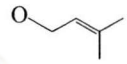
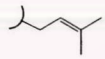
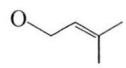
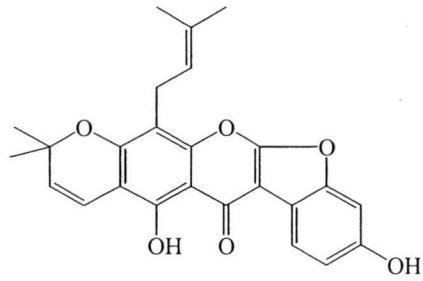
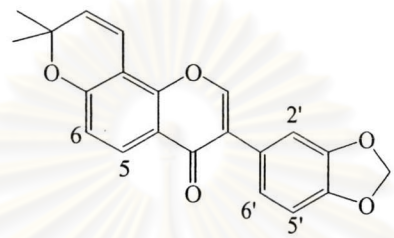
	5	8	2'	3'	4'	5'
[23]	OH		H	OH	OH	H
[24]	OH		OH	H	OH	H
[25]	OH		OH	H	OCH_3	H
[27]	OH	H	H	H		H
[28]	OH	H	H	OH		H
[29]	OH	H	OH	H		H
[31]	OH	H	OCH_3	H		H
[33]	OH		H	H	OH	H
[106]	H	H	OCH_3	H	OCH_3	OCH_3
[184]	OH	H	H	H	OH	H
[185]	OH	H	H	OH	OCH_3	H
[186]	OCH_3	H	H	H	OCH_3	H
[187]	OCH_3	H	H	H	OH	H
[188]	OH	H	H	H	OCH_3	H
[189]	OCH_3	H	H	H		H
[191]	OH	H	H	O-CH_2-O		H

Figure 5 Structures of flavonoids isolated from *Millettia* spp.

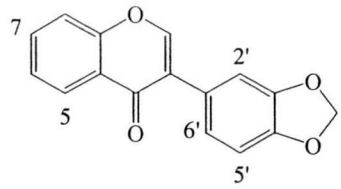


[**32**]



	5	6	2'	5'	6'
[**35**]	OCH_3	OCH_3	H	H	OCH_3
[**40**]	OCH_3	OCH_3	H	H	H
[**48**]	H	OCH_3	H	H	H
[**49**]	H	H	OCH_3	OCH_3	H
[**54**]	H	H	H	H	OCH_3
[**81**]	H	OCH_3	H	H	OCH_3
[**84**]	H	H	H	H	H
[**88**]	H	H	OCH_3	OCH_3	H
[**95**]	OCH_3	OH	H	H	H
[**198**]	H	H	H	OH	H

Figure 5 Structures of flavonoids isolated from *Millettia* spp.(continued)



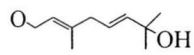
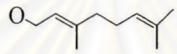
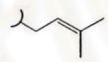
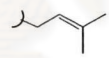
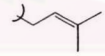
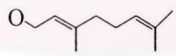
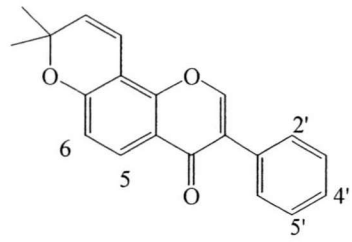
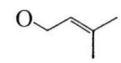
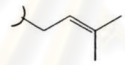
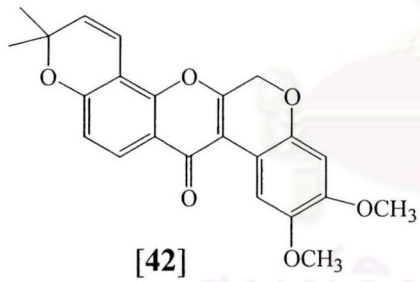
	5	6	7	8	2'	5'	6'
[36]	H	OCH_3		H	H	H	H
[39]	H	OCH_3	OH	H	H	H	H
[45]	H	H	OCH_3	H	H	H	OCH_3
[55]	H	H		H	H	H	H
[59]	H	OCH_3	OCH_3	H	H	H	OCH_3
[80]	OCH_3	OCH_3	OH	H	H	H	H
[82]	H	OCH_3	OH		H	H	H
[83]	H	H	OH		OCH_3	OCH_3	H
[91]	OCH_3	OCH_3	OH		H	H	H
[93]	H	H		H	H	H	H
[98]	H	H	OH	H	H	H	OCH_3
[100]	OCH_3	OCH_3	OCH_3	H	H	H	H

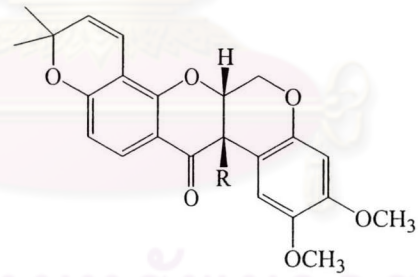
Figure 5 Structures of flavonoids isolated from *Millettia* spp.(continued)



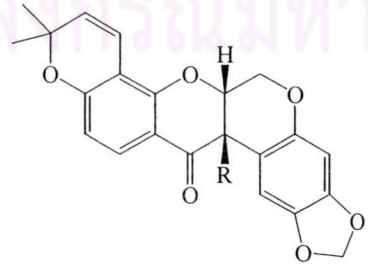
	5	6	2'	3'	4'	5'
[41]	H	H	H	H	OCH_3	H
[44]	H	OH	H	OCH_3	OCH_3	H
[46]	H	OCH_3	H	OCH_3	OCH_3	H
[53]	H	H	H	H		H
[58]	H	OCH_3	H	H	OCH_3	H
[78]	H	H	OCH_3	H	OCH_3	OCH_3
[132]	OH	H	H	H	OCH_3	H
[148]	OH		H	OH	OH	H



[42]

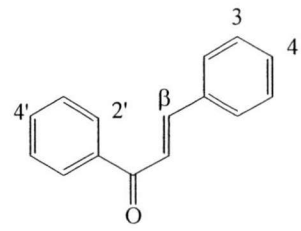


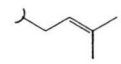
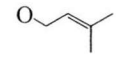
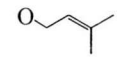
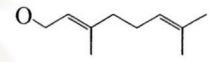
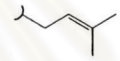
	R
[43]	H
[63]	OH

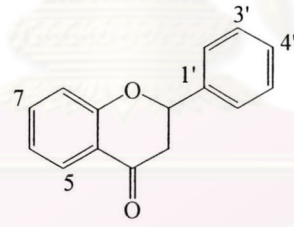


	R
[60]	H
[61]	OH

Figure 5 Structures of flavonoids isolated from *Millettia* spp.(continued)



	β	3	4	2'	3'	4'	6'
[**51**]	H	H	OH	OH		OCH_3	H
[**64**]	H	H	H	OH	H		H
[**66**]	H	$O\text{-}CH_2\text{-}O$		OH	H		H
[**69**]	OH	$O\text{-}CH_2\text{-}O$		OCH_3	H	OCH_3	H
[**86**]	H	H	OH	OH	H		H
[**118**]	H	H	H	OH		OCH_3	OCH_3
[**197**]	H	H	OH	OH	OH	H	H



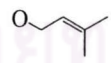
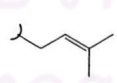
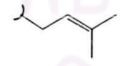
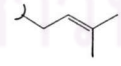
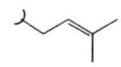
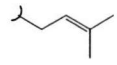
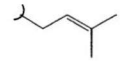
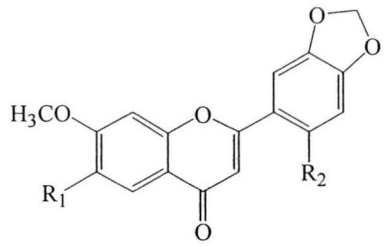
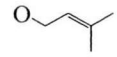
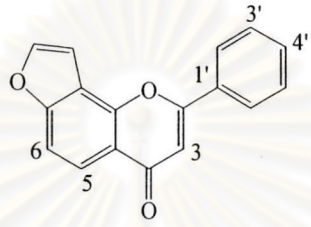
	6	7	8	3'	4'
[**65**]	H		H	H	H
[**112**]		OH		H	H
[**113**]	H	OH		H	H
[**116**]	OCH_3	OCH_3	H	$O\text{-}CH_2\text{-}O$	
[**122**]	H	OH		$O\text{-}CH_2\text{-}O$	
[**123**]		OH		$O\text{-}CH_2\text{-}O$	

Figure 5 Structures of flavonoids isolated from *Millettia* spp.(continued)



	R_1	R_2
[67]	OCH_3	H
[68]	H	H
[70]	H	OCH_3
[71]		H



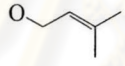
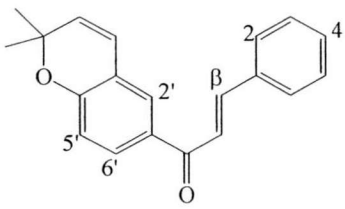
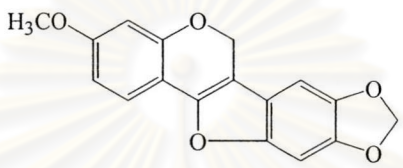
	3	5	6	2'	3'	4'	5'	6'
[72]	H	H	H	OCH_3	H	H	OCH_3	H
[73]	H	H		H	H	H	H	H
[74]	H	H	H	H	$O\text{-}CH_2\text{-}O$		H	H
[76]	H	H	H	H	OCH_3	H	H	H
[103]	H	H	H	H	H	H	H	H
[105]	OCH_3	H	OCH_3	H	H	H	H	H
[114]	H	H	OCH_3	H	H	H	H	H
[115]	OCH_3	H	H	H	H	H	H	H
[130]	OCH_3	H	H	H	$O\text{-}CH_2\text{-}O$		H	H
[141]	H	OCH_3	H	H	H	H	H	H
[142]	OCH_3	H	H	H	OCH_3	OCH_3	H	H
[143]	OCH_3	H	H	OCH_3	H	H	H	OCH_3
[153]	H	OH	H	H	H	H	H	H

Figure 5 Structures of flavonoids isolated from *Millettia* spp.(continued)

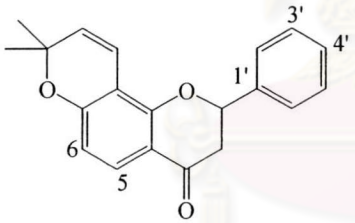


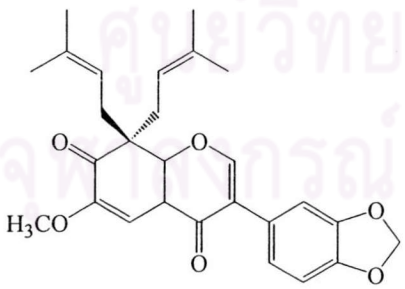
	β	4	2'	5'	6'
[52]	H	OH	OH	H	H
[75]	OH	H	OCH_3	OCH_3	H
[128]	H	H	OH	H	OCH_3
[131]	H	OCH_3	OH	H	H



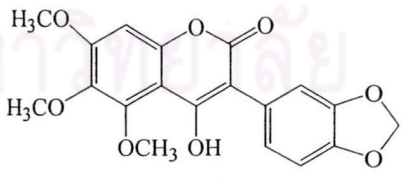
[79]

	6	3'	4'
[87]	H	H	OH
[119]	OCH_3	H	H
[120]	OCH_3	O-CH_2-O	
[121]	H	O-CH_2-O	
[139]	H	H	H



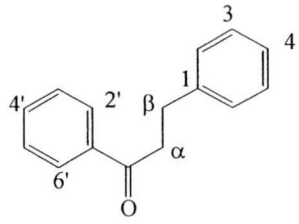


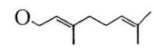
[96]

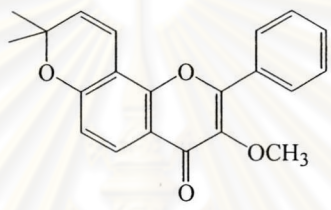


[97]

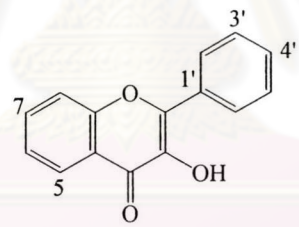
Figure 5 Structures of flavonoids isolated from *Millettia* spp.(continued)



	α	β	2	3	4	2'	3'	4'
[**101**]	H	OCH_3	OCH_3	H	OCH_3	H	$O\text{-}CH_2\text{-}O$	
[**102**]	H	OCH_3	H	$O\text{-}CH_2\text{-}O$		OCH_3	H	OCH_3
[**199**]	OH	H	H	H	OH	OH	H	

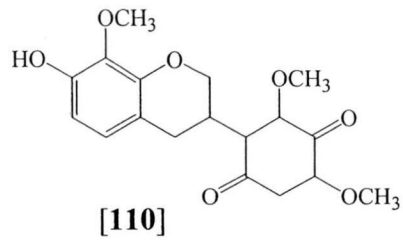


[104]

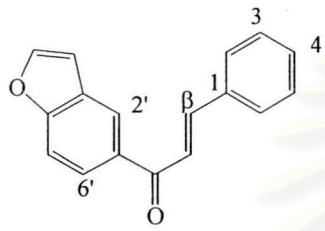


	3	5	7	8	3'	4'	5'
[**109**]	OH	H	OH	H	OCH_3	OH	OCH_3
[**203**]	OH	H	H	H	H	OCH_3	H
[**204**]	OH	OH	OGlc	OH	OH	OH	H
[**205**]	OGlc	OH	OH	H	H	OH	H
[**206**]	ORha	OH	OH	H	H	OH	H
[**209**]	OGlc	OH	OH	H	OH	OH	H

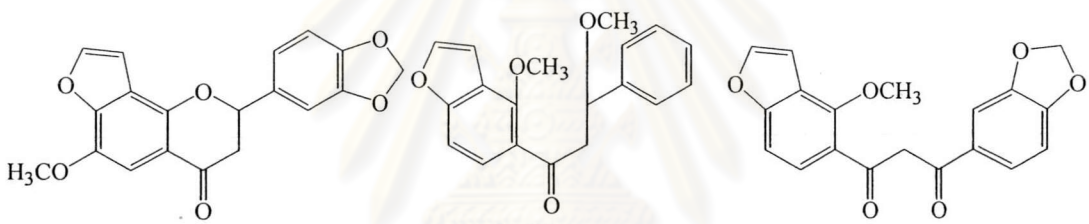
Figure 5 Structures of flavonoids isolated from *Millettia* spp.(continued)



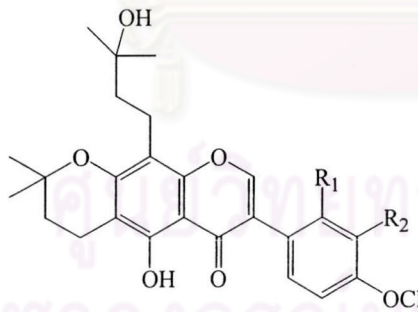
[110]



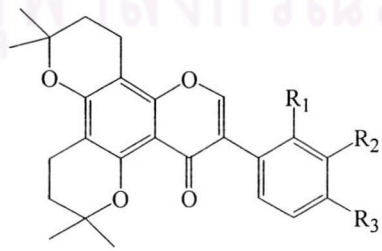
	β	3	4	2'
[111]	H	H	H	OH
[124]	H	H	H	OCH_3
[126]	H	O-CH_2-O		OCH_3
[129]	OH	H	H	OCH_3



[117] [125] [127]

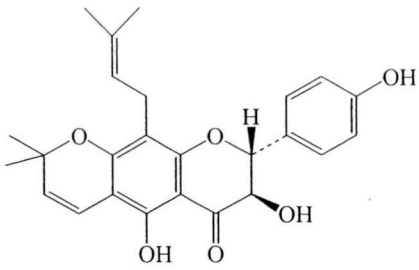


	R_1	R_2
[134]	H	OCH_3
[135]	OCH_3	H

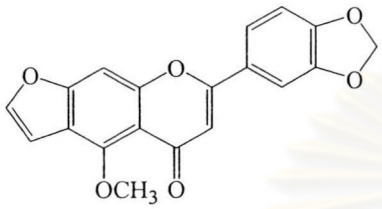


	R_1	R_2	R_3
[136]	H	OCH_3	OH
[137]	OH	H	OCH_3

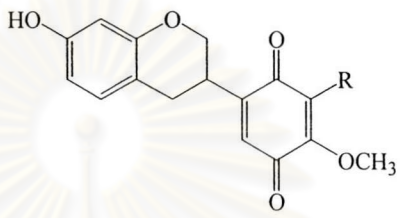
Figure 5 Structures of flavonoids isolated from *Millettia* spp.(continued)



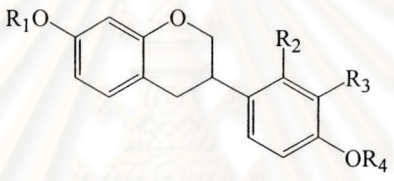
[**140**]



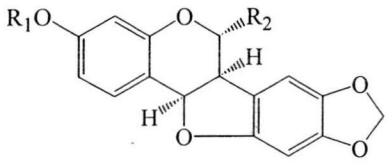
[**147**]



	R
[**154**]	H
[**157**]	OCH_3

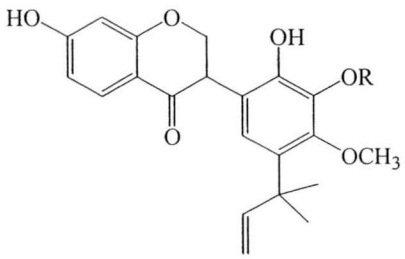


	R_1	R_2	R_3	R_4
[**155**]	H	H	H	H
[**174**]	H	OH	H	H
[**176**]	H	CH_3	OCH_3	H
[**181**]	CH_3	H	H	H
[**182**]	H	H	H	CH_3



	R_1	R_2
[**156**]	H	H
[**167**]	CH_3	OCH_3
[**171**]	CH_3	H

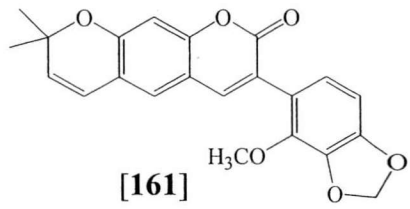
Figure 5 Structures of flavonoids isolated from *Millettia* spp.(continued)



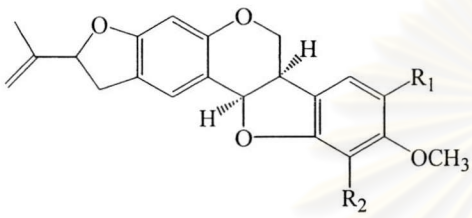
R

[158] H

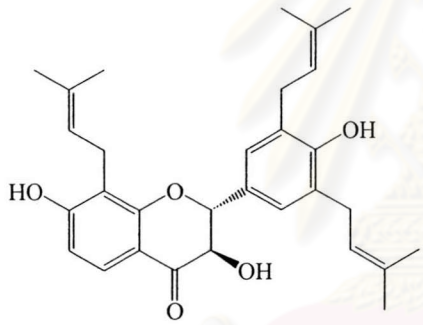
[162] CH_3



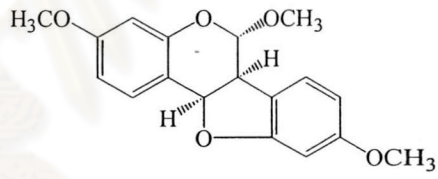
[161]



	R_1	R_2
[163]	H	OH
[164]	OH	H



[165]



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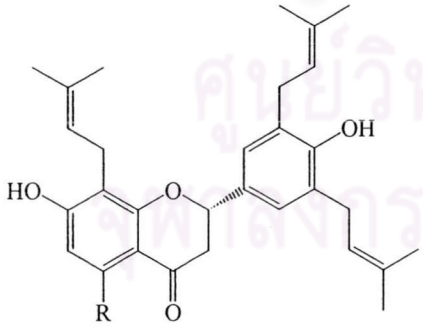
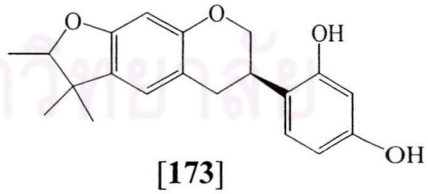


R

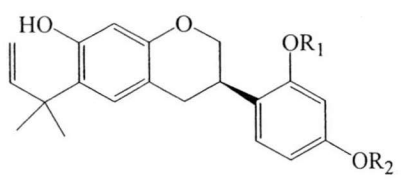
[170] OH

[172] H

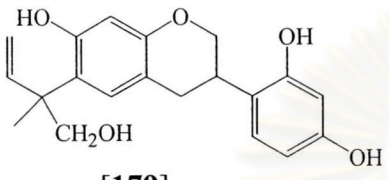


[173]

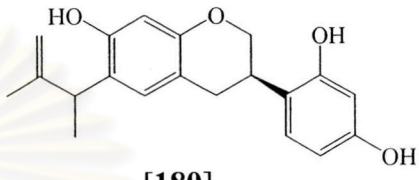
Figure 5 Structures of flavonoids isolated from *Millettia* spp.(continued)



	R_1	R_2
[175]	H	CH_3
[177]	H	H
[178]	CH_3	H



[179]



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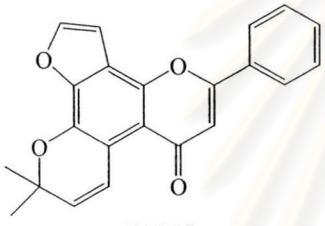
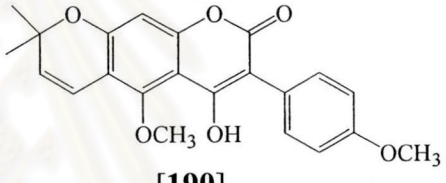
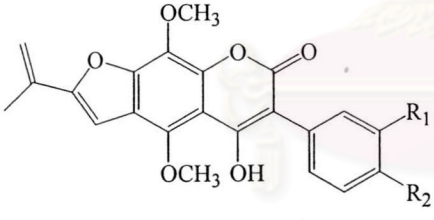


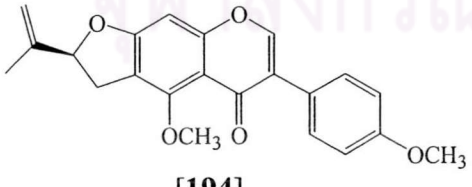
[183]



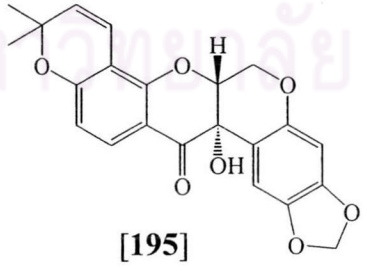
[190]



	R_1	R_2
[192]	O-CH_2-O	
[193]	H	OCH_3

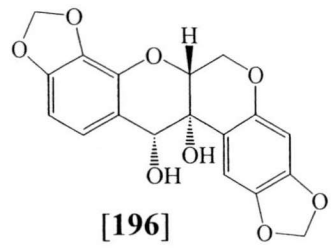


[194]

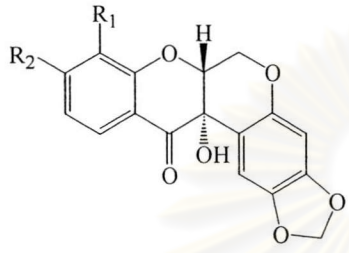


[195]

Figure 5 Structures of flavonoids isolated from *Millettia* spp.(continued)



[**196**]



	R_1	R_2
[**200**]	O-CH_2-O	
[**201**]	OCH_3	OCH_3

Figure 5 Structures of compounds isolated from *Millettia* spp.(continued)

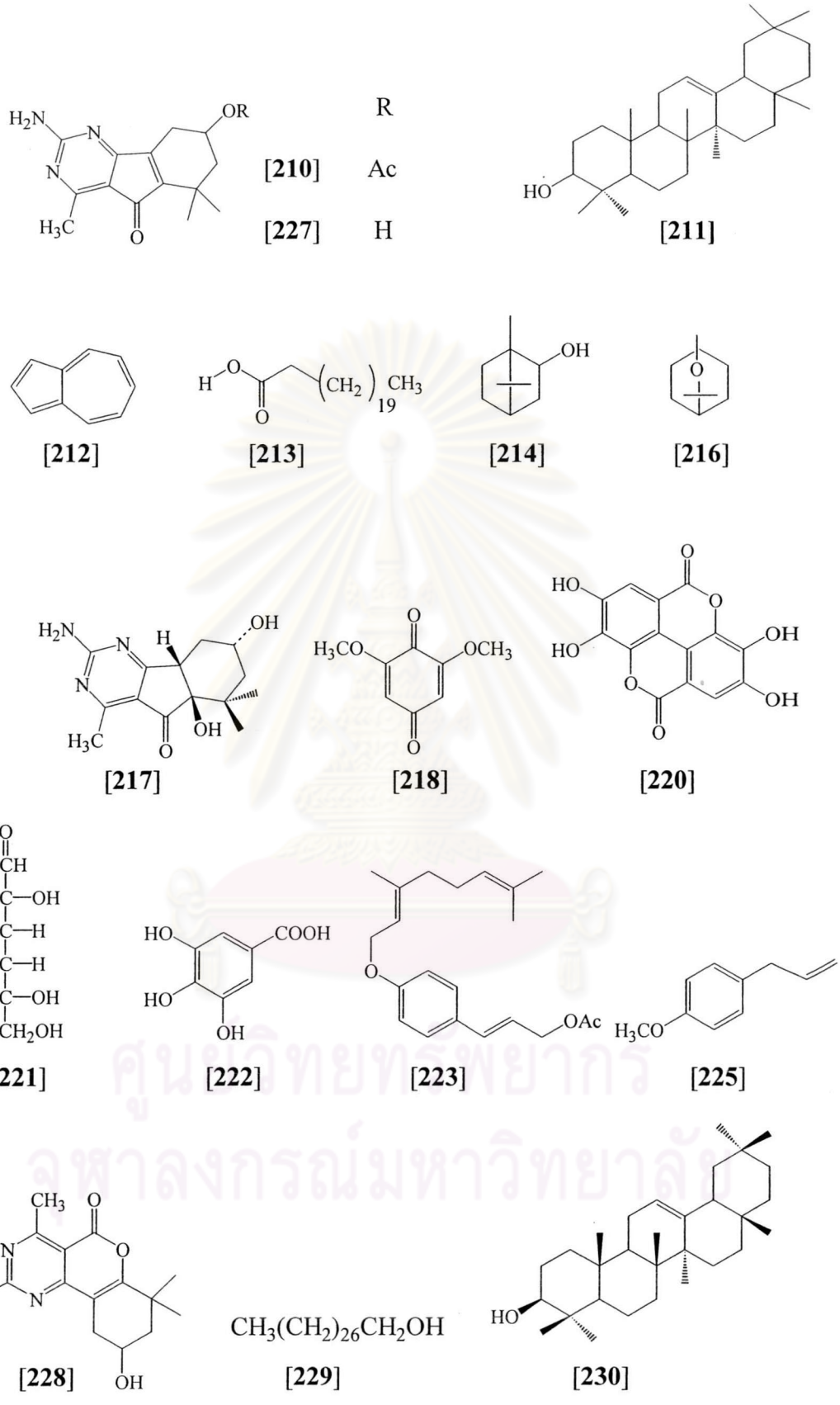
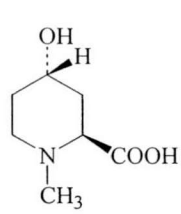


Figure 6 Structures of the other compounds isolated from *Millettia* spp.



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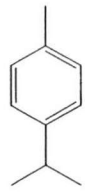
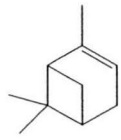
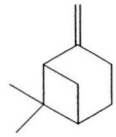


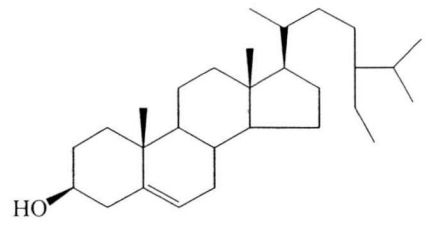
[233]



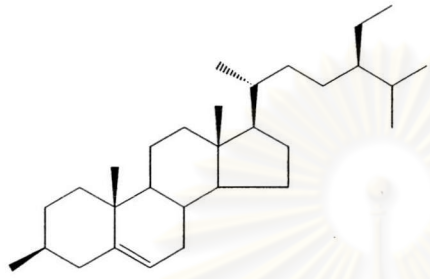
[234]



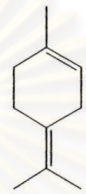
[235]



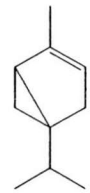
[236]



[237]



[238]



[239]

Figure 6 Structures of the other compounds isolated from *Millettia* spp.

(continued)

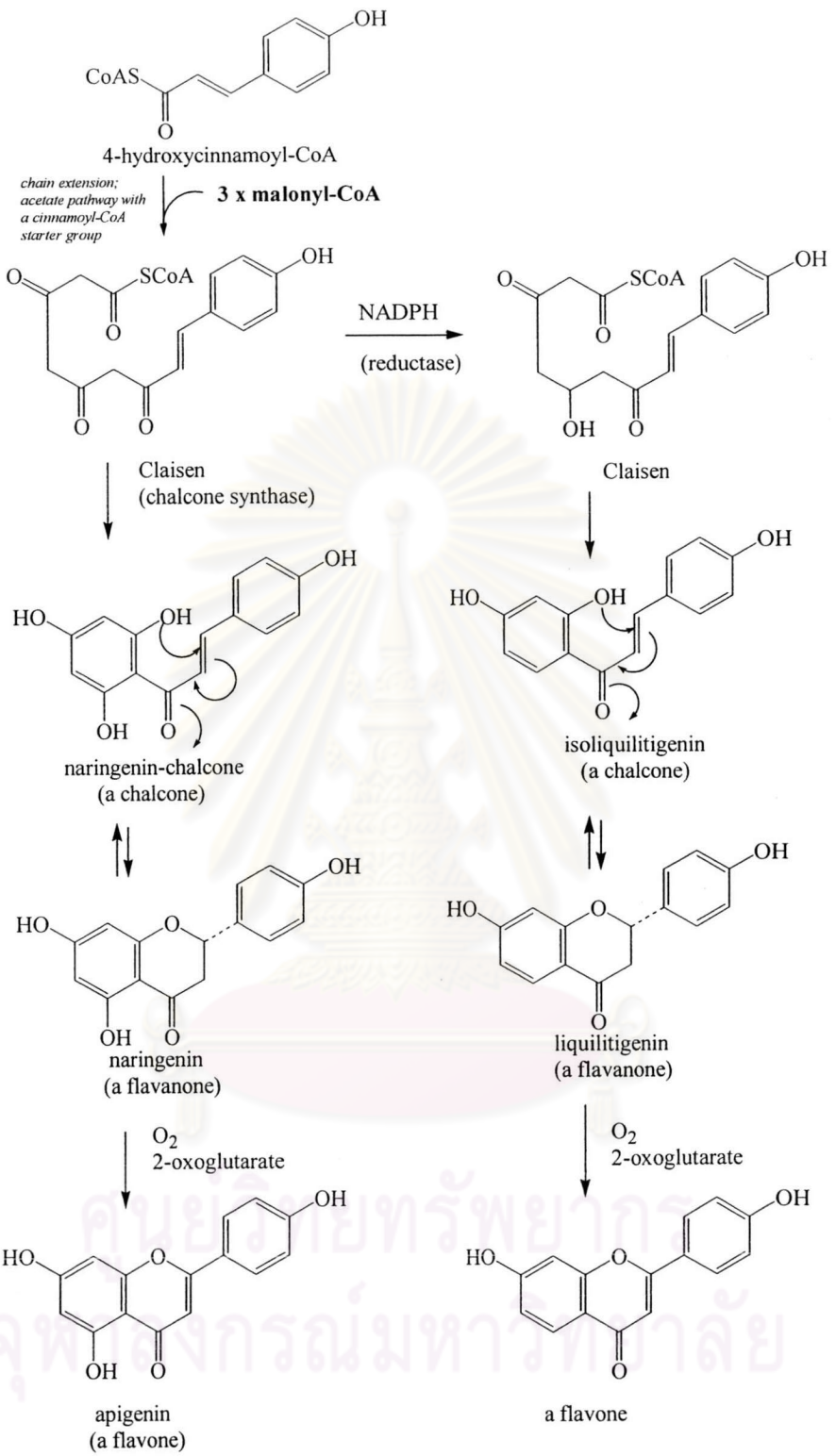
3. Biosynthetic Relationship among Flavonoids

The flavonoids; chalcones, flavones, isoflavones and rotenoids have related biosynthetic pathway as shown in **Schemes 1-3** (Dewick, 2002; Harborne, 1994).

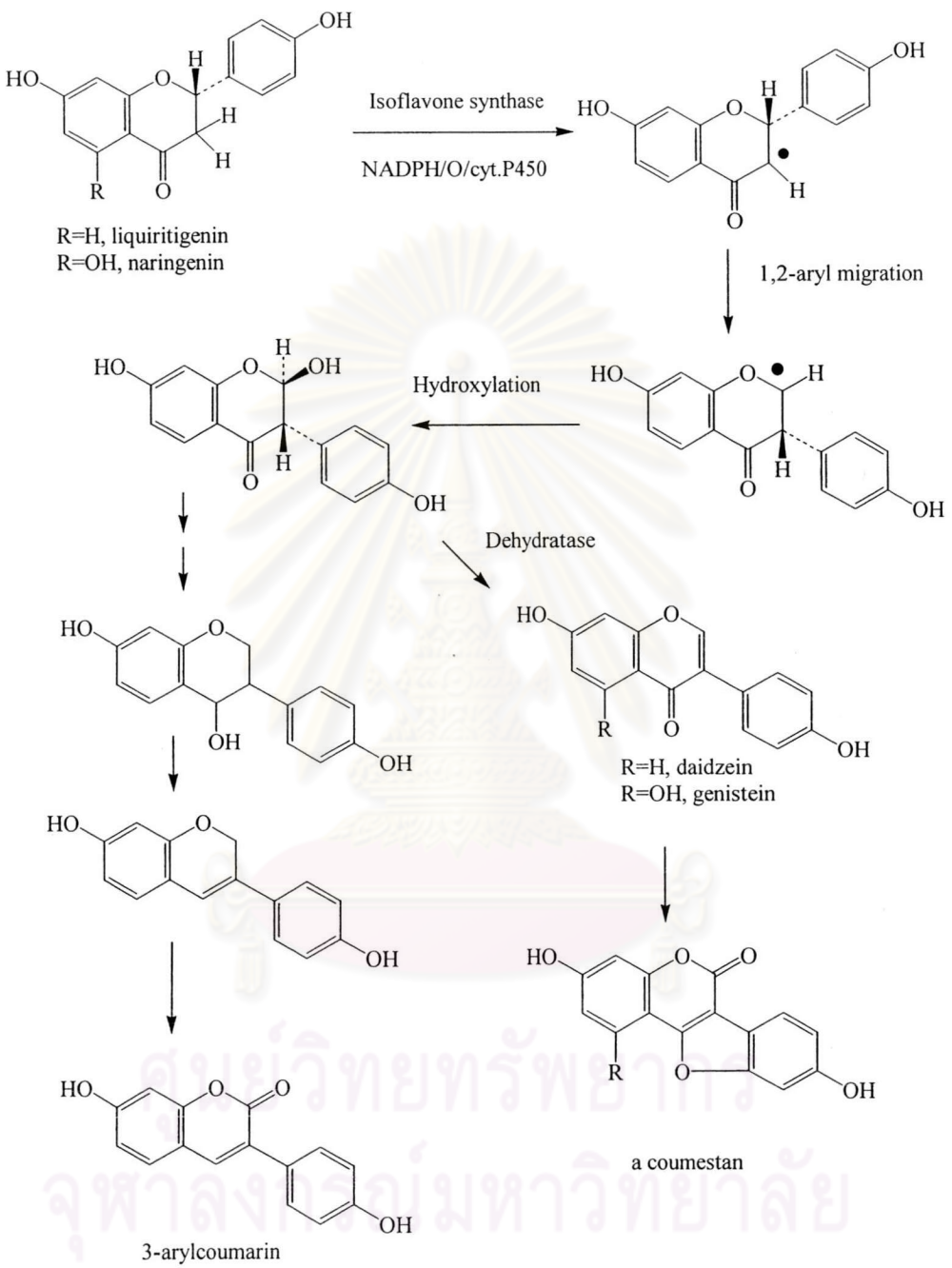
Flavonoids are products from a cinnamoyl-CoA starter unit, with chain extension using three molecules of malonyl-CoA. This initially gives a polyketide, according to the nature of the enzyme responsibility. This allows aldol or Claisen-like reactions to occur, generating aromatic rings. Enzyme chalcone synthase couples a cinnamoyl-CoA unit with three malonyl-CoA units giving chalcone, naringenin or isoliquiritigenin. Both structures nicely illustrate the different characteristic oxygenation patterns in aromatic rings derived from the acetate or shikimate pathways. Chalcones act as precursors for a vast range of flavonoid derivatives. Most contain a six-membered heterocyclic ring, formed by Michael-type nucleophilic attack of a phenol group on to the unsaturated ketone giving flavanone, naringenin or liquiritigenin. Flavanones can then give rise to flavones (**Scheme 1**).

The isoflavonoids form a quite distinct subclass of flavonoid compounds, being structural variants in which the shikimate-derived aromatic ring has migrated to the adjacent carbon of the heterocycle. This arrangement process is brought about by a cytochrome P-450-dependent enzyme requiring NADPH and O_2 cofactors, which transforms the flavanones liquiritigenin or naringenin into isoflavones daidzein or genistein respectively *via* intermediate hydroxyisoflavanones. A radical mechanism has been proposed. Nevertheless, many hundreds of different isoflavonoids have been identified and structural complexity is brought about by hydroxylation and alkylation reactions, varying the oxidation level of the heterocyclic ring as occurring of 3-arylcoumarin (**Scheme 2**).

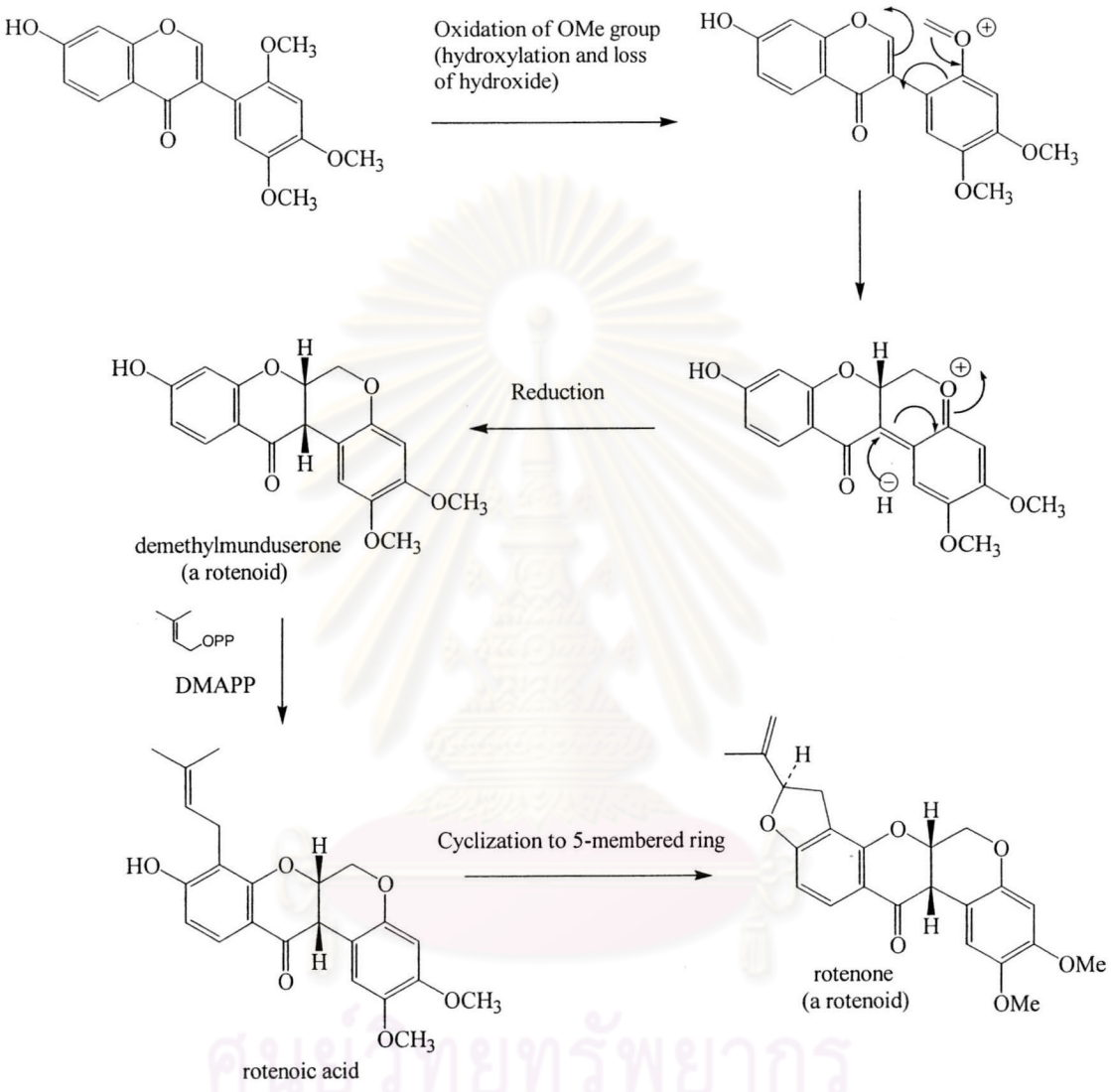
The rotenoids take their name from the first known example, rotenone, and are formed by ring cyclization of a methoxyisoflavone. Rotenone itself contains a C_5 isoprene unit introduced *via* dimethylallylation of demethylmunduserone. The isopropenylfurano system of rotenone is formed *via* from rotenoic acid (**Scheme 3**).



Scheme 1 Biosynthetic relationship among chalcones and flavones



Scheme 2 Biosynthetic relationship among flavanones and isoflavones



Scheme 3 Biosynthetic relationship among isoflavones and rotenoids

4. Bioactive Flavonoids from Natural Sources

Flavonoids, a class of natural products of high pharmacological potency are known to be great sources of drug development (Havsteen, 1983). Among their activities, antimicrobial, anti-Herpes Simplex Virus, anti-inflammatory (COX-2 inhibitory activity) and cytotoxic activities have been recognized to possess many subclasses of flavonoids as follows.

4.1 Antimicrobial Activity

Pongamol[**129**] showed 85% antifungal activity to *Helminthosporium oryzae* at concentration of 100 ppm and 70% inhibition at 250 ppm (Saxena *et al.*, 1987). Isomillinol B [**175**] and vestitol [**182**] showed bactericidal activity against *Staphylococcus aureus* and *Escherichia coli* with highly toxic even 0.1 μg/ml (Rao and Krupadanam, 1994), whilst millinolol [**179**] and neomillinol [**180**] possessed selective toxicity towards a Gram-positive bacteria (*S. aureus*) at concentration of 0.1 μg/ml (Rao, Prashant and Krupadanam, 1996). Alpinumisoflavone [**184**] prevented schistosomal infection when applied topically (Perrett *et al.*, 1995). 4-Hydroxyderricin [**240**] and xanthoangelol [**241**] isolated from *Angelica keiskei* (Umbelliferae), demonstrated antibacterial activity against the gram-positive pathogenic bacteria *S. aureus*, *S. epidermidis*, *Bacillus subtilis* and *Micrococcus luteus*. In the case of *M. luteus*, xanthoangelol had similar potency as gentamicin at MIC of 0.76 μg/ml (Inamori *et al.*, 1991). Phloretin [**242**], found in *Pyrus malus* (Rosaceae), had activity against a variety of microorganisms (Hunter and Hull, 1993). Petalostemumol [**243**] isolated from *Petalostemum purpureum* (Leguminosae), inhibited bacteria and fungi (Hufford *et al.*, 1993). (+)-Catechin [**244**] from *Camellia sinensis* (Theaceae) inhibited *in vitro Streptococcus mutans* (Batista *et al.*, 1994), *Shigella* (Vijaya, Ananthan and Nalini, 1995) and *Vibrio cholerae* O1 (Borris, 1996). Galangin [**245**], derived from *Helichrysum aureonitens* (Compositae), showed activity against a wide range of gram-positive bacteria (Afolayan and Meyer, 1997). Remangiflavanone A [**246**] and remangiflavanone B [**247**] isolated from *Physena madagascariensis* (Capparidaceae) showed antimicrobial activity against several bacteria at concentration as low as 4 μM (Deng *et al.*, 2000).

4.2 Anti-Herpes Simplex Virus (HSV) Activity

(+)-Catechin [**244**] from *Camellia sinensis* (Theaceae) and quercetin [**248**] from *Quercus rubra* (Fagaceae), inhibited infectivity but not intracellular replication of HSV-1, whereas hesperetin [**249**] from *Citrus* spp. (Rutaceae) reduced intracellular replication of HSV-1 (Kaul *et al.*, 1985). Galangin [**245**], derived from *Helichrysum aureonitens* (Compositae), inhibited HSV-1 (Meyer *et al.*, 1997).

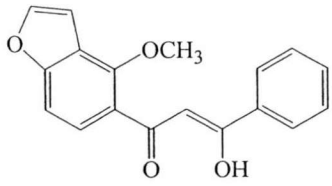
4.3 COX-2 Inhibitory Activity

(+)-Catechin [**244**], galangin [**245**], luteolin [**250**] and morin [**251**] were moderately active inhibitors of rat renal medulla COX (Baumann *et al.*, 1980). Among their IC_{50} value, IC_{50} value of 5.5 μM for galangin [**245**] as an inhibitor of COX was observed (Wagner, Knaus and Jordan, 1987). Phloretin [**242**], apigenin [**252**] and chrysin [**253**] depressed COX activity (Landolfi *et al.*, 1984). (+)-Catechin [**244**] from *Syzygium corynocarpum* and *S. malaccense* (Myrtaceae) showed weak COX-2 inhibitory effect at IC_{50} of 130 μM (Noreen *et al.*, 1998). Cyanidin [**254**] from tart cherries showed COX-2 inhibitory activity at IC_{50} of 60 nM when tested with human recombinant COX-2 (Wang *et al.*, 1999). Apigenin [**252**], kaempferol [**255**] and genistein [**256**] inhibited PEG_2 production by more than 50% at 15 μM. Among them, apigenin was the most potent inhibitor of PEG_2 production at IC_{50} of 8.04 μM (Liang *et al.*, 1999). Genistein [**256**], daidzein [**257**] (isolated from the rhizomes of *Pueraria thunbergiana*, Leguminosae), Glycitein [**258**] and irisolidone [**259**] (isolated from the flowers of *P. thunbergiana*), whereas tectoridin [**260**] and tectorigenin [**261**] (isolated from the rhizomes of *Belamcanda chinensis*, Iridaceae) showed COX-2 inhibitory activity at IC_{50} value ranged from 3 to >30 μM (Yamaki *et al.*, 2002). Sophoraflavanone G [**262**] isolated from *Sophora flavescens* (Leguminosae) inhibited COX-2 activity from Raw 264.7 cells at IC_{50} value of 2.7 μM (Kim *et al.*, 2002).

4.4 Cytotoxic Activity

Quercetin [**248**] exerted growth inhibitory effects on several malignant tumor cell lines *in vitro*, such as Ehrlich ascites cells, L1210 and P-388 leukaemia cells (Soulinna *et al.*, 1975), and possessed cytotoxicity towards Walker carcinoma 256 cell line (Edwards *et al.*, 1979) and also found to be an inhibitor of multidrug-resistant

human breast cancer cells (Scambia *et al.*, 1991). Nobiletin [**263**] and tangeretin [**264**] from *Citrus hassaku* (Rutaceae) showed growth inhibitory effects on HTB 43 cells at concentration of 5-20 μM (Kandaswami *et al.*, 1991). Butein [**265**] reported from *Spatholobus suberectus* and *Caesalpinia japonica* (Leguminosae) displayed potent cytotoxicity towards Raji lymphoma and Hela cell lines (Ramanthan, Tan and Das, 1992) and also displayed cytotoxicity towards human colon adenocarcinoma cell line 220.1 at IC_{50} value of 2 μM (Yit and Das, 1994). Calythropsin [**266**] isolated from *Calythropsis aurea* (Myrtaceae) demonstrated differential cytotoxicity towards a variety of human tumor cell lines (Beutler *et al.*, 1993). Kurzichalcolactone [**267**], found in *Cryptocarya kurzii* (Lauraceae), showed cytotoxicity against KB cells at IC_{50} figure of 15 μg/ml (Fu *et al.*, 1993).



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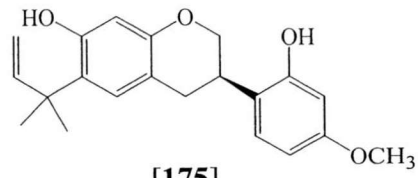

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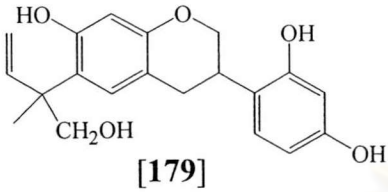

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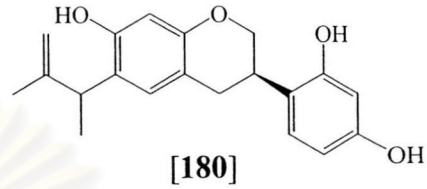

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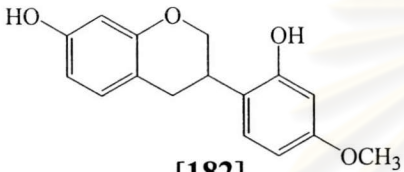

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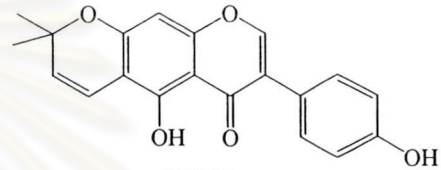

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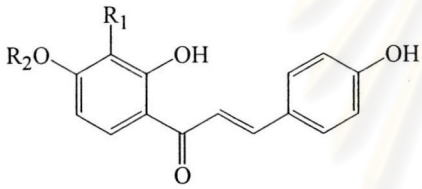

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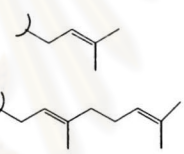
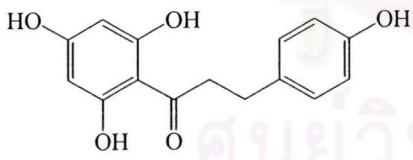


R_1 R_2

CH_3

H



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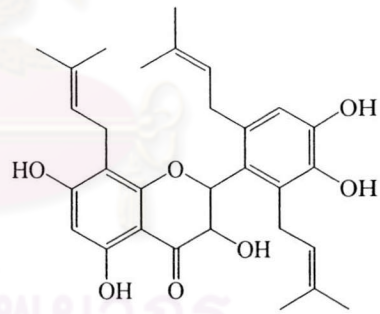

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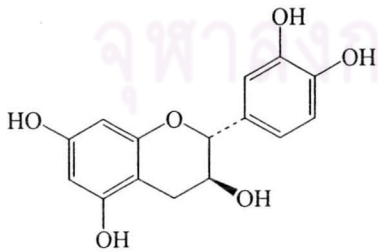

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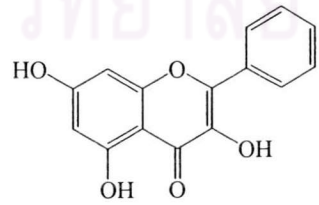

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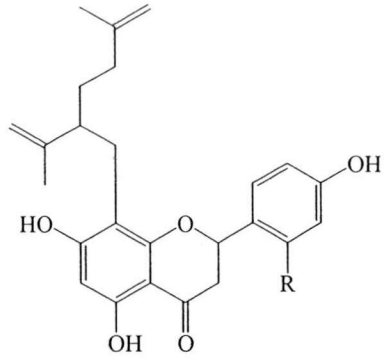
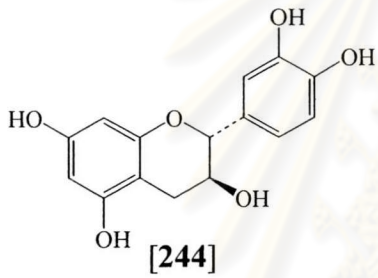
Figure 7 Structures of flavonoids possess antimicrobial activity



	R
[246]	H
[247]	OH

Figure 7 Structures of flavonoids possess antimicrobial activity (continued)



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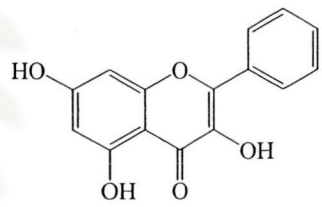

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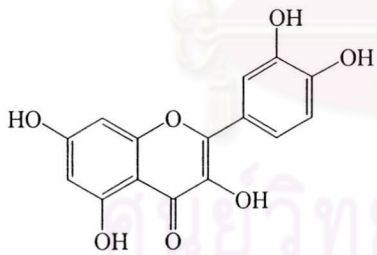

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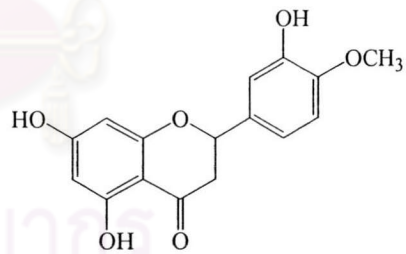

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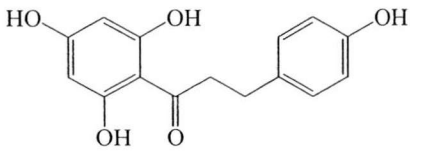
Figure 8 Structures of flavonoids with anti-Herpes Simplex Virus



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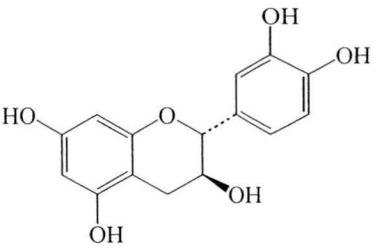

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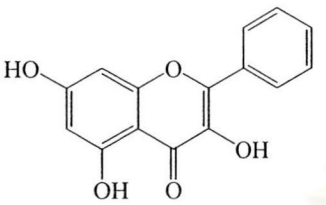

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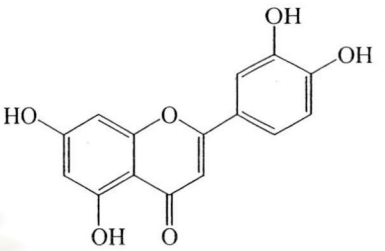

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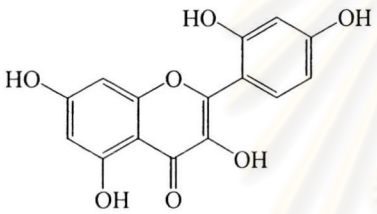

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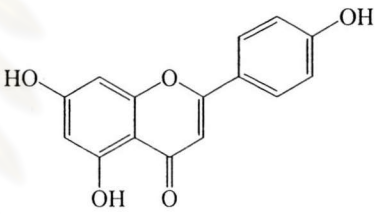

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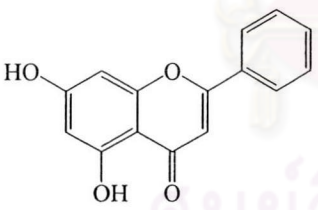

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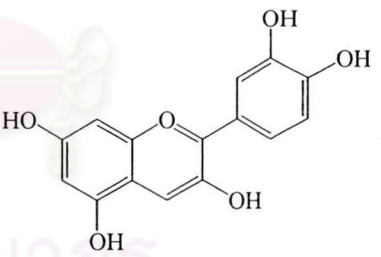

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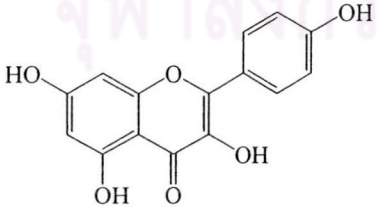

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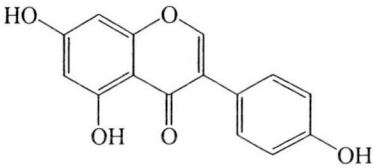

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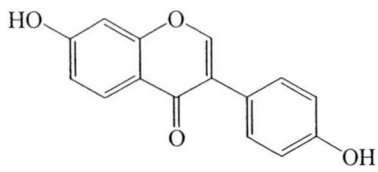
Figure 9 Structures of flavonoids possess COX-2 inhibitory activity



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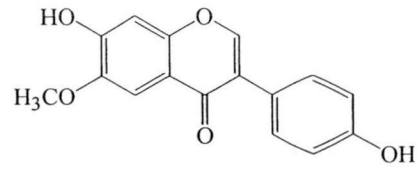

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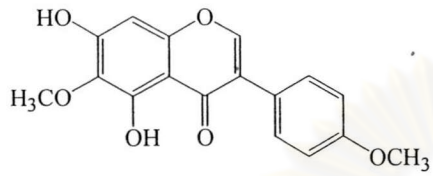

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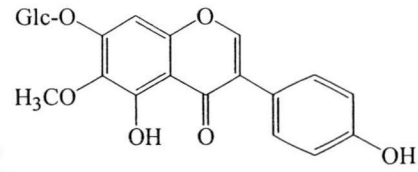

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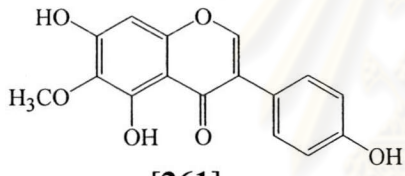

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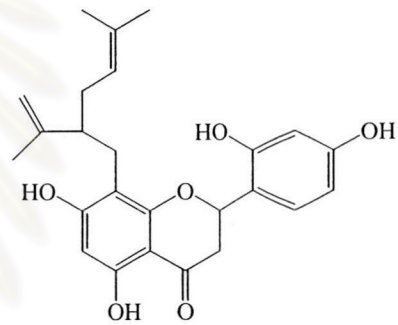

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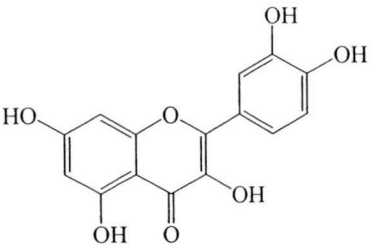
Figure 9 Structures of flavonoids possess COX-2 inhibitory activity (continued)



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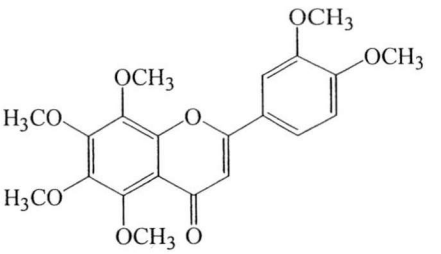

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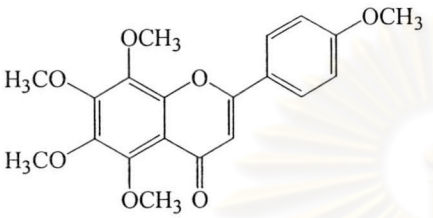

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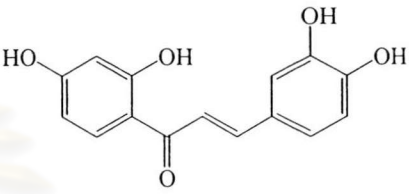

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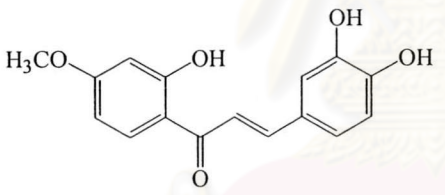

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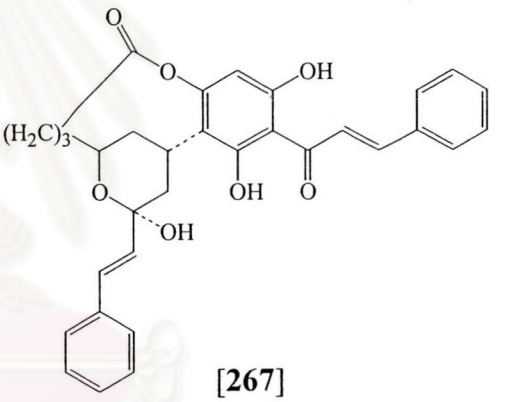

[267]

Figure 10 Structures of flavonoids possess cytotoxic activity

5. Biological Activities of *Pachyrrhizus* Compounds

Pachyrrhizus erosus is well studied phytochemically and rotenone and its derivatives have been evaluated for their cytotoxic potential, in a battery of tumor cell lines. Two compounds, (-)-12a-hydroxyrotenone [**12**] and (-)-rotenone [**19**] were observed to exhibit potent but non specific activity (ED_{50}: 0.01-0.30 μg/ml) (Kardono *et al.*, 1990).

6. Biological Activities of *Millettia* Compounds

In view of biological activities of compounds isolated from *Millettia* plants, pongamol [**129**] showed 85% antifungal activity against *Helminthosporium oryzae* at concentration of 1000 ppm and 70% inhibition at 250 ppm (Saxena *et al.*, 1987), (+)-cyclomillinol [**173**], (+)-millinol [**177**] and (+)-millinol B [**178**] showed insecticidal activity to the larvae of *Spodoptera litura* with the % protection of castor leaves 98.85, 98.32 and 98.74 respectively (Kumar, Krupadanam and Srimannarayana, 1989), isomillinol B [**175**] and vestitol [**182**] showed bactericidal activity against *S. aureus* and *E. coli* with highly toxic even at 0.1 μg/ml (Rao and Krupadanam, 1994), whilst millinolol [**179**] and neomillinol [**180**] possessed selective toxicity to *S. aureus* at concentration 0.1 μg/ml (Rao, Prashant and Krupadanam, 1996) and alpinumisoflavone [**184**] showed topical antischistosomal activity when applied to mouse skin 2 and 24 h prior to exposure to *Schistosoma mansoni* (Perrett *et al.*, 1995).