

## CHAPTER II

### HISTORICAL

#### 1. Chemical Constituents of *Artocarpus* spp.

A number of compounds have been isolated from the genus *Artocarpus*. They can be classified as flavonoids, triterpenoids, steroids, stilbenes and miscellaneous substances (Tables 1-3).

**Table 1 Distribution of flavonoids in *Artocarpus*.**

Plant and chemical compound	Plant part	Reference
<i>Artocarpus altilis</i>		
Apigenin [1]	Heartwood	Shimizu <i>et al.</i> , 1998
Artobiloxanthone [2]	Bark	Aida <i>et al.</i> , 1997
Artocarpesin [3]	Heartwood	Shimizu <i>et al.</i> , 1998
Artocarpin[4]	Heartwood	Venkataraman, 1972
Artocarpus chalcone AC-3-1 [5]	Flower	Fujimoto <i>et al.</i> , 1987
Artocarpus chalcone AC-3-2 [6]	Flower	Fujimoto <i>et al.</i> , 1987
Artocarpus chalcone AC-5-1 [7]	Flower	Fujimoto <i>et al.</i> , 1987
Artocarpus chalcone I [8]	Flower	Fujimoto, Agusutein, and Made, 1987
Artocarpus flavone AC-3-3 [9]	Flower	Fujimoto <i>et al.</i> , 1987
Artocarpus flavone AC-5-2 [10]	Flower	Fujimoto <i>et al.</i> , 1987
Artocarpus flavone KB-1 [11]	Bark	Fujimoto <i>et al.</i> , 1990
Artocarpus flavone KB-2 [12]	Bark	Fujimoto <i>et al.</i> , 1990
Artocarpus flavone KB-3 [13]	Bark	Fujimoto <i>et al.</i> , 1990
Artomunoxanthentrione [14]	Root bark	Shieh and Lin, 1992
Artomunoxanthone [15]	Root bark	Shieh and Lin, 1992
Artomunoxanthotrione epoxide [16]	Root bark	Lin, Shieh, and Jong, 1992
Artonin E [13]	Bark	Hano <i>et al.</i> , 1990

Table 1 (continued)

Plant and chemical compound	Plant part	Reference
Artonin F [17]	Bark	Hano <i>et al.</i> , 1990
Artonin K [18]	Bark	Aida <i>et al.</i> , 1997
Artonin V [19]	Root bark	Hano, Inami, and Nomura, 1994
Artonols A [20]	Bark	Aida <i>et al.</i> , 1997
Artonols B [21]	Bark	Aida <i>et al.</i> , 1997
Artonols C [22]	Bark	Aida <i>et al.</i> , 1997
Artonols D [23]	Bark	Aida <i>et al.</i> , 1997
Artonols E [24]	Bark	Aida <i>et al.</i> , 1997
Cudraflavone A [25]	Root bark	Shieh and Lin, 1992
Cycloaltilisin [26]	Stem	Chen <i>et al.</i> , 1993
Cycloartobiloxanthone [27]	Bark	Hano <i>et al.</i> , 1990
Cycloartocarpin [28]	Heartwood	Venkataraman, 1972
Cycloartomunin [29]	Root bark	Lin and Shieh, 1991
Cycloartomunoxanthone [30]	Root bark	Lin and Shieh, 1991
Cyclocommunin [31]	Root bark	Lin and Shieh, 1991
Cyclocommunol [32]	Root bark	Lin and Shieh, 1991
Cyclomorusin [33]	Root bark	Lin and Shieh, 1991
	Stem	Chen <i>et al.</i> , 1993
Cyclomulberrin [34]	Root bark	Lin and Shieh, 1992
	Stem	Chen <i>et al.</i> , 1993
Dihydrocycloartomunin [35]	Root bark	Lin and Shieh, 1991
Dihydroisocycloartomunin [36]	Root bark	Lin and Shieh, 1992
Dihydromorin [37]	Heartwood	Shimizu <i>et al.</i> , 1998
Engeletin [38]	Stem	Chen <i>et al.</i> , 1993
Isoartocarpetin [39]	Heartwood	Shimizu <i>et al.</i> , 1998
Isocyclomorusin (Cudraflavone A) [25]	Stem	Chen <i>et al.</i> , 1993
Isocyclomulberrin (Cyclocommunin) [31]	Stem	Chen <i>et al.</i> , 1993
Morin [40]	Heartwood	Venkataraman, 1972

Table 1 (continued)

Plant and chemical compound	Plant part	Reference
Morusin [41]	Bark	Fujimoto <i>et al.</i> , 1990
(+)-Norartocarpanone [42]	Heartwood	Shimizu <i>et al.</i> , 1998
Norartocarpetin [43]	Heartwood	Venkataraman, 1972
<i>Artocarpus champeden</i>		
Cyclochampedol [44]	-	Paolo <i>et al.</i> , 1998
<i>Artocarpus chaplacha</i>		
Artocarpesin [3]	Heartwood	Rao, Rathi, and Venkataraman, 1972
Artocarpin [4]	Heartwood	Rao <i>et al.</i> , 1972
Chaplashin [45]	Heartwood	Rao <i>et al.</i> , 1972
Cycloartocarpesin [46]	Heartwood	Rao <i>et al.</i> , 1972
Cycloartocarpin [28]	Heartwood	Rao <i>et al.</i> , 1972
<i>Artocarpus elasticus</i>		
Artelasticin [47]	Heartwood	Kijjoa <i>et al.</i> , 1996
Artelastin [48]	Heartwood	Kijjoa <i>et al.</i> , 1996
Artelastinin [49]	Heartwood	Kijjoa <i>et al.</i> , 1998
Artelastochromene [50]	Heartwood	Kijjoa <i>et al.</i> , 1996
Artelastofuran [51]	Heartwood	Kijjoa <i>et al.</i> , 1998
Artocarpesin [3]	Heartwood	Kijjoa <i>et al.</i> , 1996
Artocarpin [4]	Heartwood	Kijjoa <i>et al.</i> , 1976
Cycloartocarpesin [46]	Heartwood	Pense <i>et al.</i> , 1976
Cycloartocarpin [28]	Heartwood	Pense <i>et al.</i> , 1976
Integrin [52]	Heartwood	Pense <i>et al.</i> , 1976
Norartocarpin [53]	Heartwood	Pense <i>et al.</i> , 1976
<i>Artocarpus gomezianus</i>		
Artocarpesin [3]	Heartwood	Venkataraman, 1972
Artocarpin [4]	Heartwood	Venkataraman, 1972
Cycloartocarpin [28]	Heartwood	Venkataraman, 1972
Morin [40]	Heartwood	Venkataraman, 1972
Norartocarpetin [43]	Heartwood	Venkataraman, 1972

Table 1 (continued)

Plant and chemical compound	Plant part	Reference
<i>Artocarpus heterophyllus</i>		
Afzelechin-(4 $\alpha$ →8)-catechin [54]	Leaf	An <i>et al.</i> , 1992
Artocarpanone [55]	Heartwood	Radhakrishnan, Rao and Venkataraman, 1965
Artocarpanone A [56]	Root bark	Lin <i>et al.</i> , 1995
Artocarpesin [3]	Heartwood	Radhakrishnan <i>et al.</i> , 1965
Artocarpetin [57]	Heartwood	Venkataraman, 1972
Artocarpetin A [58]	Root bark	Lin <i>et al.</i> , 1995
Artocarpetin B [59]	Root	Chung <i>et al.</i> , 1995
Artocarpin [4]	Heartwood	Radhakrishnan <i>et al.</i> , 1965
Artoflavanone [60]	Root	Dayal and Seshadri, 1974
Artonin A [61]	Root bark	Hano <i>et al.</i> , 1989
Artonin B [62]	Root bark	Hano <i>et al.</i> , 1989
Artonin C [63]	Root bark	Hano, Aida and Nomura, 1990
Artonin D [64]	Root bark	Hano, Aida and Nomura, 1990
Artonin I [65]	Root bark	Hano <i>et al.</i> , 1989
Artonin J [66]	Root bark	Aida <i>et al.</i> , 1993
Artonin K [18]	Root bark	Aida <i>et al.</i> , 1993
Artonin L [67]	Root bark	Aida <i>et al.</i> , 1993
Artonin Q [68]	Bark	Aida <i>et al.</i> , 1994
Artonin R [69]	Bark	Aida <i>et al.</i> , 1994
Artonin S [70]	Bark	Aida <i>et al.</i> , 1994
Artonin T [71]	Bark	Aida <i>et al.</i> , 1994
Artonin U [72]	Bark	Aida <i>et al.</i> , 1994
Artonin X [73]	Bark	Shinomiya <i>et al.</i> , 1995
Catechin [74]	Leaf	Yamazaki <i>et al.</i> , 1987
Cudraflavone A [25]	Root bark	Lin <i>et al.</i> , 1995
Cyanomaclurin [75]	Heartwood	Radhakrishnan <i>et al.</i> , 1965
Cycloartocarpesin [46]	Heartwood	Parthasarathy <i>et al.</i> , 1969
Cycloartocarpin [28]	Heartwood	Venkataraman, 1972

Table 1 (continued)

Plant and chemical compound	Plant part	Reference
Cycloartocarpin A [76]	Root bark	Lu and Lin, 1994
Cycloheterophyllin [77]	Bark	Rao, Varadan and Venkataraman, 1971
	Root bark	Hano <i>et al.</i> , 1989
Dihydromorin [37]	Heartwood	Venkataraman, 1972
Heteroartoinin A [78]	Root	Chung <i>et al.</i> , 1995
Heteroflavanone A [79]	Root bark	Lu and Lin, 1993
Heteroflavanone B [80]	Root bark	Lu and Lin, 1993
Heteroflavanone C [81]	Root bark	Lu and Lin, 1994
Heterophyllin [82]	Root bark	Hano <i>et al.</i> , 1989
Heterophyllol [83]	Root bark	Lin and Lu, 1993
Isocycloheterophyllin [84]	Bark	Rao, Varadan and Venkataraman, 1973
Kuwanon R [85]	Root bark	Shinomiya <i>et al.</i> , 1995
Kuwanon T [86]	Root bark	Shinomiya <i>et al.</i> , 1995
Morin [40]	Heartwood	Radhakrishnan <i>et al.</i> , 1965; Parthasarathy <i>et al.</i> , 1969; Mu and Li, 1982
Morin-calcium-chelate [87]	Heartwood	Mu and Li, 1982
Norartocarpetin [43]	Heartwood	Radhakrishnan <i>et al.</i> , 1965
Norartocarpin [53]	Heartwood	Venkataraman, 1972
Oxydihydroartocarpesin [88]	Heartwood	Pathasarathy <i>et al.</i> , 1969
Procyanidin B-3 [89]	Leaf	An <i>et al.</i> , 1992
Procyanidin C-1 [90]	Leaf	An <i>et al.</i> , 1992
<i>Artocarpus hirsuta</i>		
Artocarpanone [55]	Heartwood	Venkataraman, 1972
Artocarpesin [3]	Heartwood	Venkataraman, 1972
Artocarpetin [57]	Heartwood	Venkataraman, 1972
Artocarpin [4]	Heartwood	Venkataraman, 1972
Cyanomaclurin [75]	Heartwood	Venkataraman, 1972

Table 1 (continued)

Plant and chemical compound	Plant part	Reference
Cycloartocarpesin [46]	Heartwood	Venkataraman, 1972
Cycloartocarpin [28]	Heartwood	Venkataraman, 1972
Dihydromorin [37]	Heartwood	Venkataraman, 1972
Morin [40]	Heartwood	Venkataraman, 1972
Norartocarpetin [43]	Heartwood	Venkataraman, 1972
Oxydihydroartocarpesin [88]	Heartwood	Venkataraman, 1972
<i>Artocarpus integer</i>		
Artocarpanone [55]	Heartwood	Pendse <i>et al.</i> , 1976
Artocarpesin [3]	Heartwood	Pendse <i>et al.</i> , 1976
Artocarpetin [57]	Heartwood	Pendse <i>et al.</i> , 1976
Catechin [74]	Leaf	Yamazaki <i>et al.</i> , 1987
Chaplashin [45]	Heartwood	Pendse <i>et al.</i> , 1976
Cycloartocarpesin [46]	Heartwood	Pendse <i>et al.</i> , 1976
Cycloartocarpin [28]	Heartwood	Pendse <i>et al.</i> , 1976
Cyclointegrin [91]	Heartwood	Pendse <i>et al.</i> , 1976
Cyanomaclurin [75]	Heartwood	Pendse <i>et al.</i> , 1976
Dihydromorin [37]	Heartwood	Pendse <i>et al.</i> , 1976
Integrin [52]	Heartwood	Pendse <i>et al.</i> , 1976
Morin [40]	Heartwood	Pendse <i>et al.</i> , 1976
Norartocarpetin [43]	Heartwood	Pendse <i>et al.</i> , 1976
Oxydihydroartocarpesin [88]	Heartwood	Pendse <i>et al.</i> , 1976
Oxyisocyclointegrin [92]	Heartwood	Pendse <i>et al.</i> , 1976
<i>Artocarpus lakoocha</i>		
Artocarpin [4]	Heartwood	Venkataraman, 1972
Cycloartocarpin [28]	Heartwood	Venkataraman, 1972
5,7-Dihydroxyflavone-3-O- $\alpha$ -L-rhamnoside [93]	Root bark	Chauhan and Kumari, 1979

Table 1 (continued)

Plant and chemical compound	Plant part	Reference
5-Hydroxy-7,2',4'-trimethoxyflavone [94]	Stemwood	Pavaro and Reutrakul, 1976
Galangin-3-0- $\alpha$ -L-(-)-rhamno-pyranoside [95]	Root bark	Chauhan and Kumari, 1979
Galangin-3-0- $\beta$ -D-galactopyranosyl-(1 $\rightarrow$ 4)- $\alpha$ -L- rhamnopyranoside [96]	Root bark	Chauhan, Kumari and Saraswat, 1979
Kaempferol-3-0- $\beta$ -D-xylanopyranoside [97]	Root bark	Chauhan <i>et al.</i> , 1982
Norartocarpin [53]	Heartwood	Venkataraman, 1972
Norcycloartocarpin [98]	Heartwood	Venkataraman, 1972
Quercetin-3-0- $\alpha$ -L-rhamno-pyranoside [99]	Root bark	Chauhan <i>et al.</i> , 1982
<i>Artocarpus nobilis</i>		
Artobilochromen [100]	Bark	Pavanasasivam,Sultanbawa and Mageswaran, 1974; Kumar <i>et al.</i> , 1977 Sultanbawa and Surendrakumar, 1989
Artobiloxanthone [101]	Bark	Sultanbawa and Surendrakumar, 1989
Chromanoartobilochromen A [102]	Trunk bark	Kumar <i>et al.</i> , 1977
Chromanoartobilochromen B [103]	Trunk bark	Pavanasasivum <i>et al.</i> , 1974; Kumar <i>et al.</i> , 1977
Chromanoartobilochromene [104]	Bark	Pavanasasivum <i>et al.</i> , 1974;
Cycloartobiloxanthone [105]	Bark	Pavanasasivum <i>et al.</i> , 1974;
(-)-Dihydrofuranoartobilochromen A [106]	Trunk bark	Kumar <i>et al.</i> , 1977
(-)-Dihydrofuranoartobilochromen B-1 [107]	Trunk bark	Kumar <i>et al.</i> , 1977
DihydrofuranoartobilochromenB-2[108]	Trunk bark	Kumar <i>et al.</i> , 1977

Table 1 (continued)

Plant and chemical compound	Plant part	Reference
Furanoartobilochromen A [109]	Bark	Pavanasasivum <i>et al.</i> , 1974;
Furanoartobilochromen B-1 [110]	Bark	Pavanasasivum <i>et al.</i> , 1974;
Furanoartobilochromen B-2 [111]	Bark	Pavanasasivum <i>et al.</i> , 1974;
Oxydihydromorusin [112]	Trunk bark	Kumar <i>et al.</i> , 1977; Fukai and Nomura, 1993
<i>Artocarpus pithecofilla</i>		
Morin [40]	Heartwood	Mu and Li, 1982
Morin-calcium-chelate [87]	Heartwood	Mu and Li, 1982
<i>Artocarpus rigida</i>		
Artobiloxanthone [101]	Bark	Hano, Inami and Nomura 1990
Artonin E [13]	Bark	Hano, Inami and Nomura 1990
Artonin G [113]	Bark	Hano, Inami and Nomura 1990
Artonin H [114]	Bark	Hano, Inami and Nomura 1990
Artonin M [115]	Bark	Hano, Inami and Nomura 1990
Artonin N [116]	Bark	Hano, Inami and Nomura 1990
Artonin O [117]	Bark	Hano, Inami and Nomura 1990
Artonin P [118]	Bark	Hano, Inami and Nomura 1990
Cycloartobiloxanthone [105]	Bark	Hano, Inami and Nomura 1990



Table 2 Distribution of triterpenoids in *Artocarpus*.

Plant and chemical compound	Plant part	Reference
<i>Artocarpus altilis</i>		
$\alpha$ -Amyrin [119]	Latex	Ultee, 1949
$\alpha$ -Amyrin acetate [120]	Fruit	Altman and Zito, 1976
$\beta$ -Amyrin acetate [121]	Latex	Ultee, 1949
Cycloart-23-ene-3 $\beta$ -25-diol [122]	Fruit	Altman and Zito, 1976
Cycloart-24-ene-3 $\beta$ -ol [123]	Fruit	Altman and Zito, 1976
Cycloart-25-ene-3 $\beta$ -24-diol [124]	Fruit	Altman and Zito, 1976
Cycloartenol (Cycloart-24-ene-3 $\beta$ -ol) [123]	Bark	Pavanasasivam and Sultanbawa, 1973
Cycloartenone [125]	Bark	Pavanasasivam and Sultanbawa, 1973
Cycloartenyl acetate [126]	Bark	Pavanasasivam and Sultanbawa, 1973
Lupeol acetate [127]	Root bark	Shieh and Lin, 1992
<i>Artocarpus chaplasha</i>		
Cycloartenyl acetate [126]	Stem bark	Mahato, Banerjee, and Chakravarti, 1971
Isocycloartenol acetate [128]	Stem bark	Mahato <i>et al.</i> , 1971
Lupeol acetate [127]	Stem bark	Mahato <i>et al.</i> , 1971
<i>Artocarpus elasticus</i>		
$\beta$ -Amyrin acetate [121]	Latex	Ultee, 1949
Lupeol acetate [127]	Latex	Ultee, 1949
<i>Artocarpus gomezianus</i>		
Lupeol acetate [127]	Leaf	Kingroungpet, 1994
Simiarenol [129]	Leaf	Kingroungpet, 1994
<i>Artocarpus heterophyllus</i>		
Artostenone (Cycloartenone ) [125]	Fruit	Nath and Mukherjee, 1939
Betulin [130]	Root bark	Lu and Lin, 1994
Betulinic acid [131]	Root	Dayal and Seshadri, 1974

Table 2 (continued)

Plant and chemical compound	Plant part	Reference
Butyrospermol [132]	Root bark	Lu and Lin, 1994
	Fruit	Barton, 1951
Cycloartenol [123]	Fruit	Barton, 1951
	Wood	Nogueira and Correia, 1958
Cycloartenone [125]	Bark	Pavanasasivam and Sultanbawa, 1973
	Latex	Barik <i>et al.</i> , 1994
	Fruit	Barton, 1951
	Bark	Pavanasasivam and Sultanbawa, 1973
	Root	Dayal and Seshadri, 1974
	Latex	Pant and Chaturvedi, 1989
Cycloartenyl acetate [126]	Bark	Barik <i>et al.</i> , 1994
	Bark	Pavanasasivam and Sultanbawa, 1973
9,19-Cyclolanost-23-ene-3 $\beta$ ,25-diol (Cycloart-23-ene-3,25-diol) [122]	Fruit	Kielland and Malterud, 1994
9,19-Cyclolanost-25-ene-3 $\beta$ ,24-diol [133]	Fruit	Kielland and Malterud, 1994
9,19-Cyclolanost-25-ene-3 $\beta$ ,24-diol (24R) [133]	Latex	Barik <i>et al.</i> , 1997
9,19-Cyclolanost-25-ene-3 $\beta$ ,24-diol (24S) [133]	Latex	Barik <i>et al.</i> , 1997
9,19-Cyclolanost-3-one-24,25-diol (24R) [134]	Latex	Barik <i>et al.</i> , 1994
9,19-Cyclolanost-3-one-24,25-diol (24S) [134]	Latex	Barik <i>et al.</i> , 1994
Ursolic acid [135]	Root	Dayal and Seshadri, 1974
	Root bark	Lu and Lin, 1994

Table 2 (continued)

Plant and chemical compound	Plant part	Reference
<i>Artocarpus lakoocha</i>		
Amyrin acetate [121]	Bark	Kapil and Joshi, 1960
Cycloartenol [123]	Bark	Pavanasasivam and Sultanbawa, 1973
Cycloartenone [125]	Bark	Pavanasasivam and Sultanbawa, 1973
Lupeol [136]	Root bark	Chauhan and Kumari, 1979;
Lupeol acetate [127]	Bark	Kapil and Joshi, 1960
<i>Artocarpus nobilis</i>		
Cycloartenol [123]	Bark	Pavanasasivam and Sultanbawa, 1973
	Heartwood	Pavanasasivam and Sultanbawa, 1973
Cycloartenone [125]	Bark	Pavanasasivam and Sultanbawa, 1973
	Heartwood	Pavanasasivam and Sultanbawa, 1973
Cycloartenyl acetate [126]	Bark	Pavanasasivam and Sultanbawa, 1973
	Heartwood	Pavanasasivam and Sultanbawa, 1973

Table 3 Distribution of other compounds in *Artocarpus*.

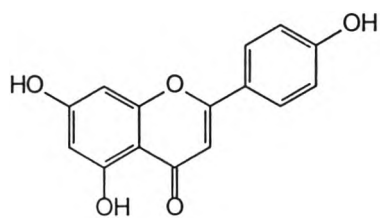
Plant and chemical compound	Category	Plant part	Reference
<i>Artocarpus altilis</i>			
$\gamma$ -Aminobutyric acid [137]	Amino acid	Leaf	Durand <i>et al.</i> , 1962
Artocarbene [138]	Stilbene	Heartwood	Shimizu <i>et al.</i> , 1997
4-Prenyloxyresveratrol [139]	Stilbene	Heartwood	Shimizu <i>et al.</i> , 1997
$\beta$ -Sitosterol [140]	Steroid	Root bark	Shieh and Lin, 1992
<i>Artocarpus chaplasha</i>			
Oxyresveratrol [141]	Stilbene	Heartwood	Rao <i>et al.</i> , 1972
Resorcinol [142]	Benzenoid	Heartwood	Rao <i>et al.</i> , 1972
$\beta$ -Resorcyaldehyde [143]	Benzenoid	Heartwood	Rao <i>et al.</i> , 1972
Resveratrol [144]	Stilbene	Heartwood	Rao <i>et al.</i> , 1972
$\beta$ -Sitosterol [140]	Steroid	Stem bark	Mahato <i>et al.</i> , 1971
<i>Artocarpus elasticus</i>			
$\beta$ -Sitosterol [140]	Steroid	Heartwood	Pendse <i>et al.</i> , 1976
<i>Artocarpus gomezianus</i>			
Arbutin [145]	Phenolic glycoside	Leaf	Kingroungpet, 1994
1-Dotriacontanol [146]	Alcohol	Leaf	Kingroungpet, 1994
Mesoerythritol [147]	Phenolic compound	Heartwood	Venkataraman, 1972
$\beta$ -Sitosterol [140]	Steroid	Leaf	Kingroungpet, 1994
<i>Artocarpus heterophyllus</i>			
Acetylcholine [148]	Amine	Seed	Pereira, Medina and Bustos, 1962
Artocarpus integra $\alpha$ -D-Galactose specific lectin [149]	Lectin	Seed	Suresh, Appukuttan, and Basu, 1962
Artocarpus integrifolia lectin [150]	Lectin	Seed	Chatterjee, Sarkar, and Rao, 1982; Namjuntra and Culavatnatol, 1984
Artocarpus lectin CE-A-I [151]	Lectin	Seed	Ferreira <i>et al.</i> , 1992

Table 3 (continued)

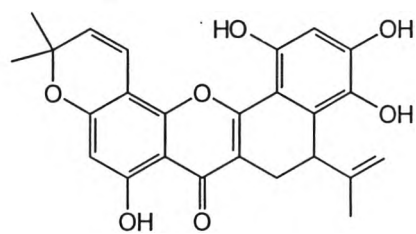
Plant and chemical compound	Category	Plant part	Reference
Aurantiamide acetate [152]	Protein	Seed	Chakraborty and Mandal, 1981
9-Hydroxytridecyldocosanoate [153]	Lipid	Root bark	Lu and Lin, 1994
4-Hydroxytridecyldocosanoate [154]	Lipid	Latex	Pant and Chaturvedi, 1989
Jacalin [155]	Lectin	Seed	Hagiwara <i>et al.</i> , 1988 Ferreira <i>et al.</i> , 1992
Lymphoagglutinin [156]	Lectin	Seed	Arora <i>et al.</i> , 1987
Recinoleic acid [157]	Lipid	Seed oil	Daulatabad and Mirajkar, 1989
$\beta$ -Sitosterol [140]	Steroid	Heartwood	Pathasarathy <i>et al.</i> , 1969
		Root	Dayal and Seshadri, 1974
		Root bark	Lu and Lin, 1994
<i>Artocarpus hirsuta</i> Lymphoagglutinin [156]	Lectin	Seed	Arora <i>et al.</i> , 1987
<i>Artocarpus integer</i> Artocarpus lectin C [158]	Lectin	Seed	Hashim, Gendeh and Jaafar, 1992
$\beta$ -Sitosterol [140]	Steroid	Heartwood	Pense <i>et al.</i> , 1976
<i>Artocarpus lakoocha</i> Artocarpus lakoocha lectin [159]	Lectin	Seed	Chatterjee <i>et al.</i> 1982
Lymphoagglutinin [156]	Lectin	Seed	Arora <i>et al.</i> , 1987
Oxyresveratrol [141]	Stilbene	Heartwood	Venkataraman, 1972 Mongolsuk, Robertson and Towers, 1957
Resorcinol [142]	Benzenoid	Heartwood	Venkataraman, 1972

Table 3 (continued)

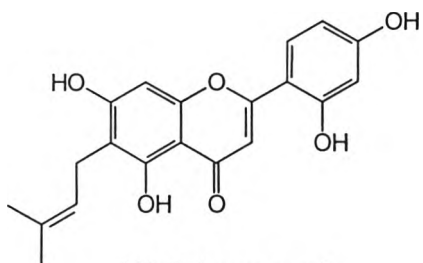
Plant and chemical compound	Category	Plant part	Reference
Resveratrol [144]	Stilbene	Heartwood	Venkataraman, 1972
$\beta$ -Sitosterol [140]	Steroid	Root bark	Chauhan and Kumari, 1979



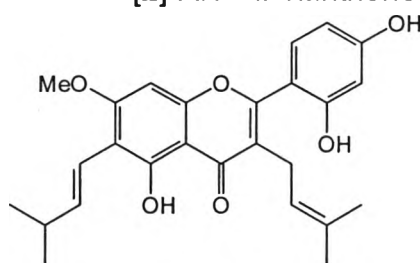
[1] Apigenin



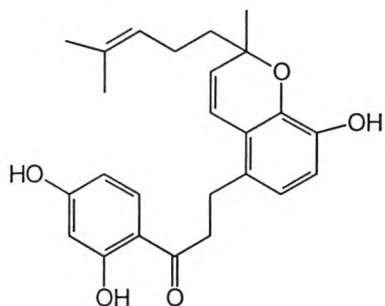
[2] Artobiloxanthone



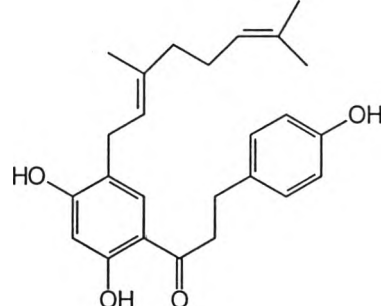
[3] Artocarpesin



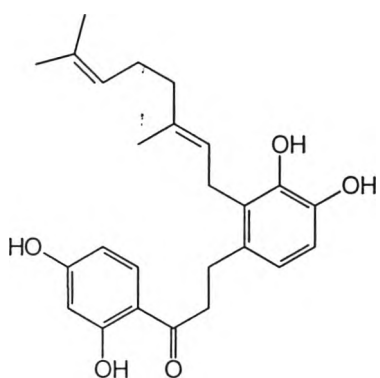
[4] Artocarpin



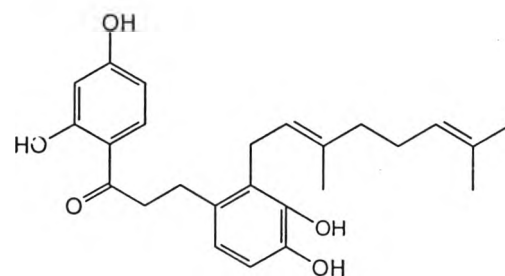
[5] Artocarpus chalcone AC-3-1



[6] Artocarpus chalcone AC-3-2

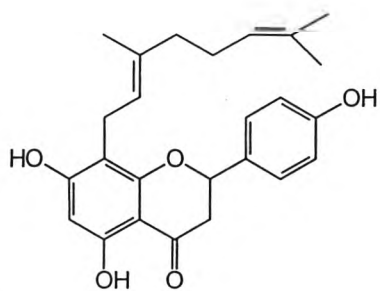


[7] Artocarpus chalcone AC-5-1

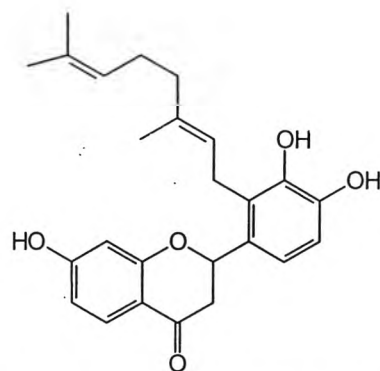


[8] Artocarpus chalcone I

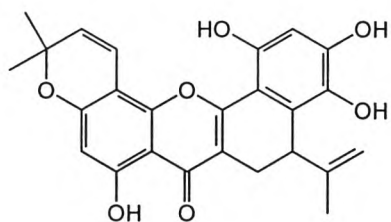
Figure 3 Structures of compounds previously isolated from *Artocarpus*



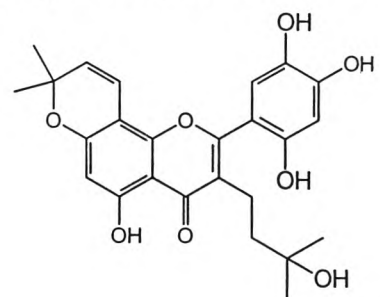
[9] Artocarpus flavanone AC-3-3



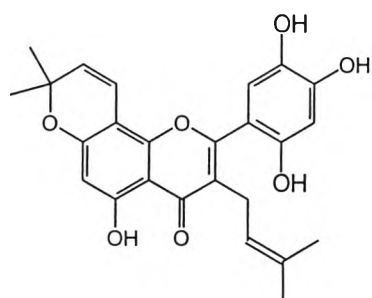
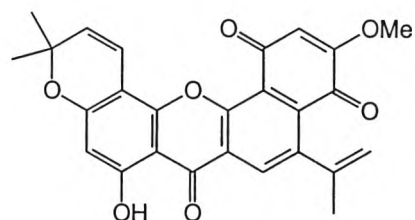
[10] Artocarpus flavanone AC-5-2



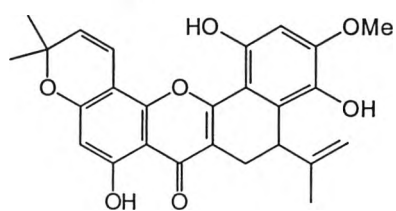
[11] Artocarpus flavanone KB-1



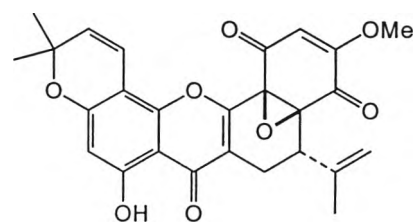
[12] Artocarpus flavanone KB-2

[13] Artocarpus flavanone KB-3  
(Artonin E)

[14] Artomunoxanthetrione



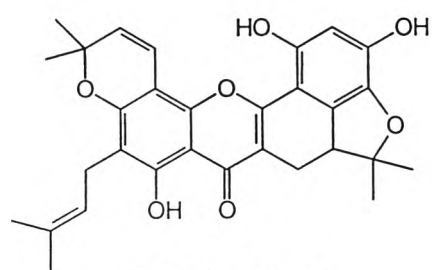
[15] Artomunoxanthone



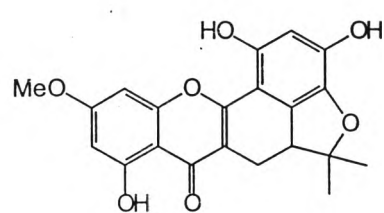
[16] Artomunoxanthotrione epoxide

Figure 3 Structures of compounds previously isolated from *Artocarpus* (continued)

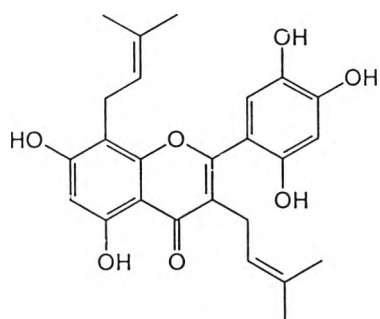




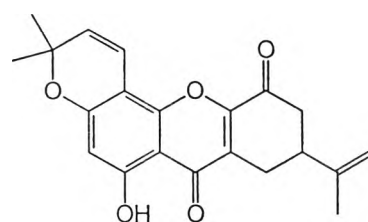
[17] Artonin F



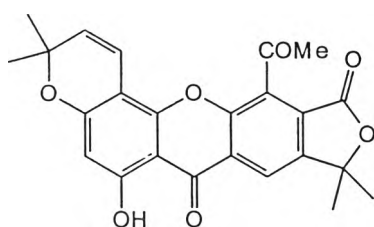
[18] Artonin K



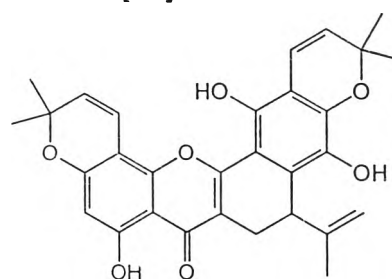
[19] Artonin V



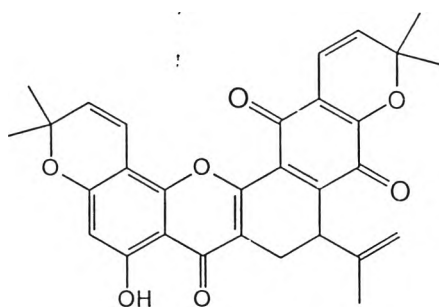
[20] Artonol A



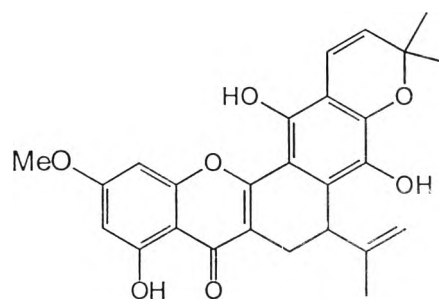
[21] Artonol B



[22] Artonol C

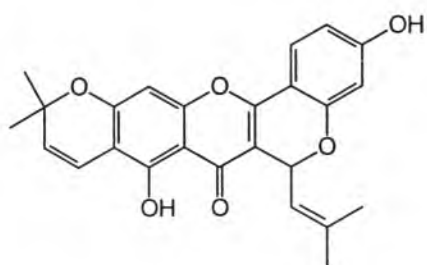


[23] Artonol D

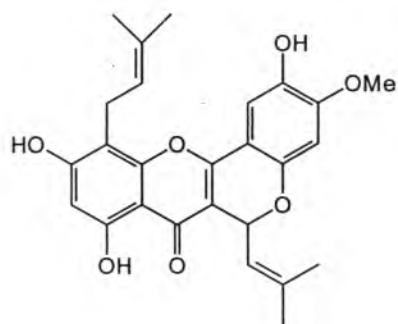


[24] Artonol E

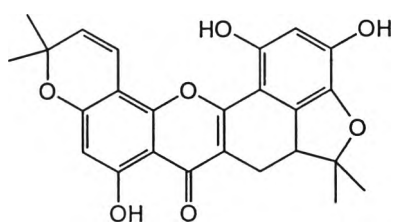
Figure 3 Structures of compounds previously isolated from *Artocarpus* (continued)



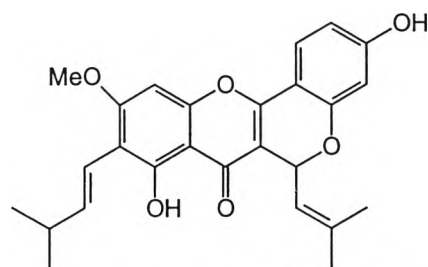
[25] Cudraflavone A



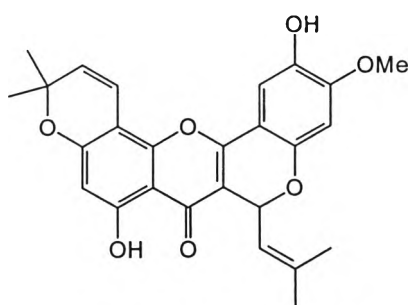
[26] Cycloaltilisins



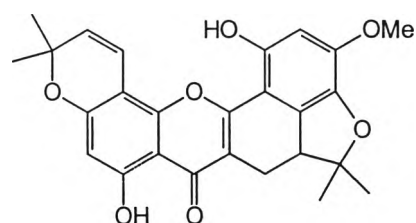
[27] Cycloartobiloxanthone



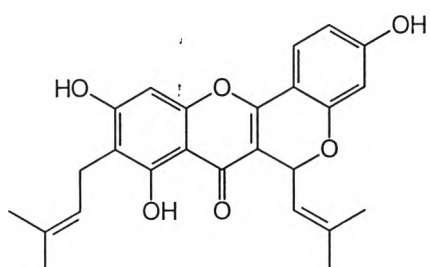
[28] Cycloartocarpin



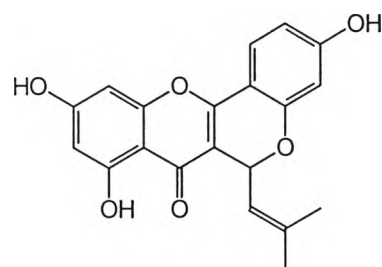
[29] Cycloartomunin



[30] Cycloartomunoxanthone

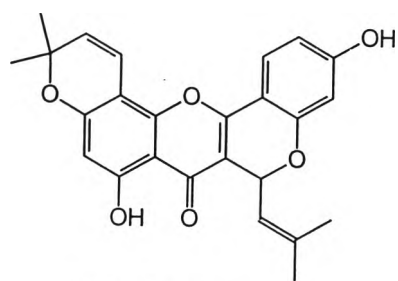


[31] Cyclocommunin

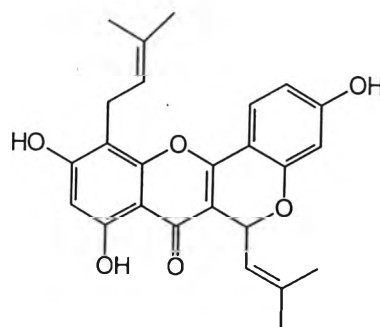


[32] Cyclocommunol

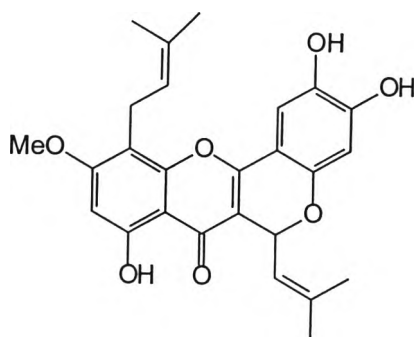
Figure 3 Structures of compounds previously isolated from *Artocarpus* (continued)



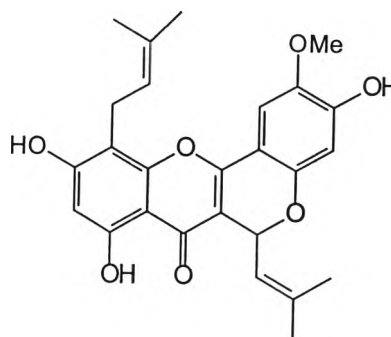
[33] Cyclomorusin



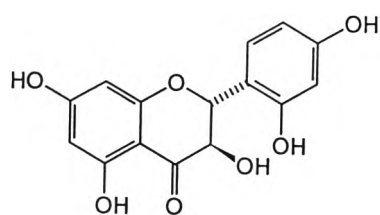
[34] Cyclomulberrin



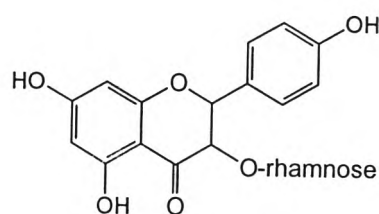
[35] Dihydrocycloartomunin



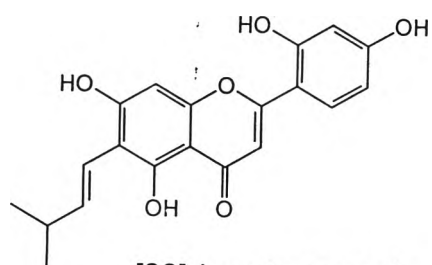
[36] Dihydroisocycloartomunin



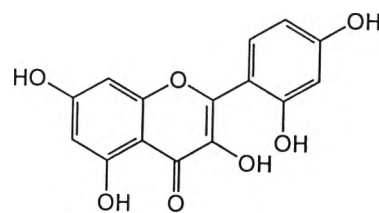
[37] (+)-Dihydromorin



[38] Engeletin

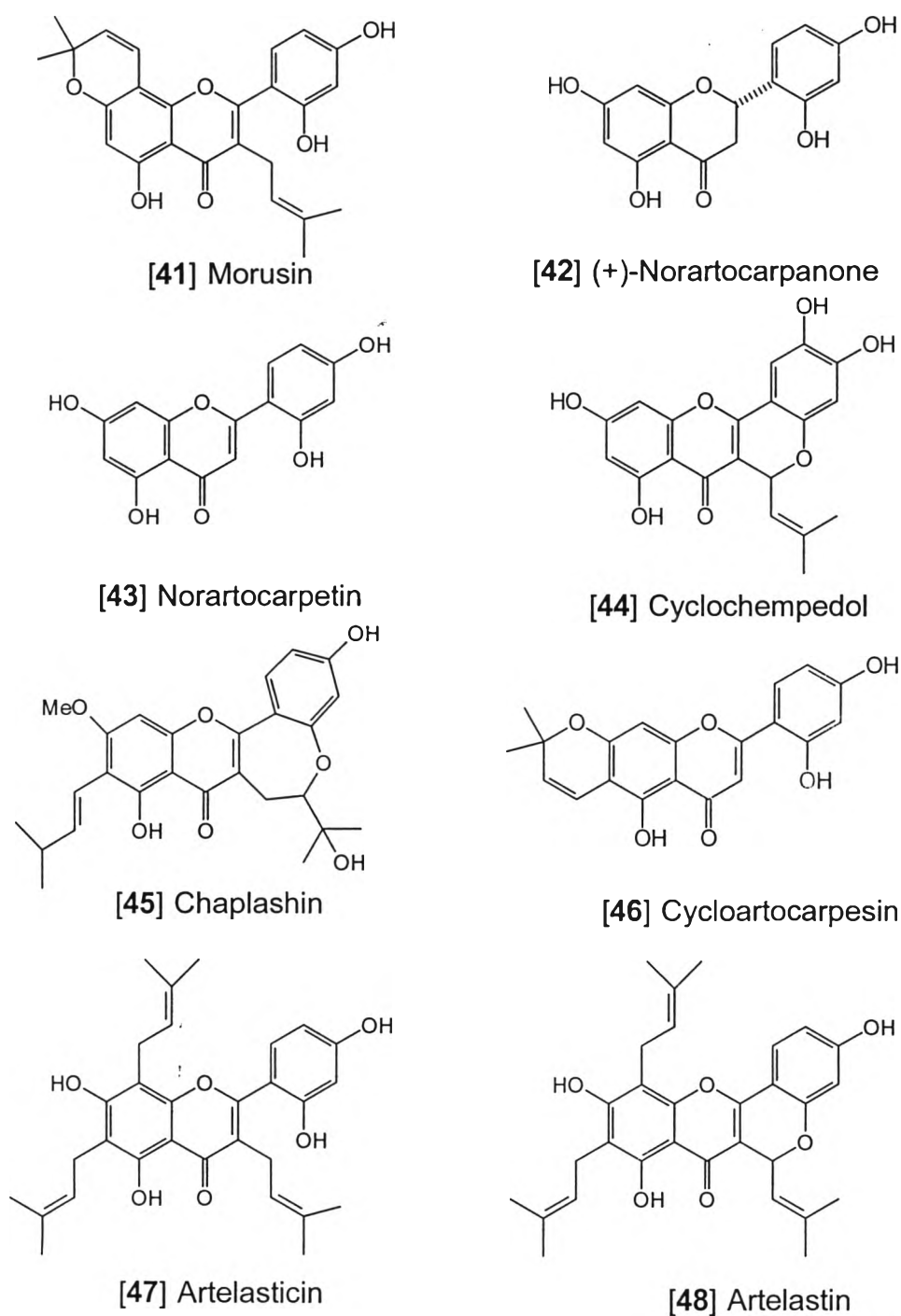


[39] Isoartocarpesin

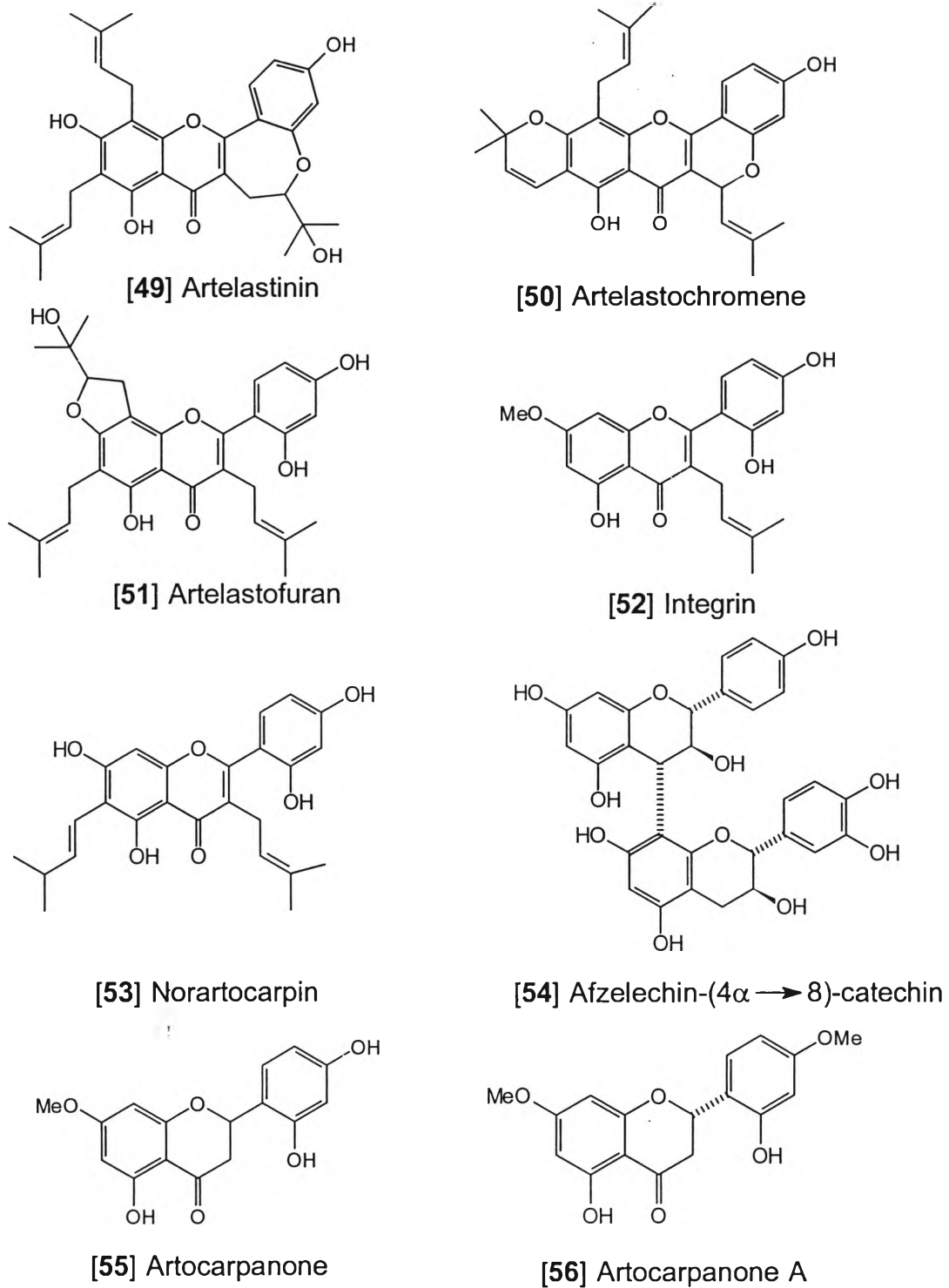


[40] Morin

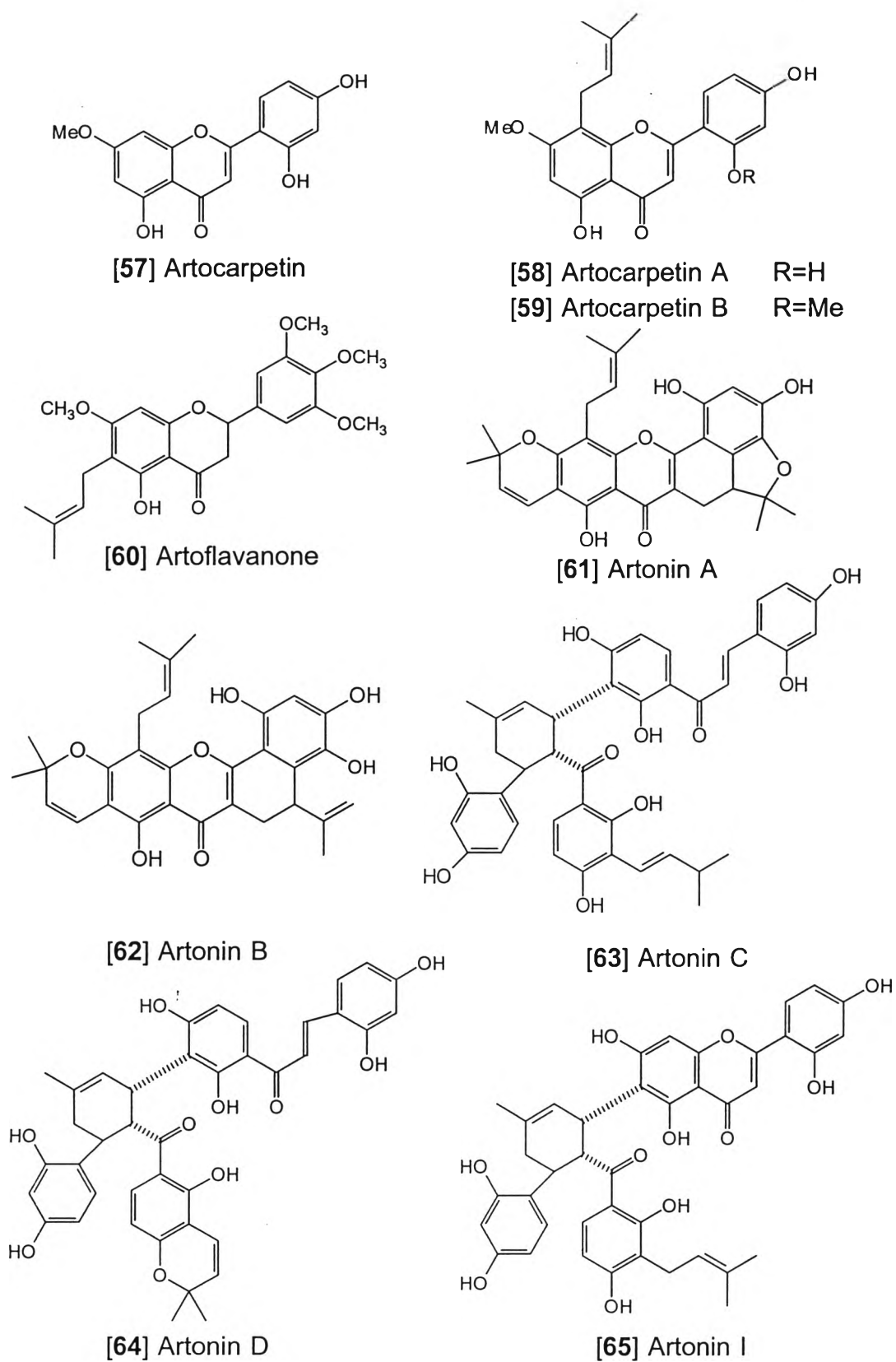
**Figure 3** Structures of compounds previously isolated from *Artocarpus* (continued)



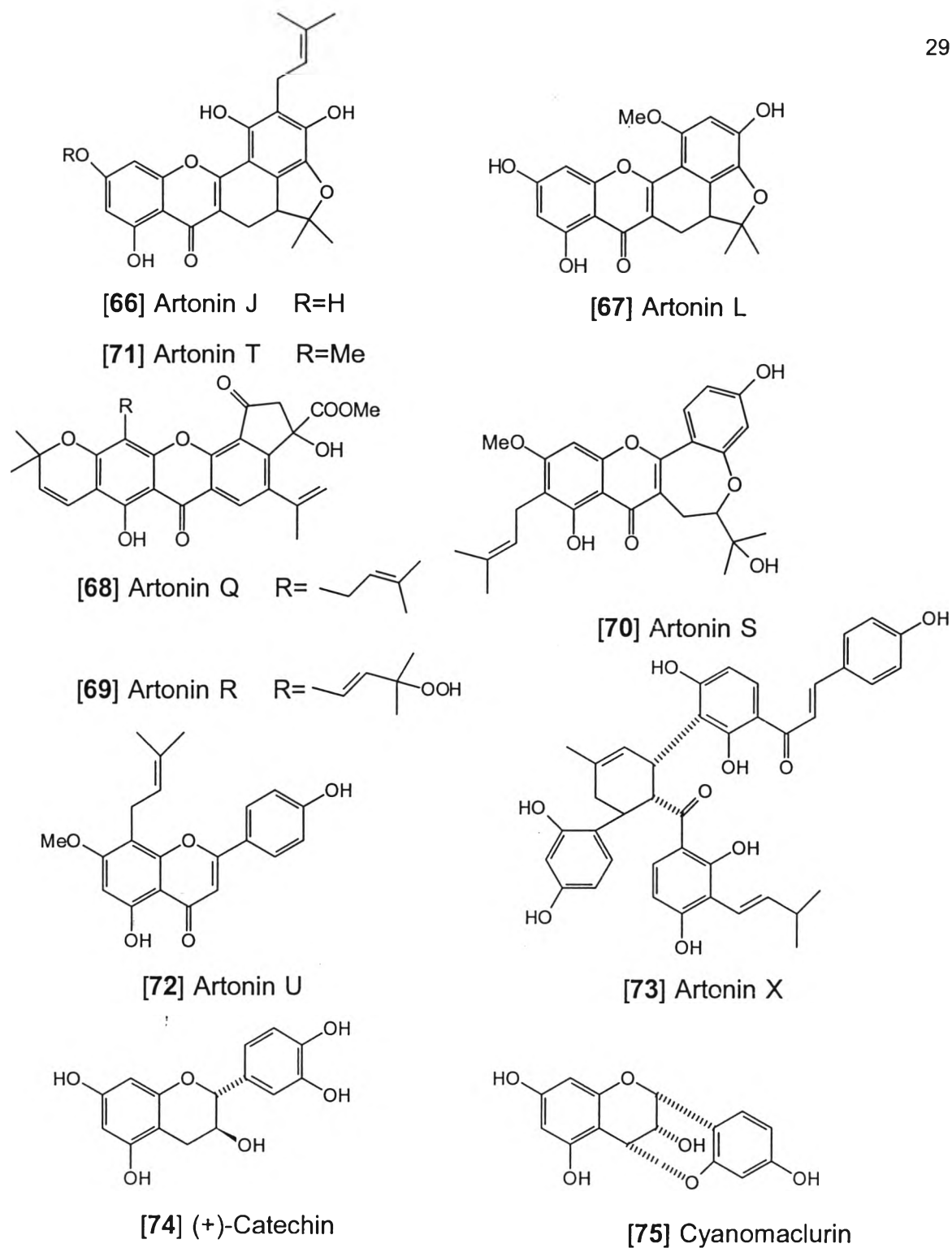
**Figure 3** Structures of compounds previously isolated from *Artocarpus* (continued)



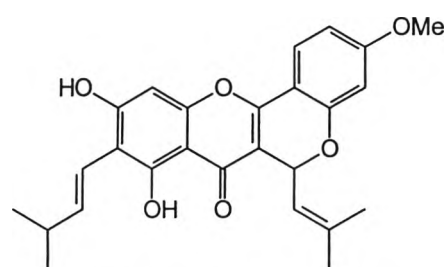
**Figure 3** Structures of compounds previously isolated from *Artocarpus* (continued)



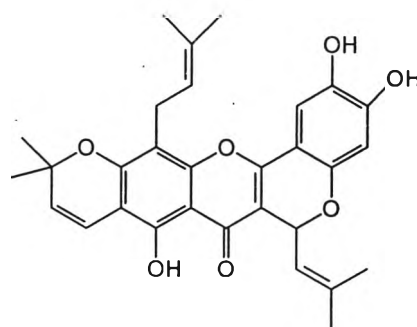
**Figure 3** Structures of compounds previously isolated from *Artocarpus* (continued)



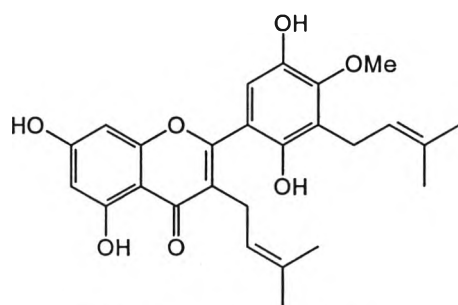
**Figure 3** Structures of compounds previously isolated from *Artocarpus* (continued)



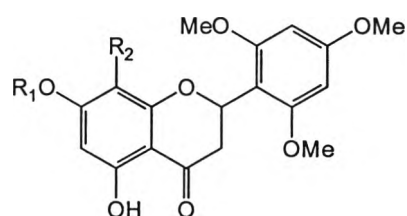
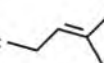
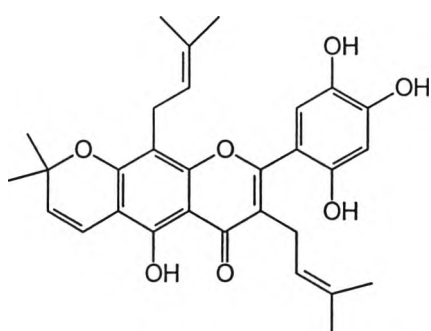
[76] Cycloartocarpin A



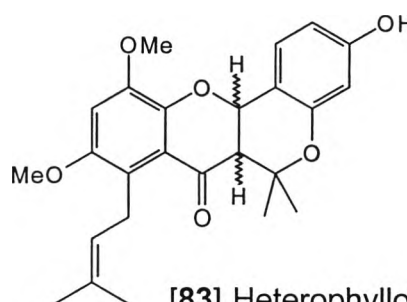
[77] Cycloheterophyllin



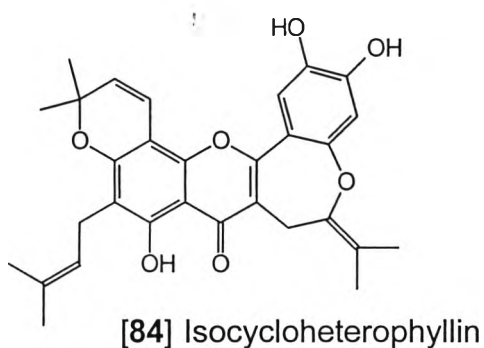
[78] Heteroartonin A

[79] Heteroflavanone A  $R_1=R_2=H$ [80] Heteroflavanone B  $R_1=Me$   $R_2=$  [81] Heteroflavanone C  $R_1=H$   $R_2=$  

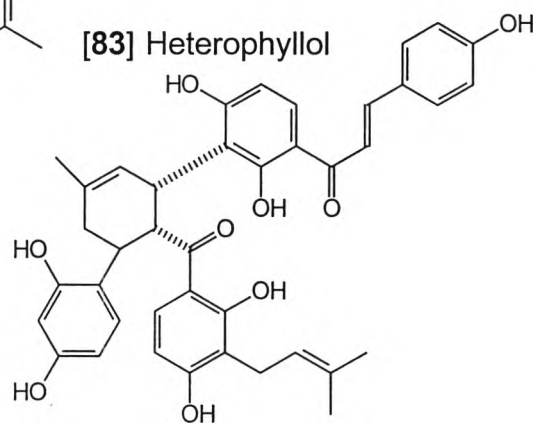
[82] Heterophyllin



[83] Heterophyllol



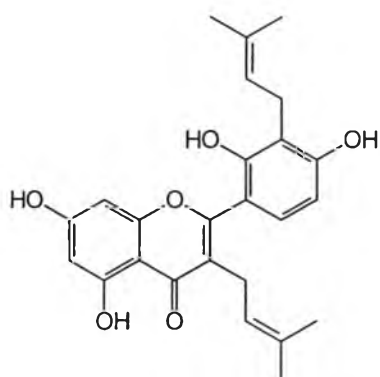
[84] Isocycloheterophyllin



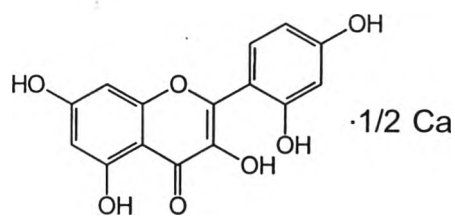
[85] Kuwanon R

**Figure 3** Structures of compounds previously isolated from *Artocarpus* (continued)

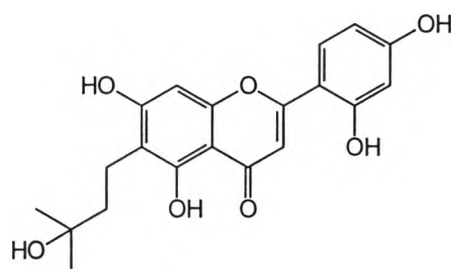




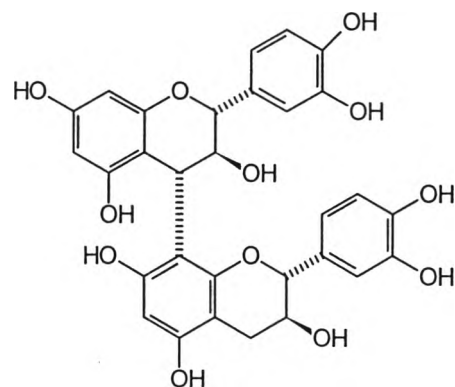
[86] Kuwanon T



[87] Morin-Calcium-chelate

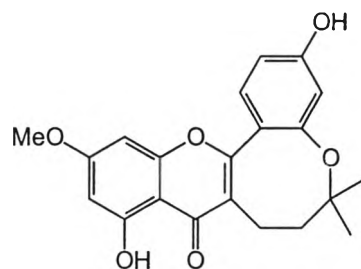


[88] Oxydihydroartocarpesin



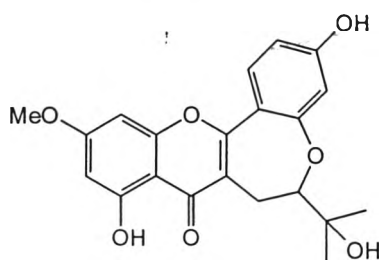
[89] Procyanidin B-3

unknown structure

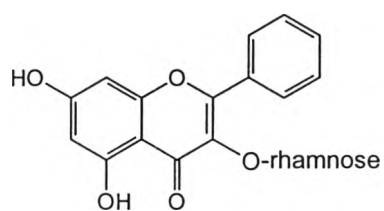


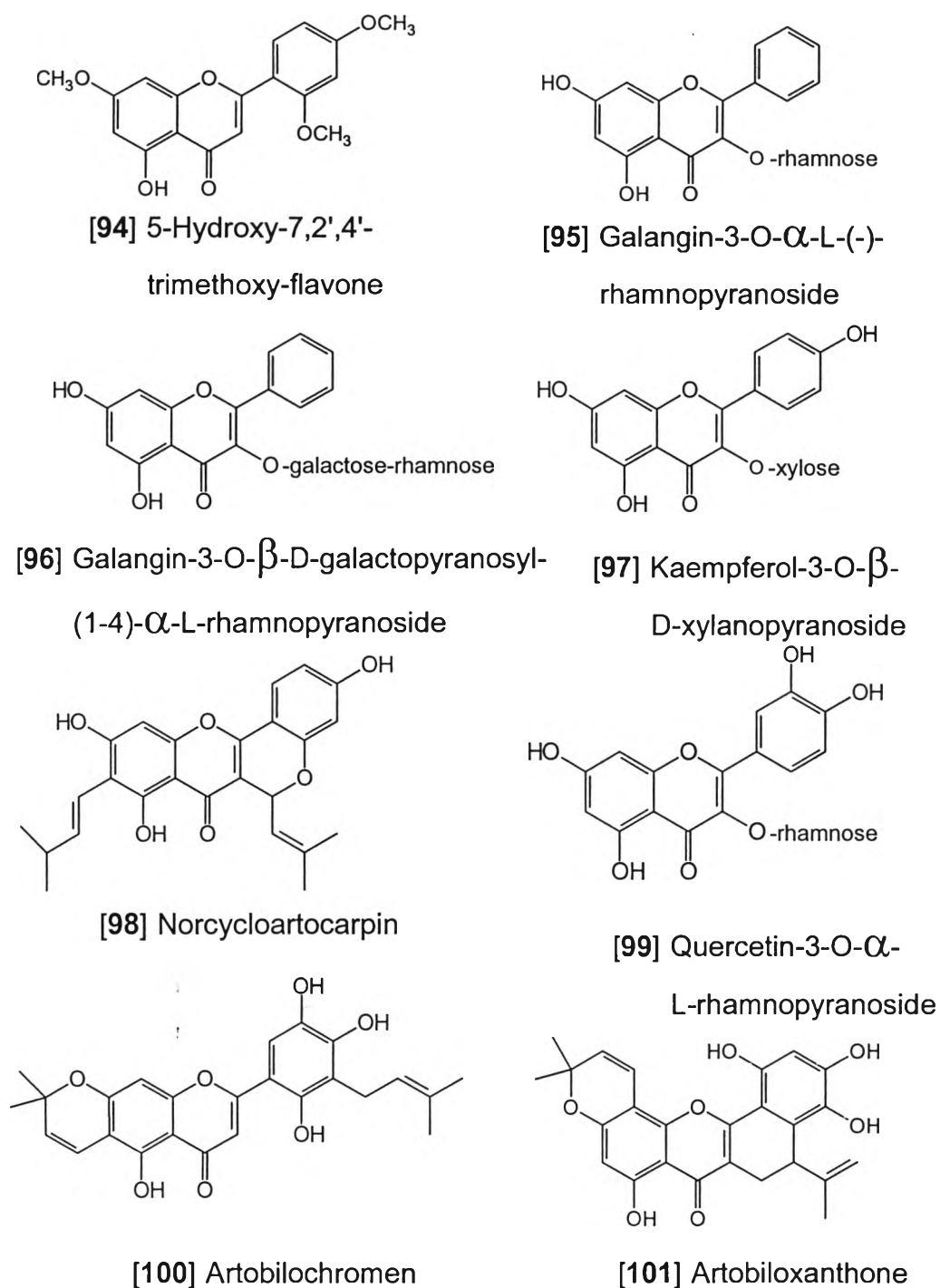
[91] Cyclointegrin

[90] Procyanidin C-1

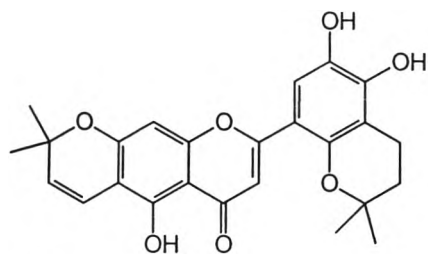


[92] Oxyisocyclointegrin

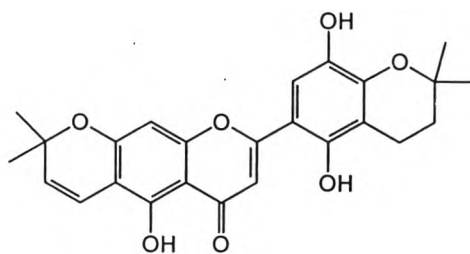
[93] 5,7-Dihydroxyflavone-  
3-O- $\alpha$ -L-rhamnosideFigure 3 Structures of compounds previously isolated from *Artocarpus* (continued)



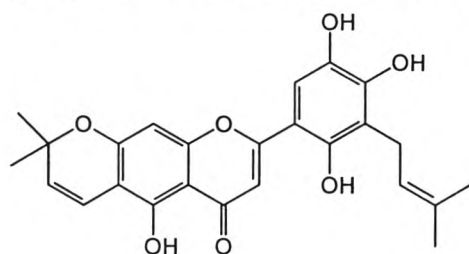
**Figure 3** Structures of compounds previously isolated from *Artocarpus* (continued)



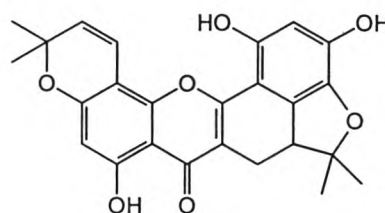
[102] Chromanoartobilochromen A



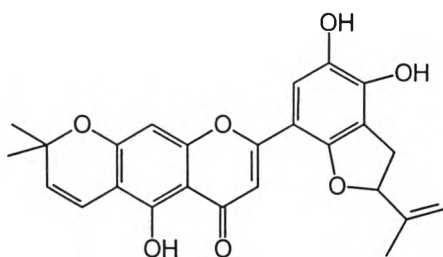
[103] Chromanoartobilochromen B



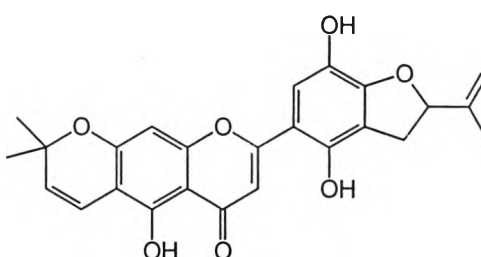
[104] Chromanoartobilochromene



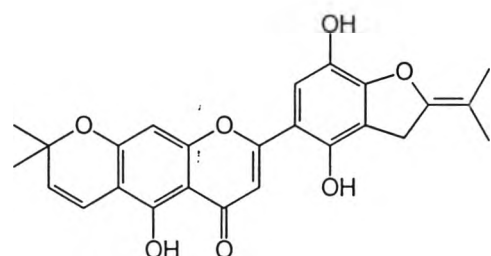
[105] Cycloartobiloxanthone



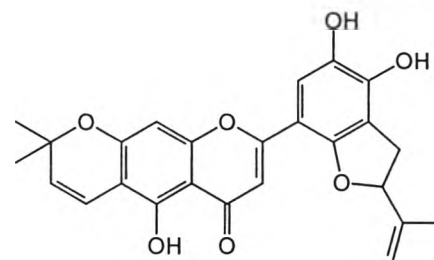
[106] (-)-Dihydrofuranoartobilochromen A



[107] (-)-Dihydrofuranoartobilochromen B-1

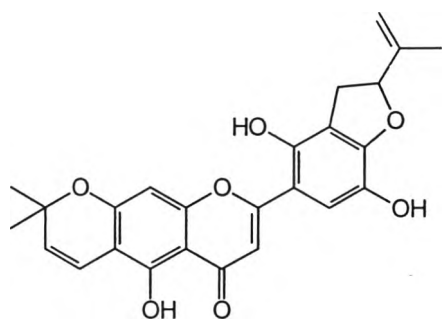


[108] Dihydrofuranoartobilochromen B-2

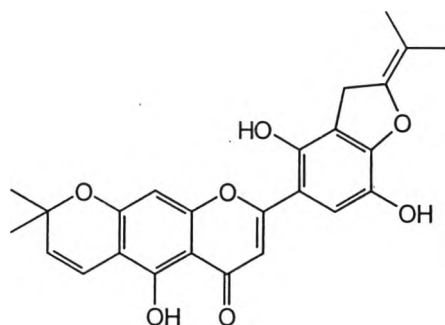


[109] Furanoartobilochromen A

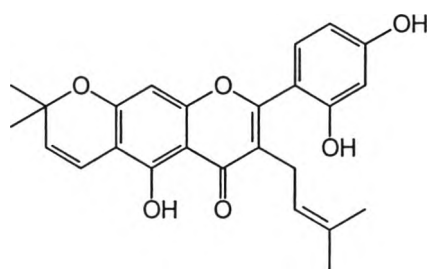
**Figure 3** Structures of compounds previously isolated from *Artocarpus* (continued)



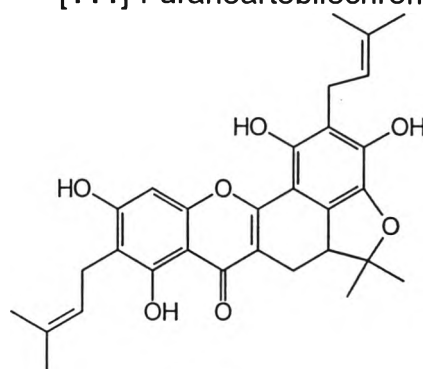
[110] Furanoartobilochromen B-1



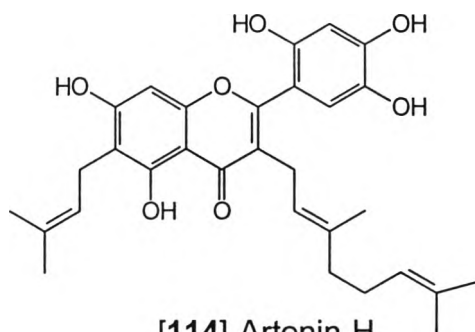
[111] Furanoartobilochromen B-2



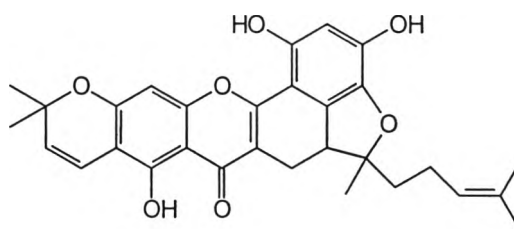
[112] Oxydihydromorusin



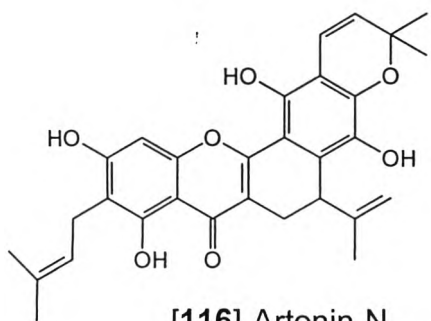
[113] Artonin G



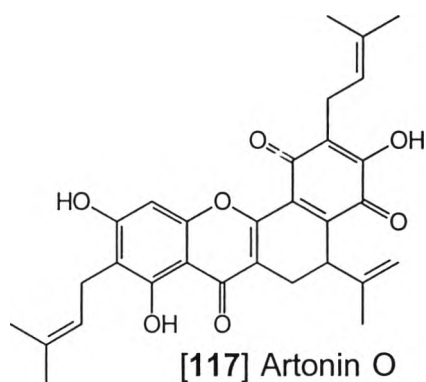
[114] Artonin H



[115] Artonin M

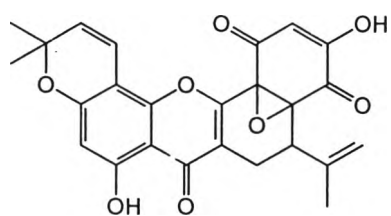


[116] Artonin N

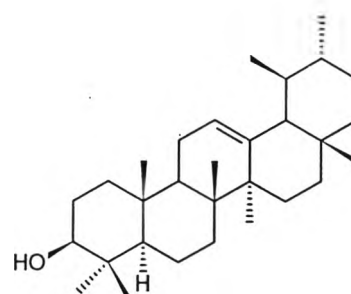
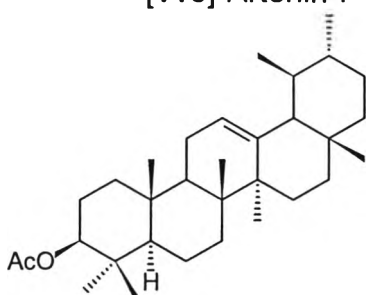
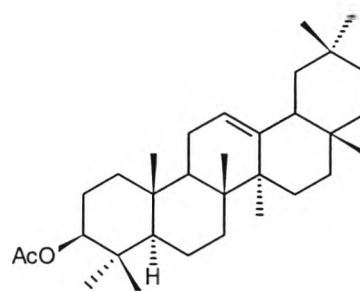
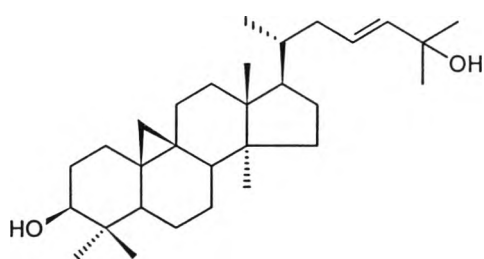
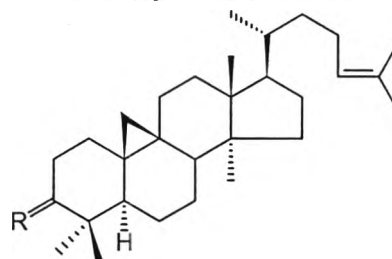



[117] Artonin O

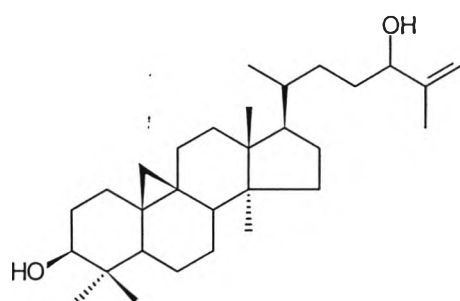

Figure 3 Structures of compounds previously isolated from *Artocarpus* (continued)

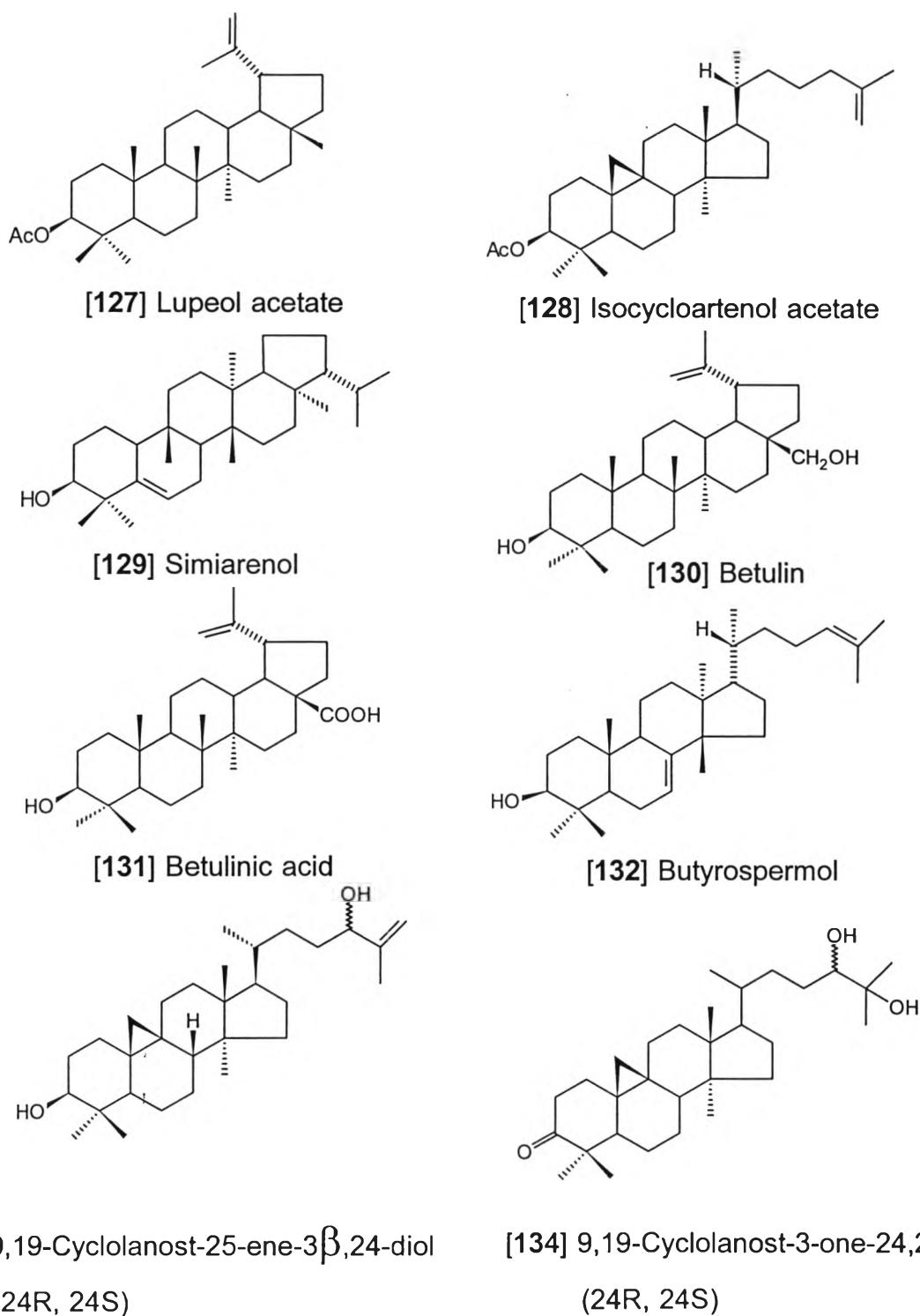


[118] Artonin P

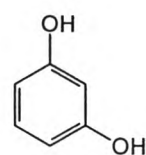
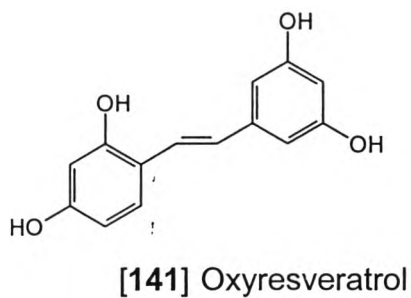
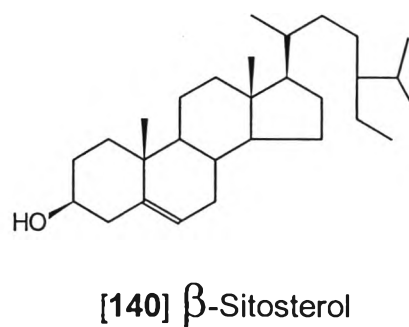
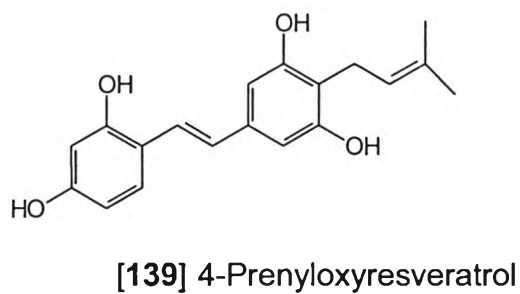
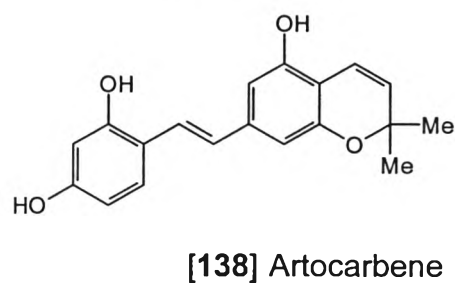
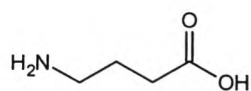
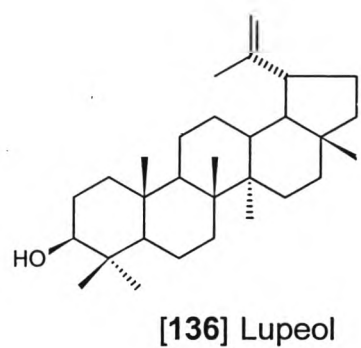
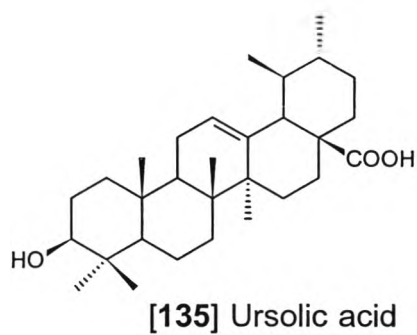
[119]  $\alpha$ -Amyrin[120]  $\alpha$ -Amyrin acetate[121]  $\beta$ -Amyrin acetate[122] Cycloart-23-ene-3 $\beta$ -25-diol[123] Cycloart-24-ene-3 $\beta$ -25-diol  
(Cycloartenol) R= 

[125] Cycloartenone R= =O

[126] Cycloartenyl acetate R= [124] Cycloart-25-one-3 $\beta$ -24-diolFigure 3 Structures of compounds previously isolated from *Artocarpus* (continued)



**Figure 3** Structures of compounds previously isolated from *Artocarpus* (continued)



Unknown structure

[143]  $\beta$ -Resorcyaldehyde

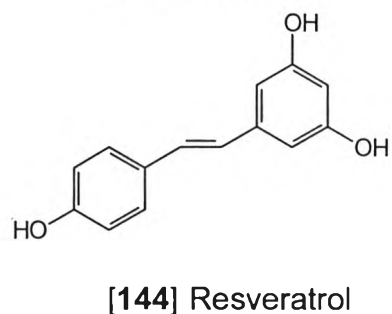
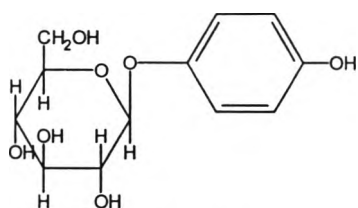
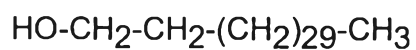


Figure 3 Structures of compounds previously isolated from *Artocarpus* (continued)

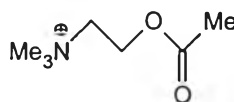


[145] Arbutin



[146] 1-Dotriacontanol

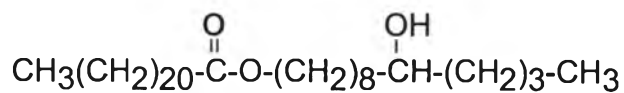
unknown structure



[147] Mesoerythritol

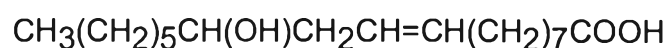
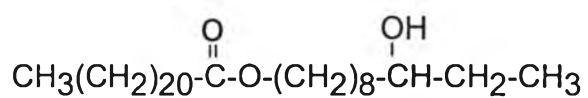
[148] Acetylcholine

unknown structure



[152] Aurantiamide acetate

[153] 9-Hydroxytridecyldocosanoate



[154] 9-Hydroxyundecyldocosanoate

[157] Ricinoleic acid

**Figure 3** Structures of compounds previously isolated from *Artocarpus* (continued)



## 2. Traditional uses and Biological activities of *Artocarpus* compounds.

*Artocarpus* plants have been used in traditional medicine in many countries with several purposes. In West Indies, many parts of *A. altilis* or bread-fruit tree were used: ground fruit rind tea for oliguria, yellow leaf tea for hypertension and diabetes, latex cataplasm for pain, crushed leaves for pain, crushed leaves bound to head for headache and boil leaves for tea for high blood pressure (Ayensu, 1981). In Indonesia, *A. altilis* the bark of the seedless form is one of the constituents of medicine administered postpartum. The ashes of the leaves, with coconut oil and *Curcuma*, are applied to a skin disease with creeps like herpes. A poultice of the roasted and crushed leaves with water is applied to enlarged spleen. The heated flowers, after cooling, are rubbed on the gums to ease toothache. The fruit meat is used to treat cough, the root bark to treat diarrhea and dysentery and the seeds as an aphrodisiac. In the Philippines, a decoction of the bark is employed as a vulnerary and also to treat stomachache. In New Guinea, the latex is a medicine taken to cure dysentery (Perry, 1980). The stems and roots have been used for the treatment of liver cirrhosis and hypotension in Taiwan (Chen *et al.*, 1993).

Concerning *A. heterophyllus* or Jack fruit tree, the fruit is edible. The sap is used to treat ulcers and abscess in Burma, China and the Philippines, and the bark as poultices for the same purposes in Malay Peninsular. The roots are used to treat diarrhea, and in a compound extract to treat fever in Burma. In Indo-China, the wood is used as a sedative to treat convulsions. The boiled leaves are given to both animals and women to activate the secretion of milk, and the sap is antisyphilitic and vermifuge (Perry, 1980).

Traditional uses of the other *Artocarpus* species have been recorded. The sap from the wounded bark of *A. dadah* is employed to cleanse foul leg-wounds in Indonesia. In the same country, a strip of *A. elasticus* pounded is applied as a bandage to treat lumbago. Its leaves mixed with rice are ingested for the treatment of tuberculosis, and the latex is used to treat dysentery. In Indo-China, the latex of *A. rigidus* is applied to wounds of domestic animals. The *A. lakoocha* roots are tonic and deobstruent and its leaves are used for treating dropsy. The boiled bark of *A. ovatus* is used to treat stomachache. The fresh leaves of *A. rubroveniosus* is administered for fevers. In Burma, the juice and seeds of *A. lakoocha* are purgative, and the bark is astringent (Perry, 1980).

A famous Thai traditional medicine from *A. lakoocha* known as "Puag-Haad" has been used as an anthelmintic and antipruritic. Puag-Haad is an aqueous extract of the heartwood of *A. lakoocha* and its activities come from 2,4,3',5'-tetrahydroxystilbene. (Farnsworth and Bunyapraphatsara, 1992; Poopyruchpong *et al.*, 1978).

The anti-inflammatory activities of *Artocarpus* flavonoids have been studied by testing these compounds for their inhibitory actions on arachidonate 5-lipoxygenase. Several compounds such as artonin E [13] from the bark of *A. communis* (Reddy *et al.*, 1991) and chalcones (AC-5-1) [7] from the dried flowers of *A. communis* (Koshihara *et al.*, 1988; Nomura *et al.*, 1998) showed potent inhibition on arachidonate 5-lipoxygenase.

According to a review by Nomura and co-workers in 1998, the *Artocarpus* flavonoids have been studied for many biological activities. Morusin [41] has been found to be an anti-tumor in a two-stage carcinogenesis experiment with teleocidin, and several *Artocarpus* flavonoids act as anti-tumor promoters against the okadaic acid type promotion. About cytotoxic activities, *Artocarpus* flavonoids such as artonin E [13], heterophyllin [82] and cycloheterophyllin [77] showed cytotoxic activities against the cancer cells mouse-L1210 and colon 38. Artomunoxanthotrione epoxide [16], cyclocommunol [32], cyclomulberrin [34] and cyclocommunin [31] showed *in vitro* cytotoxic activities against human hepatoma PLC/PRF/5 and KB cells. The prenyl flavonoids isolated from Formosan *A. communis* and *A. heterophyllus* showed inhibition of arachidonic acid-induced platelet aggregation. Furthermore, the extract of *A. heterophyllus* showed intensive antibacterial activities against cariogenic bacteria and also inhibited the growth of *streptococci* on plaque-forming. In 1998, Shimizu *et al.* reported that several constituents of the heartwood of *A. incisus* showed potent inhibitory activity for tyrosinase enzyme.