CHAPTER II

HISTORICAL

1. Chemical Constiuents of the Genus *Garcinia*

The chemical constiuents of the genus *Garcinia* have been studied for more than 40 years. These compounds were reported as xanthones, flavonoids, triterpenoids, steroids and several miscellaneous substances. However, the main group is xanthones. The distribution of compounds found in various parts of *Garcinia* spp. is shown in Table 1.

Table 1 Distribution of compounds in the genus *Garcinia*

Plant and chemical compound	Category	Plant part	Reference
Garcinia andamanica			
Scutellarein-7-diglucoside	Flavonoid	Leaf	Alam *et al.*, 1986
Sorbifolin-6-galactoside	Flavonoid	Leaf	Alam *et al.*, 1986
4-Hydroxywogonin-7-neo-hesperidoside	Flavonoid	Leaf	Alam *et al.*, 1986
G. atroviridis			
(-)-Hydroxycitric acid	Organic acid	Fruit	Lewis and Neelakantan, 1965
G. buchananii			
Biflavanone GB-1	Flavonoid	Heartwood	Jackson *et al.*, 1972

Table 1 (Continued)

Plant and chemical compound	Category	Plant part	Reference
Biflavanone GB-1a	Flavonoid	Heartwood	Jackson *et al.*, 1972
Biflavanone GB-2	Flavonoid	Heartwood	Jackson *et al.*, 1972
Biflavanone GB-2a	Flavonoid	Heartwood	Jackson *et al.*, 1972
G. cambogia			
Cambogin	Benzenoid	Latex	Rao, Venkatswamy and Pendse, 1980
Garcinol	Benzenoid	Latex	Rao, Venkatswamy and Pendse, 1980
(-)-Hydroxycitric acid	Organic acid	Fruit	Lewis and Neelakantan, 1965
G. conrauana			
Eriodictyol	Flavonoid	Bark	Waterman and Crichton, 1980
Manniflavanone	Flavonoid	Leaf	Hussain and Waterman, 1982
O-Methylfukugetin	Flavonoid	Heartwood	Hussain and Waterman, 1982

Table 1 (Continued)

Plant and chemical compound	Category	Plant part	Reference
Morelloflavone	Flavonoid	Heartwood	Hussain and Waterman, 1982
5,7-Dihydroxychromone	Chromone	Bark	Hussain and Waterman, 1982
Conrauanalactone	Lactone	Bark	Waterman and Crichton, 1980
3-(3",3"-Dimethylally)-conrauanalactone	Lactone	Bark	Hussain and Waterman, 1982
G. cowa			
Cowanin	Xanthone	Latex	Na Pattalung *et al.*, 1994
Cowanol	Xanthone	Latex	Na Pattalung *et al.*, 1994
Cowaxanthone	Xanthone	Latex	Na Pattalung *et al.*, 1994
Norcowanin	Xanthone	Latex	Na Pattalung *et al.*, 1994
1,3,6-Trihydroxy-7-methoxy -2,5-bis(3-methyl-2-butenyl) xanthone	Xanthone	Latex	Na Pattalung *et al.*, 1994
1,3,6-Trihydroxy-7-methoxy -8-(3,7-dimethyl-2,6-octadienyl)xanthone	Xanthone	Stem	Lee and Chan, 1977

Table 1 (Continued)

Plant and chemical compound	Category	Plant part	Reference
G. densivenia			
Pyranojacareubin	Xanthone	Bark	Waterman and Crichton, 1980
Rheediaxanthone-A	Xanthone	Bark	Waterman and Crichton, 1980
Morelloflavone	Flavonoid	Bark	Waterman and Crichton, 1980
O-Methylfukugetin	Flavonoid	Bark	Waterman and Crichton, 1980
G. dulcis			
Amentoflavone	Flavonoid	Leaf	Ansari and Rahman, 1976
Morelloflavone	Flavonoid	Leaf	Ansari and Rahman, 1976
Biflavanone GB-2a	Flavonoid	Leaf	Ansari and Rahman, 1976
Volkensiflavone	Flavonoid	Leaf	Ansari and Rahman, 1976
G. echinocarpa			
1,5-Dihydroxyxanthone	Xanthone	Heartwood	Bandaranayake *et al.*,1975
1,3,6,7-Tetrahydroxyxanthone	Xanthone	Heartwood	Bandaranayake *et al.*,1975

Table 1 (Continued)

Plant and chemical compound	Category	Plant part	Reference
Morelloflavone	Flavonoid	Heartwood	Bandaranayake *et al.*,1975
Volkensiflavone	Flavonoid	Heartwood	Bandaranayake *et al.*,1975
β-Sitosterol	Steroid	Heartwood	Bandaranayake *et al.*,1975
G. eugeniifolia			
1,7-Dihydroxyxanthone	Xanthone	Heartwood	Jackson,Locksley, and Scheinmann, 1969
1,7-Dihydroxy-3-methoxy-xanthone	Xanthone	Heartwood	Jackson,Locksley, and Scheinmann, 1969
1,5,6-Trihydroxyxanthone	Xanthone	Heartwood	Jackson,Locksley, and Scheinmann, 1969
1,6,7-Trihydroxyxanthone	Xanthone	Heartwood	Jackson,Locksley, and Scheinmann, 1969
1,4,7-Trihydroxy-3-methoxy-xanthone	Xanthone	Heartwood	Jackson,Locksley, and Scheinmann, 1969

Table 1 (Continued)

Plant and chemical compound	Category	Plant part	Reference
Biflavanone GB-1	Flavonoid	Heartwood	Jackson,Locksley, and Scheinmann, 1969
Biflavanone GB-1a	Flavonoid	Heartwood	Jackson,Locksley, and Scheinmann, 1969
Biflavanone GB-2	Flavonoid	Heartwood	Jackson,Locksley, and Scheinmann, 1969
Biflavanone GB-2a	Flavonoid	Heartwood	Jackson,Locksley, and Scheinmann, 1969
G. forbesii			
Forbexanthone	Xanthone	Branch	Harrison *et al.*, 1993
Pyranojacareubin	Xanthone	Branch	Harrison *et al.*, 1993
1,3,7-Trihydroxy-2-(3-methyl-but-2-enyl)xanthone	Xanthone	Branch	Harrison *et al.*, 1993
G. gerrardii			
Garcigerrin A	Xanthone	Root bark	Sordat-Diserens *et al.*, 1989
Garcigerrin B	Xanthone	Root bark	Sordat-Diserens *et al.*, 1989

Table 1 (Continued)

Plant and chemical compound	Category	Plant part	Reference
12b-Hydroxy-des-D-garcigerrin	Xanthone	Root bark	Sordat-Diserens *et al.*, 1989
G. hanburyi			
Desoxygambogenin	Xanthone	Resin	Asano *et al.*, 1996
Gambogellic acid	Xanthone	Resin	Asano *et al.*, 1996
Gambogenic acid	Xanthone	Resin	Asano *et al.*, 1996
Gambogenin	Xanthone	Resin	Asano *et al.*, 1996
Gambogenin dimethyl acetal	Xanthone	Resin	Asano *et al.*, 1996
Gambogic acid	Xanthone	Latex	Asano *et al.*, 1996
Gambogin	Xanthone	Resin	Asano *et al.*, 1996
Hanburin	Xanthone	Resin	Asano *et al.*, 1996
Isogambogenin	Xanthone	Resin	Asano *et al.*, 1996
Isogambogic acid	Xanthone	Latex	Asano *et al.*, 1996
Isomorellinol	Xanthone	Latex	Asano *et al.*, 1996
Isomorellin-B	Xanthone	Resin	Asano *et al.*, 1996
Morellin dimethyl acetal	Xanthone	Resin	Asano *et al.*, 1996
Moreollic acid	Xanthone	Resin	Asano *et al.*, 1996
G. huillensis			
Garcinol	Benzenoid	Bark	Bakana *et al.*, 1987
β-Sitosterol	Steroid	Bark	Bakana *et al.*, 1987
Stigmasterol	Steroid	Bark	Bakana *et al.*, 1987

Table 1 (Continued)

Plant and chemical compound	Category	Plant part	Reference
G. indica			
1,7-Dihydroxyxanthone	Xanthone	Heartwood	Cotterill, Scheinmann and Puranik, 1977
Morellcflavone	Flavonoid	Heartwood	Cotterill, Scheinmann and Puranik, 1977
Volkensiflavone	Flavonoid	Heartwood	Cotterill, Scheinmann and Puranik, 1977
Hydroxycitric acid	Organic acid	Fruit	Lewis and Neelakantan, 1965
Garcinol	Benzenoid	Fruit peel	Krishnaumurthy, Lewis and Ravindrawath, 1981
G. kola			
Amentoflavone	Flavonoid	Seed	Iwu and Igboko, 1982
4'-Methylapigenin	Flavonoid	Seed	Iwu and Igboko, 1982
4',5,7-Trimethylapigenin	Flavonoid	Seed	Iwu and Igoboko, 1982

Table 1 (Continued)

Plant and chemical compound	Category	Plant part	Reference
Kolaflavanone	Flavonoid	Seed	Iwu and Igboko, 1982
Biflavanone GB-1	Flavonoid	Seed	Iwu and Igboko, 1982
Biflavanone GB-1a	Flavonoid	Seed	Cotterill and Scheinmann, 1978
Biflavanone GB-2	Flavonoid	Seed	Cotterill and Scheinmann, 1978
Biflavanone GB-3	Flavonoid	Seed	Kabangu *et al.*, 1987
Kolanone	Benzenoid	Fruit pulp	Hussain *et al.*, 1982
Garcinol	Benzenoid	Root	Niwa, Terashima and Agil, 1993
Garcipyran	Benzenoid	Root	Niwa *et al.*, 1994
Garcifuran A	Benzenoid	Root	Niwa *et al.*, 1994
Garcifuran B	Benzenoid	Root	Niwa *et al.*, 1994
Cycloartenol	Benzenoid	Seed	Aplin *et al.*, 1967
24-Methylenecycloartenol	Benzenoid	Seed	Aplin *et al.*, 1967
G. livingsonei			
6,11-Dihydroxy-2,2-dimethylpyrano [3,2-C] xanthen-7(2H)-one	Xanthone	Root bark	Sordat-Diserens *et al.*, 1992

Table 1 (Continued)

Plant and chemical compound	Category	Plant part	Reference
6,11-Dihydroxy-3-methyl-3-(4-methylpent-3-enyl) -3H-pyrano [2,3-C]xanthen-7-one	Xanthone	Root bark	Sordat-Diserens *et al.*, 1992
4-(3',7'-Dimethylocta-2',6'-dienyl)-1,3,5-trihydroxy-9H-xanthen-9-one	Xanthone	Root bark	Sordat-Diserens *et al.*, 1992
Garcilvin A	Xanthone	Root bark	Sordat-Diserens *et al.*, 1992
Garcilvin B	Xanthone	Root bark	Sordat-Diserens *et al.*, 1992
Garcilvin C	Xanthone	Root bark	Sordat-Diserens *et al.*, 1992
12b-Hydroxy-des-D-garcigerrin	Xanthone	Root bark	Sordat-Diserens *et al.*, 1992
1,4,5-Trihydroxy-3-(3-methyl but-2-enyl)-9H-xanthene-9-one	Xanthone	Root bark	Sordat-Diserens *et al.*, 1992
Guttiferone A	Benzenoid	Fruit	Gustafson *et al.*, 1992
Amentoflavone	Flavonoid	Leaf	Pelter and Warren, 1971
G. lucida			
30-Hydroxycycloartenol	Triterpene	Bark	Nyemba *et al.*, 1990

Table 1 (Continued)

Plant and chemical compound	Category	Plant part	Reference
31-Norcycloartenol	Triterpene	Bark	Nyemba *et al.*, 1990
24,25-Epoxycycloartenol	Triterpene	Bark	Nyemba *et al.*, 1990
G. mangostana			
2,8-bis-(γ,γ-Dimethylallyl)-1,3,7-trihydroxyxanthone	Xanthone	Aril	Mahabusarakam, Wiriyachitra and Taylor, 1987
Calabaxanthone	Xanthone	Aril	Mahabusarakam, Wiriyachitra and Taylor, 1987
Demethylcalabaxanthone	Xanthone	Aril	Mahabusarakam, Wiriyachitra and Taylor, 1987
Gartanin	Xanthone	Fruit hull	Mahabusarakam, Wiriyachitra and Taylor, 1987
1-Isomangostin	Xanthone	Fruit hull	Mahabusarakam, Wiriyachitra and Taylor, 1987
1-Isomangostin hydrate	Xanthone	Fruit hull	Mahabusarakam, Wiriyachitra and Taylor, 1987

Table 1 (Continued)

Plant and chemical compound	Category	Plant part	Reference
3-Isomangostin	Xanthone	Fruit hull	Mahabusarakam, Wiriyachitra and Taylor, 1987
3-Isomangostin hydrate	Xanthone	Fruit hull	Mahabusarakam, Wiriyachitra and Taylor, 1987
α-Mangostin	Xanthone	Fruit hull	Mahabusarakam, Wiriyachitra and Taylor, 1987
β-Mangostin	Xanthone	Fruit hull	Mahabusarakam, Wiriyachitra and Taylor, 1987
γ-Mangostin	Xanthone	Fruit hull	Mahabusarakam, Wiriyachitra and Taylor, 1987
8-Deoxygartanin	Xanthone	Fruit hull	Govindachari *et al.*, 1971
BR-xanthone A	Xanthone	Fruit hull	Balasubramanian and Rajagopalan, 1988
BR-xanthone B	Xanthone	Fruit hull	Balasubramanian and Rajagopalan, 1988
Garcinone A	Xanthone	Fruit hull	Sen *et al.*, 1982

Table 1 (Continued)

Plant and chemical compound	Category	Plant part	Reference
Garcinone B	Xanthone	Fruit hull	Sen *et al.*, 1982
Garcinone C	Xanthone	Fruit hull	Sen *et al.*, 1982
Garcinone D	Xanthone	Fruit hull	Sen *et al.*, 1986
Garcinone E	Xanthone	Fruit hull	Asai *et al.*, 1985
Mangostinone	Xanthone	Fruit hull	Asai *et al.*, 1985
1,3,6,7-Tetrahydroxyxanthone	Xanthone	Heartwood	Holloway and Scheinmann, 1975
1,3,6,7-Tetrahydroxyxanthone *O*-β-D-glucoside	Xanthone	Heartwood	Holloway and Scheinmann, 1975
Maclurin	Benzenoid	Heartwood	Holloway and Scheinmann, 1975
Egonol	Benzenoid	Fruit hull	Sakai *et al.*, 1993
G. mannii			
Biflavanone GB-1	Flavonoid	Bark	Crichton and Waterman, 1979
Biflavanone GB-1a	Flavonoid	Bark	Crichton and Waterman, 1979
Biflavanone GB-2	Flavonoid	Bark	Crichton and Waterman, 1979
Biflavanone GB-2a	Flavonoid	Bark	Crichton and Waterman, 1979
Manniflavanone	Flavonoid	Bark	Crichton and Waterman, 1979

Table 1 (Contined)

Plant and chemical compound	Category	Plant part	Reference
Kolaflavanone	Flavonoid	Bark	Crichton and Waterman, 1979
β-Sitosterol	Steroid	Bark	Crichton and Waterman, 1979
Stigmasterol	Steroid	Bark	Crichton and Waterman, 1979
Xanthochymol	Benzenoid	Bark	Crichton and Waterman, 1979
G. morella			
Morelloflavone	Flavonoid	Heartwood	Karanjgaokar, Radhakrishnan and Venkataraman, 1967
G. multiflora			
1,3,6,7-Tetrahydroxyxanthone	Xanthone	Heartwood	Chen, Lin and Hung, 1975
Apigenin	Flavonoid	Heartwood	Chen, Lin and Hung, 1975
Biflavanone GB-1a	Flavonoid	Heartwood	Chen, Lin and Hung, 1975
Biflavanone GB-2a	Flavonoid	Heartwood	Chen, Lin and Hung, 1975

Table 1 (Continued)

Plant and chemical compound	Category	Plant part	Reference
GB-1a glucoside	Flavonoid	Heartwood	Chen, Lin and Hung, 1975
Fukugiside	Flavonoid	Heartwood	Chen, Lin and Hung, 1975
Morelloflavone	Flavonoid	Heartwood	Chen, Lin and Hung, 1975
Spicataside	Flavonoid	Heartwood	Chen, Lin and Hung, 1975
Volkensiflavone	Flavonoid	Heartwood	Chen, Lin and Hung, 1975
Xanthochymuside	Flavonoid	Heartwood	Chen, Lin and Hung, 1975
G. myrtifolia			
Euphol	Triterpene	Bark	Spino *et al.*, 1995
Friedelin	Triterpene	Bark	Spino *et al.*, 1995
Myrtiaphenone A	Benzenoid	Bark	Spino *et al.*, 1995
Myrtiaphenone B	Benzenoid	Bark	Spino *et al.*, 1995
Vismiaphenone C	Benzenoid	Bark	Spino *et al.*, 1995
G. nervosa			
Nervosaxanthone	Xanthone	Bark	Ampofo and Waterman, 1986
Rubraxanthone	Xanthone	Bark	Ampofo and Waterman, 1986

Table 1 (Continued)

Plant and chemical compound	Category	Plant part	Reference
β-Sitosterol	Steroid	Bark	Ampofo and Waterman, 1986
Stigmasterol	Steroid	Bark	Ampofo and Waterman, 1986
7-Methyltectorigenin	Flavonoid	Leaf	Ilyas *et al.*, 1994
Irigenin	Flavonoid	Leaf	Ilyas *et al.*, 1994
Nervosin	Flavonoid	Leaf	Ilyas *et al.*, 1994
G. opaca			
Macluraxanthone	Xanthone	Leaf	Goh *et al.*, 1992
1,3,5-Trihydroxy-6',6'-dimethylpyrano (2',3': 6,7)-4-(1,1-dimethylprop-2-enyl) xanthone	Xanthone	Leaf	Goh *et al.*, 1992
1,3,5-Trihydroxy-6',6'-dimethylpyrano-(2',3': 6,7)-2-(3-methyl-but-2-enyl)-4-(1,1-dimethylprop-2-enyl) xanthone	Xanthone	Leaf	Goh *et al.*, 1992
Friedelin	Triterpene	Leaf	Goh *et al.*, 1992
Taraxerol	Triterpene	Leaf	Goh *et al.*, 1992
β-Sitosterol	Steroid	Leaf	Goh *et al.*, 1992
G. ovalifolia			
Macluraxanthone	Xanthone	Bark	Waterman and Crichton, 1980

Table 1 (Continued)

Plant and chemical compound	Category	Plant part	Reference
Fridelin	Triterpene	Bark	Waterman and Crichton, 1980
β-Sitosterol	Steroid	Bark	Waterman and Crichton, 1980
Xanthochymol	Benzenoid	Bark	Waterman and Crichton, 1980
Guttiferone E	Benzenoid	Leaf	Gustafson *et al.*, 1992
Isoxanthochymol	Benzenoid	Leaf	Gustafson *et al.*, 1992
G. parivofolia			
Rubraxanthone	Xanthone	Latex	Na Pattalung *et al.*, 1988
G. pedunculata			
1,3,5,7-Tetrahydroxyxanthone	Xanthone	Heartwood	Rao *et al.*, 1974
1,3,6,7-Tetrahydroxyxanthone	Xanthone	Heartwood	Rao *et al.*, 1974
Biflavanone GB-1a	Flavonoid	Heartwood	Rao *et al.*, 1974
Volkensiflavone	Flavonoid	Heartwood	Rao *et al.*, 1974
2,3',4,5',6-Pentahydroxy-benzophenone	Benzenoid	Heartwood	Rao *et al.*, 1974
Cambogin	Benzenoid	Pericarp	Sahu, Das and Chatterjee, 1989

Table 1 (Continued)

Plant and chemical compound	Category	Plant part	Reference
Garcinol	Benzenoid	Pericarp	Sahu, Das and Chatterjee, 1989
Pedunculol	Benzenoid	Pericarp	Sahu, Das and Chatterjee, 1989
G. poiyantha			
Isorheediaxanthone B	Xanthone	Bark	Ampofo and Waterman, 1986
Xanthochymuside	Flavonoid	Bark	Ampofo and Waterman, 1986
Isoxanthochymol	Benzenoid	Bark	Ampofo and Waterman, 1982
Xanthochymol	Benzenoid	Bark	Ampofo and Waterman, 1982
G. pyrifera			
Isocowanin	Xanthone	Bark	Ampofo and Waterman, 1986
Isocowanol	Xanthone	Bark	Ampofo and Waterman, 1986
Rubraxanthone	Xanthone	Bark	Ampofo and Waterman, 1986
β-Amyrin	Triterpene	Bark	Ampofo and Waterman, 1986
Oleanolic aldehyde	Triterpene	Bark	Ampofo and Waterman, 1986

Table 1 (Continued)

Plant and chemical compound	Category	Plant part	Reference
G. quadrifaria			
1,3,5-Trihydroxy-4,8-di(3',3'-dimethylally) xanthone	Xanthone	Bark	Waterman and Hussain, 1982
O-Methylfukugetin	Flavonoid	Bark, Seed	Waterman and Hussain, 1982
Morelloflavone	Flavonoid	Bark, Seed	Waterman and Hussain, 1982
G. quaesita			
Hermonionic acid	Benzenoid	Bark	Gunatilaka, Sriyani and Sotheeswaran, 1984
Quaesitol	Benzenoid	Bark	Gunatilaka, Sriyani and Sotheeswaran, 1984
G. spicata			
Biflavanone GB-1	Flavonoid	Leaf	Gunatilaka *et al.*, 1984
Biflavanone GB-1a	Flavonoid	Leaf	Gunatilaka *et al.*, 1984
Biflavanone GB-2	Flavonoid	Leaf	Gunatilaka *et al.*, 1984

Table 1 (Continued)

Plant and chemical compound	Category	Plant part	Reference
Biflavanone GB-2a	Flavonoid	Leaf	Gunatilaka *et al.*, 1984
Morelloflavone	Flavonoid	Leaf	Gunatilaka *et al.*, 1984
Friedelan-3b-ol	Triterpene	Leaf	Gunatilaka *et al.*, 1984
Friedelin	Triterpene	Leaf	Gunatilaka *et al.*, 1984
β-Sitosterol	Steroid	Leaf	Gunatilaka *et al.*, 1984
G. staudtii			
Rheediaxanthone-A	Xanthone	Bark	Waterman and Hussain, 1982
Xanthochymol	Benzenoid	Bark	Waterman and Hussain, 1982
G. subelliptica			
Garciniaxanthone A	Xanthone	Heartwood	Minami *et al.*, 1994
Garciniaxanthone B	Xanthone	Heartwood	Minami *et al.*, 1994
Garciniaxanthone C	Xanthone	Heartwood	Minami *et al.*, 1994
Garciniaxanthone D	Xanthone	Heartwood	Minami *et al.*, 1995

Table 1 (Continue)

Plant and chemical compound	Category	Plant part	Reference
Garciniaxanthone E	Xanthone	Heartwood	Minami *et al.*, 1996
Symphoxanthone	Xanthone	Heartwood	Minami *et al.*, 1996
1-*O*-Methylsymphoxanthone	Xanthone	Heartwood	Minami *et al.*, 1996
2,5-Dihydroxy-1-methoxy-xanthone	Xanthone	Heartwood	Minami *et al.*, 1996
Subelliptenone A	Xanthone	Root bark	Iinuma *et al.*, 1994
Subelliptenone B	Xanthone	Root bark	Iinuma *et al.*, 1994
Subelliptenone C	Xanthone	Root bark	Iinuma *et al.*, 1995
Subelliptenone D	Xanthone	Root bark	Iinuma *et al.*, 1995
Subelliptenone E	Xanthone	Root bark	Iinuma *et al.*, 1995
Subelliptenone F	Xanthone	Root bark	Iinuma *et al.*, 1995
Subelliptenone G	Xanthone	Root bark	Iinuma *et al.*, 1995
Subelliptenone H	Xanthone	Root bark	Iinuma *et al.*, 1995

Table 1 (Continued)

Plant and chemical compound	Category	Plant part	Reference
Subelliptenone I	Xanthone	Root bark	Iinuma *et al.*, 1995
1,5-Dihydroxy-3-methoxy-xanthone	Xanthone	Root bark	Iinuma *et al.*, 1995
Globuxanthone	Xanthone	Root bark	Iinuma *et al.*, 1995
12b-Hydroxy-des-D-garcigerin	Xanthone	Root bark	Iinuma *et al.*, 1995
1,2,5-Trihydroxyxanthone	Xanthone	Heartwood	Minami *et al.*, 1994
1,5-Dihydroxyxanthone	Xanthone	Heartwood	Minami *et al.*, 1994
1,2-Dihydroxy-5,6-dimethoxy xanthone	Xanthone	Heartwood	Minami *et al.*, 1994
2,6-Dihydroxy-1,5dimethoxy xanthone	Xanthone	Heartwood	Minami *et al.*, 1994
1,6-Dihydroxy-5-methoxy-xanthone	Xanthone	Heartwood	Minami *et al.*, 1994
1,8-Dihydroxy-6-methoxy-xanthone	Xanthone	Heartwood	Minami *et al.*, 1994
Subellinone	Benzenoid	Heartwood	Fukuyama *et al.*, 1993
G. tarboti			
Talbotaflavone	Flavonoid	Root	Joshi *et al.*, 1970

Table 1 (Continued)

Plant and chemical compound	Category	Plant part	Reference
Morelloflavone	Flavonoid	Root	Joshi *et al.*, 1970
G. terpnophylla			
1,5-Dihydroxyxanthone	Xanthone	Heartwood	Bandaranayake *et al.*, 1975
Euxanthone	Xanthone	Heartwood	Bandaranayake *et al.*, 1975
α-Mangostin	Xanthone	Heartwood	Bandaranayake *et al.*, 1975
Biflavanone GB-1	Flavonoid	Bark	Bandaranayake *et al.*, 1975
Biflavanone GB-1a	Flavonoid	Bark	Bandaranayake *et al.*, 1975
Biflavanone GB-2	Flavonoid	Bark	Bandaranayake *et al.*, 1975
β-Sitosterol	Steroid	Bark	Bandaranayake *et al.*, 1975
G. thwaitesii			
2,5-Dihydroxy-1,6-dimethoxy xanthone	Xanthone	Bark, Timber	Guna tilaka et al., 1983
Biflavanone GB-1	Flavonoid	Bark, Timber	Guna tilaka et al., 1983
Biflavanone GB-1a	Flavonoid	Bark, Timber	Guna tilaka et al., 1983

Table 1 (Continued)

Plant and chemical compound	Category	Plant part	Reference
Biflavanone GB-2	Flavonoid	Bark, Timber	Guna tilaka et al., 1983
Biflavanone GB-2a	Flavonoid	Bark, Timer	Guna tilaka et al., 1983
β-Amyrin	Triterpene	Bark, Timber	Guna tilaka et al., 1983
Tirucallol	Triterpene	Bark, Timber	Guna tilaka et al., 1983
G. xanthochymus			
Betulin	Triterpene	Leaf	Singh *et al.*, 1991
Canophyllol	Triterpene	Leaf	Singh *et al.*, 1991
Friedelin	Triterpene	Leaf	Singh *et al*., 1991
β-Sitosterol	Steroid	Leaf	Singh *et al.*, 1991
Xanthochymuside	Flavonoid	Wood	Konoshima and Ikeshiro, 1970
Xanthochymol	Benzenoid	Fruit	Karanjgaokar *et al.*, 1973
Isoxanthochymol	Benzenoid	Fruit	Karanjgaokar *et al.*, 1973
1,5-Dihydroxyxanthone	Xanthone	Fruit	Karanjgaokar *et al.*, 1973
Euxanthone	Xanthone	Fruit	Karanjgaokar *et al.*, 1973

Table 1 (Continued)

Plant and chemical compound	Category	Plant part	Reference
G. volkensii			
Biflavanone GB-1a	Flavonoid	Heart wood	Herbin *et al.*, 1970
Biflavanone GB-2a	Flavonoid	Heart wood	Herbin *et al.*, 1970
Volkensiflavone	Flavonoid	Heart wood	Herbin *et al.*, 1970
Morelloflavone	Flavonoid	Heart wood	Herbin *et al.*, 1970
Naringenin	Flavonoid	Heart wood	Herbin *et al.*, 1970
Apigenin	Flavonoid	Heart wood	Herbin *et al.*, 1970

2. Xanthones from the Genus *Garcinia*

2.1 Introduction of Xanthones

Xanthones are heterocyclic ketone related to γ-pyrone and chromone, which are found in nature as glucosides and are produced as metabolic products. It is weakly basic in contrast to dimethyl γ-pyrone form isolatable and easily hydrolyzable addition compounds. Since a color, absorption spectra and solubility change is observed (Elderfield, 1950).

The presence of hydroxyl and methoxyl groups especially in the 7 position, increases the bascity of xanthones and results in the formation of move stable addition compounds with acids and metallic salt.

2.2 Biosynthesis of Xanthones

The characteristic oxygenation patterns of xanthones from higher plants were recognized early on as being due to a mixed shikimate-acetate biogenesis. Along these line various biosynthetic pathways were proposed and these have been reviewed. Therefore, polyhydroxy benzophenones or their biogentically equivalents could be intermediates in the formation of xanthones. There are summariesd in scheme 1 (Sultanbawa, 1980).

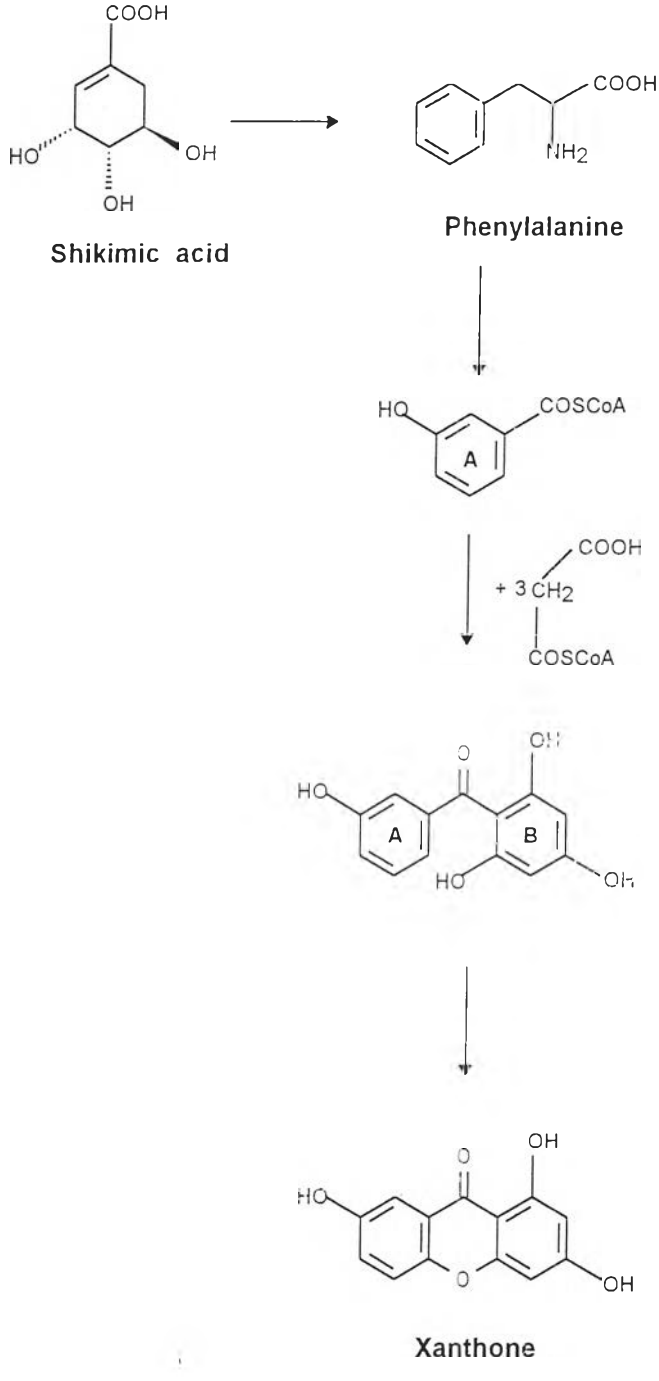
The biosynthetic pathway has been supported by the following experimental data :

(a) The radio labelled acetate studies of Floss and Retting have shown acetate incorporation in ring B of xanthone.

(b) Atkinson, Gupta and Lewis have confirmed the above results by showing 0.53% incorporation of 2-^{14}C-acetate into the xanthones formed in the rhizomes of *Gentiana lutea*

(c) Lewis *et al.* have also shown that the ^{14}C-labelled phenylalanine was in corporated into ring A

Other transformations associate with the biosynthesis of natural xanthones are connected with the presence of methoxy, methylene dioxy groups, C_5 and C_{10} residues. The biogenetic orgin of C_5 and C_{10} units is definitely 3,3-dimethylallyl pyrophosphate and geranyl pyrophosphate and these units would enter the *ortho-* or *para-* position to the phenolic OH groups to give the respective products



Scheme 1 Biosynthesis of xanthones in the Guttiferae

2.3 Classification of Xanthones

Xanthones have been found in all the major of Guttiferae. The classification of xanthone structures that have come out from the different *Garcinia* species which number about 90 investigation so far, are classifed into 4 groups.

1. Simple oxygenated xanthones

The structure of the below have been established mainly from the UV, IR and NMR data of these compounds. The UV spectrum varies in a characteristic maner depending on the oxygenation pattern and with the availability of a considerable amount of data. Assignments can be readily made. Besides use of $AlCl_3$ shifts for chelated-OH, sodium acetate, sodium hydroxide and boric acid shifts, considerable information of the position of -OH groups

In other locations can be obtained, such data have been very valuable for a preliminary assignment which can then be substantiated from NMR chemical shifts for remaining aromatic protons, whose coupling patterns provide additional and definitive information about their location. In the genus *Garcinia* can divided into 3 groups as shown in Table 2

Table 2 Simple oxygenated xanthones of the genus *Garcinia*

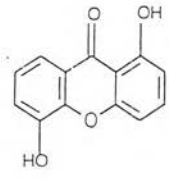
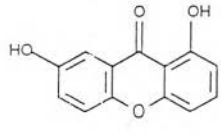
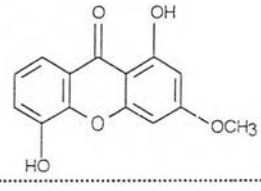
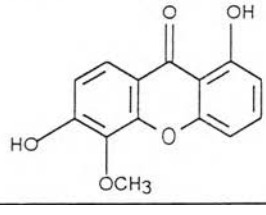
Chemical compound	Source	Reference
Dioxygenated xanthone		
1,5-Dihydroxyxanthone 	*G. echinocarpa* *G. subelliptica* *G. terpnophylla*	Bandaranayake *et al.*, 1975 Minami *et al.*,1994 Bandaranayake *et al.*, 1975
1,7-Dihydroxyxanthone 	*G. eugeniifolia* *G. indica* *G. terpnophylla*	Jackson, Locksley and Scheinmann, 1969 Cotterill, Scheinmann and Puranik, 1977 Bandaranayake *et al.*, 1975
Trioxygenated xanthone		
1,5-Dihydroxy-3-methoxy-xanthone 	*G. subelliptica*	Iinuma *et al.*, 1995
1,6-Dihydroxy-5-methoxy-xanthone 	*G. subelliptica*	Minami *et al.*,1994

Table 2 (Continued)

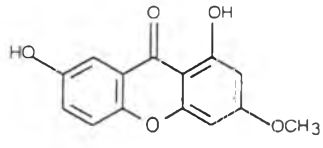
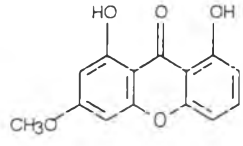
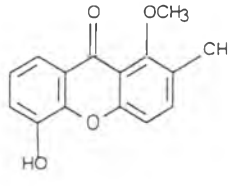
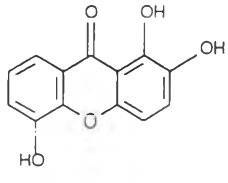
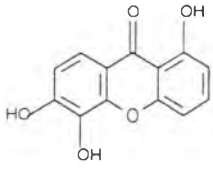
Chemical compound	Source	Reference
1,7-Dihydroxy-3-methoxy-xanthone 	*G. eugeniifolia*	Jackson, Locksley and Scheinmann, 1969
1,8-Dihydroxy-6-methoxy-xanthone 	*G. subelliptica*	Minami *et al.*,1994
2,5-Dihydroxy-1-methoxy xanthone 	*G. subelliptica*	Minami *et al.*,1994
1,2,5-Trihydroxyxanthone 	*G. subelliptica*	Minami *et al.*,1994
1,5,6--Trihydroxyxanthon 	*G. eugeniifolia*	Jackson, Locksley and Scheinmann, 1969

Table 2 (Continued)

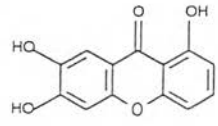
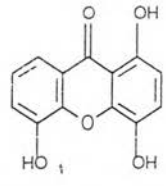
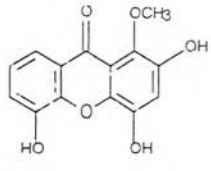
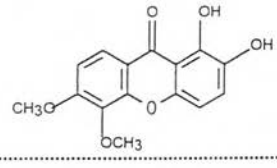
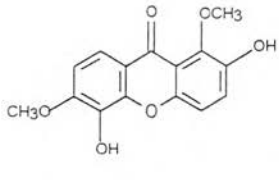
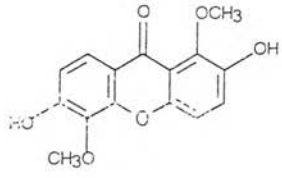
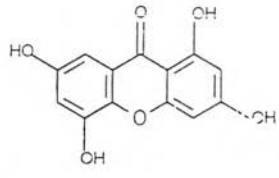
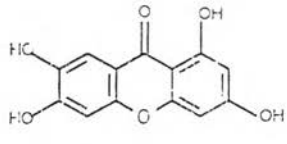
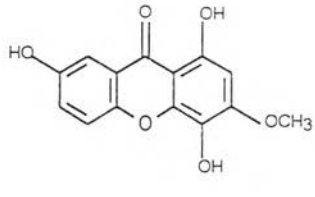
Chemical compound	Source	Reference
1,6,7-Trihydroxyxanthone 	*G. eugeniifolia*	Jackson, Locksley and Scheinmann, 1969
Subelliptenone G 	*G. subelliptica*	Minami *et al.*,1994
Tetrahydroxygenated xanthone BR-xanthone B 	*G. mangostana*	Balasubramanian and Rajagopalan, 1988
1,2-Dihydroxy-5,6-dimethoxy-xanthone 	*G. subelliptica*	Minami *et al.*,1994
2,5-Dihydroxy-1,6-dimethoxy-xanthone 	*G. thwaitesii*	Gunatilaka *et al.*, 1983

Table 2 (Continued)

Chemical compound	Source	Reference
2,6-Dihydroxy-1,5-dimethoxy-xanthone 	*G. subelliptica*	Minami *et al.*,1994
1,3,5,7-Tetrahydroxyxanthone 	*G. pedunculata*	Rao *et al.*, 1974
1,3,6,7-Tetrahydroxyxanthone 	*G. echinocarpa* *G. mangostana* *G. multiflora* *G. pedunculata*	Bandaranayake *et al.*, 1975 Holloway and Scheinmann, 1975 Chen, Lin and Hung, 1975 Rao *et al.*, 1974
1,4,7-Trihydroxy-3-methoxy-xanthone 	*G. eugeniifolia*	Jackson, Locksley and Scheinmann, 1969

2. Prenylated xanthones

The presence of prenyl and geranyl groups in the nucleus can be of chemotaxonomic value and a large number of them have been characterised in the last decade. Mono-, di- and tri-prenylated compounds have been isolated and in some of them the prenyl group has in certain cases undergone further change. The most characteristic of which is its oxidative cyclisation with an *ortho*- OH group to a chromene ring. Characterisation of these compounds and their structure elucidation has been simplified by the characteristic NMR patterns that these prenylated groups manifest. On account of which structures of some resulting complex molecules have been more rapidly established no doubt with other supplementary data. The next few figures summarise the information on these compounds. There are no mono-oxygenated prenylated xanthones reported so far.

Table 3 Prenylated xanthones of the genus *Garcinia*

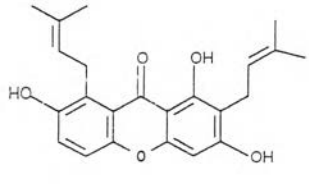
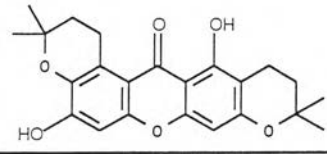
Chemical compound	Source	Reference
2,8-Bis-(γ,γ-dimethylallyl)-1,3,7-trihydroxyxanthone 	*G. mangostana*	Mahabusarakam, Wiriyachitra and Taylor, 1987
BR-xanthone A 	*G. mangostana*	Balasubramanian and Rajagopalan, 1988

Table 3 (Continued)

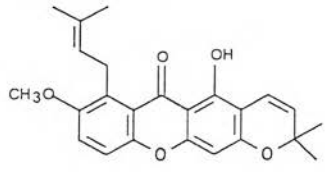
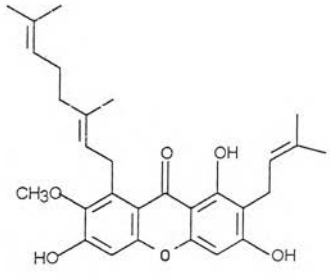
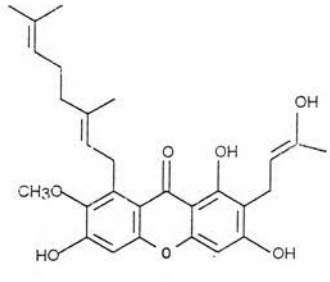
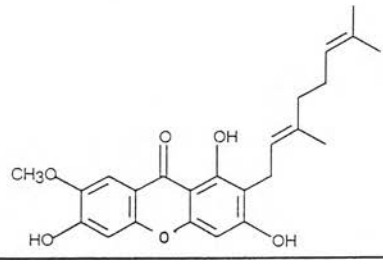
Chemical compound	Source	Reference
Calabaxanthone 	*G. mangostana*	Mahabusarakam, Wiriyachitra and Taylor, 1987
Cowanin 	*G. cowa*	Na Pattalung *et al.*,1994
Cowanol 	*G. cowa*	Na Pattalung *et al.*,1994
Cowaxanthone 	*G. cowa*	Na Pattalung *et al.*,1994

Table 3 (Continued)

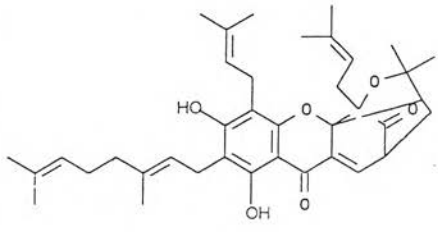
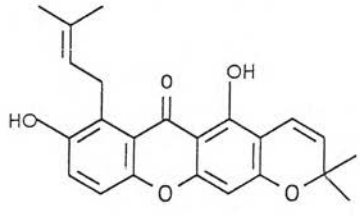
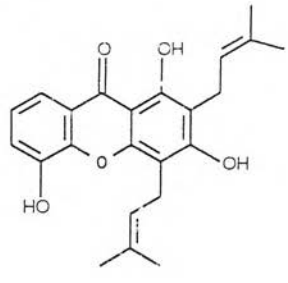
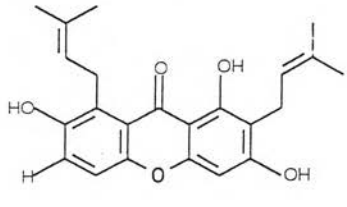
Chemical compound	Source	Reference
Desoxygambogenin 	*G. hanburyi*	Asano *et al.*,1996
Demethylcalabaxanthone 	*G. mangostana*	Mahabusarakam, Wiriyachitra and Taylor, 1987
8-Deoxygartanin 	*G. mangostana*	Govindachari *et al.*,1971 Sakai *et al.*,1993
6-Deoxy-γ-mangostin 	*G. mangostana*	Sakai *et al.*,1993

Table 3 (Continued)

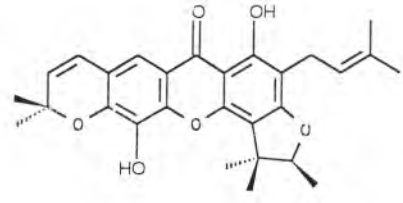
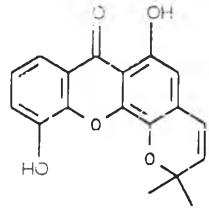
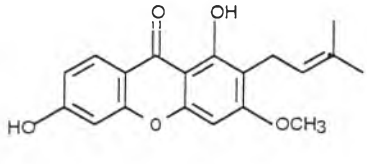
Chemical compound	Source	Reference
4'',5''-Dihydro-1,5-dihydroxy-6',6'-dimethylpyrano(2',3': 6,7)-2-(3-methylbut-2-enyl)-4'',4'',5''-trimethyl furano(2'',3'': 3,4)xanthone 	*G. opaca*	Goh *et al.*,1992
6,11-Dihydroxy-2,2-dimethylpyrano [3,2-C]xanthone-7(2H)-one 	*G. livingstonei*	Sordat-Diserens, Hamburger *et al.*, 1992
1,6-Dihydroxy-3-methoxy-2-(3 methyl-2-butenyl)xanthone 	*G. mangostana*	Parveen and Khan, 1989

Table 3 (Continued)

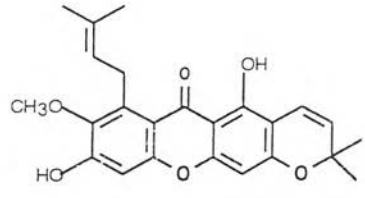
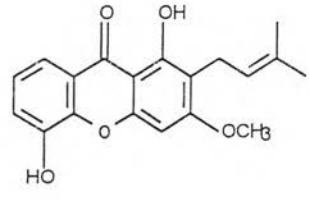
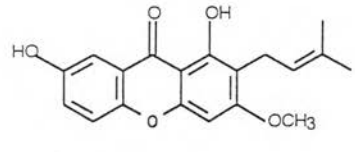
Chemical compound	Source	Reference
5,9-Dihydroxy-8-methoxy-2,2-dimethyl-7-(3-methylbut-2-enyl)-2H,6H-pyrano[3,2-b]xanthone-6-one 	*G. mangostana*	Sen *et al.*, 1980
1,5-Dihydroxy-2-(3-methylbut-2-enyl)-3-methoxyxanthone 	*G. mangostana*	Sen *et al.*, 1981
1,7-Dihydroxy-2-(3-methylbut-2-enyl)-3-methoxyxanthone 	*G. mangostana*	Mahabusarakam, Wiriyachitra and Taylor, 1987

Table 3 (Continued)

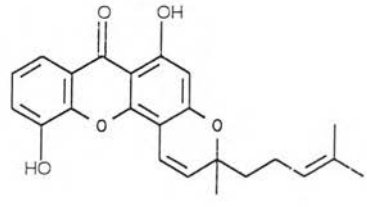
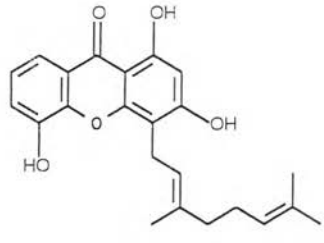
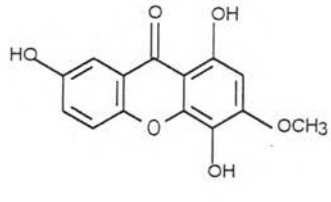
Chemical compound	Source	Reference
6,11-Dihydroxy-3-methoxy-3-(4-methylpen-3-enyl)-3H,7H-pyrano [2,3-C]xanthone-7-one 	*G. livingstonei*	Sordat-Diserens, Hamburger *et al.*, 1992
4-(3',7'-Dimethylocta-2',6'-dienyl) 1,3,5-trihydroxy-9H-xanthone-9-one 	*G. livingstonei*	Sordat-Diserens, Hamburger *et al.*, 1992
Forbexanthone 	*G. forbesii*	Harrison *et al.*, 1993

Table 3 (Continued)

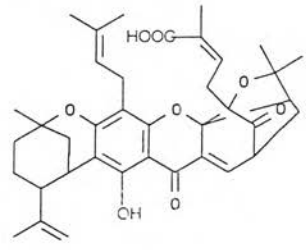
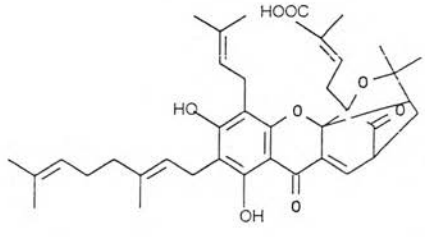
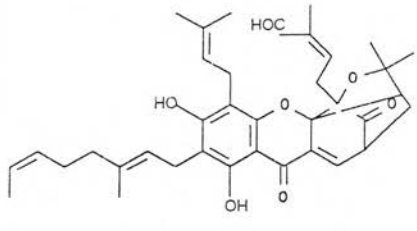
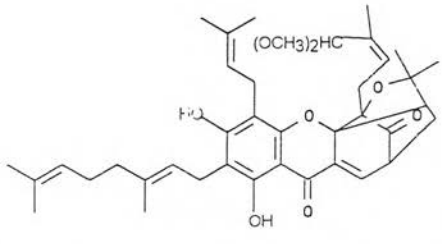
Chemical compound	Source	Reference
Gambogellic acid 	*G. hanburyi*	Asano *et al.*, 1996
Gambogenic acid 	*G. hanburyi*	Asano *et al.*, 1996
Gambogenin 	*G. hanburyi*	Asano *et al.*, 1996
Gambogenin dimethyl acetal 	*G. hanburyi*	Asano *et al.*, 1996

Table 3 (Continued)

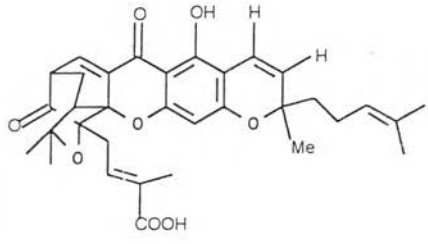
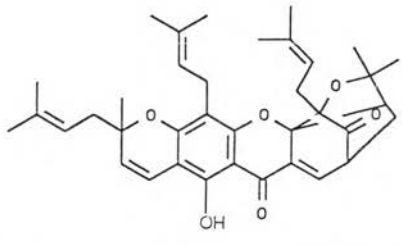
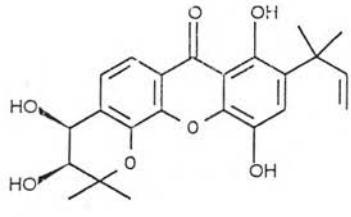
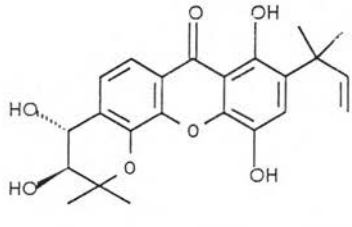
Chemical compound	Source	Reference
Gambogic acid 	*G. hanburyi*	Asano *et al.*, 1996
Gambogin 	*G. hanburyi*	Asano *et al.*, 1996
Garcigerrin A 	*G. gerrardii*	Sordat-Diserens, Marston *et al.*, 1989
Garcigerrin B 	*G. gerrardii*	Sordat-Diserens, Marston *et al.*, 1989

Table 3 (Continued)

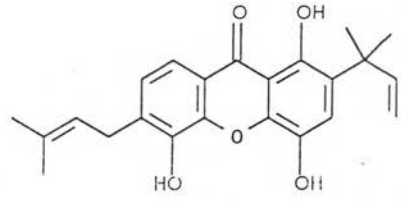
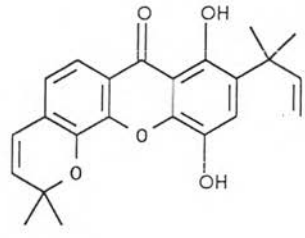
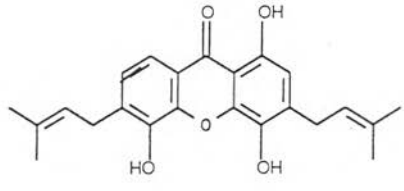
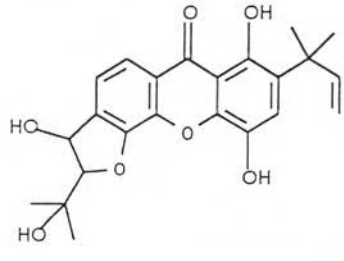
Chemical compound	Source	Reference
Garciniaxanthone A 	*G. subelliptica*	Minami *et al.*, 1994
Garciniaxanthone B 	*G. subelliptica*	Minami *et al.*, 1994
Garciniaxanthone C 	*G. subelliptica*	Minami *et al.*, 1994
Garciniaxanthone D 	*G. subelliptica*	Minami *et al.*, 1994

Table 3 (Continued)

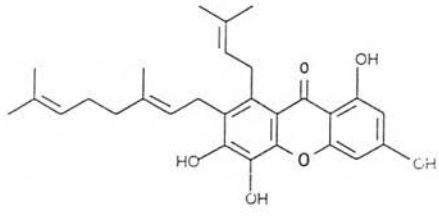
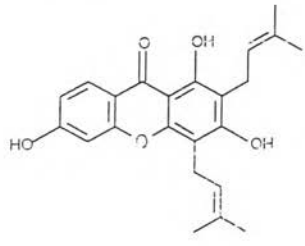
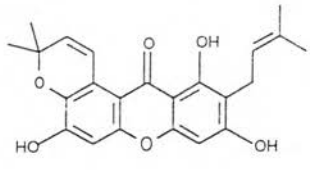
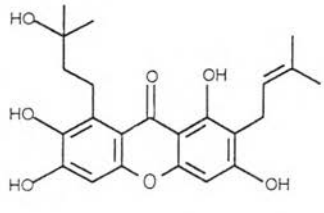
Chemical compound	Source	Reference
Garciniaxanthone E 	*G. subelliptica*	Minami *et al.*, 1994
Garcinone A 	*G. mangostana*	Sen *et al.*, 1982
Garcinone B 	*G. mangostana*	Sen *et al.*, 1982
Garcinone C 	*G. mangostana*	Sen *et al.*, 1982

Table 3 (Continued)

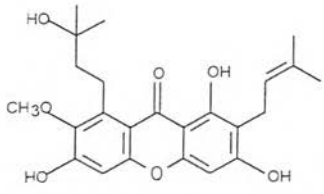
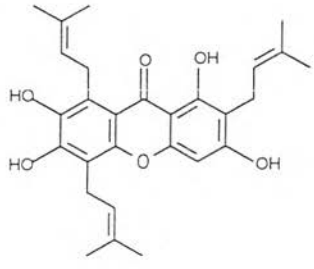
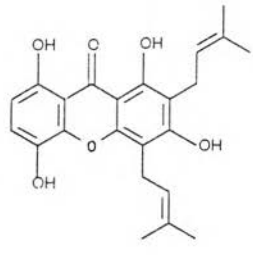
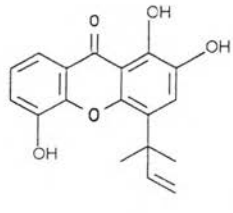
Chemical compound	Source	Reference
Garcinone D 	*G. mangostana*	Sen *et al.*, 1982
Garcinone E 	*G. mangostana*	Sakai *et al.*, 1982
Gartanin 	*G. mangostana*	Mahabusarakam, Wiriyachitra and Taylor, 1987
Globuxanthone 	*G. subelliptica*	Iinuma *et al.*, 1994

Table 3 (Continued)

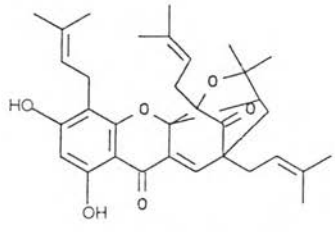
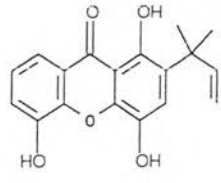
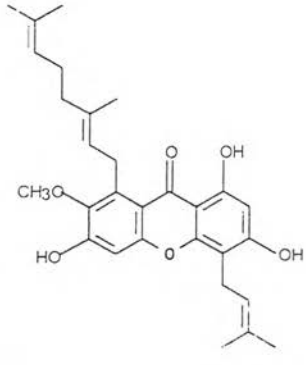
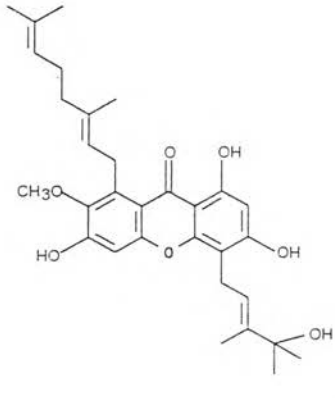
Chemical compound	Source	Reference
Hanburin 	*G. hanburyi*	Asano *et al.*, 1996
12b-Hydroxy-des-D-garcigerrin A 	*G. gerrardii* *G. livingstonei* *G. subelliptica*	Sordat-Diserens, Marston *et al.*, 1989 Sordat-Diserens, Hamburger *et al.*, 1992 Fukuyama *et al.*, 1991
Isocowanin 	*G. pyrifera*	Ampofo and Waterman, 1986
Isocowanol 	*G. pyrifera*	Ampofo and Waterman, 1986

Table 3 (Continued)

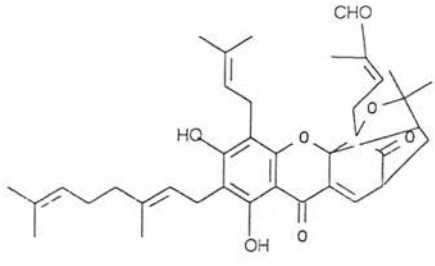
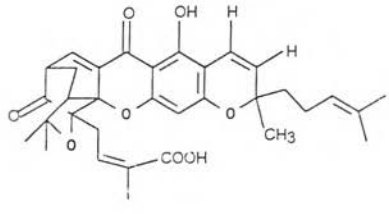
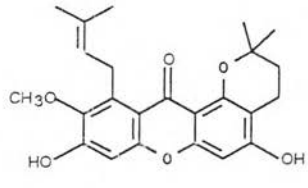
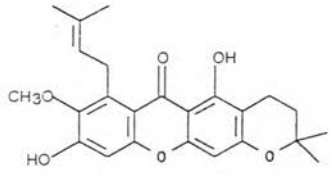
Chemical compound	Source	Reference
Isogambogenin 	*G. hanburyi*	Asano *et al.*, 1996
Isogambogic acid 	*G. hanburyi*	Asano *et al.*, 1996
1-Isomangostin 	*G. mangostana*	Mahabusarakam, Wiriyachitra and Taylor, 1987
3-Isomangostin 	*G. mangostana*	Mahabusarakam, Wiriyachitra and Taylor, 1987

Table 3 (Continued)

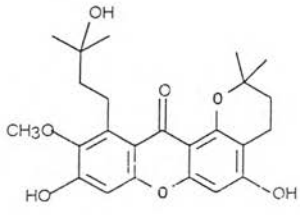
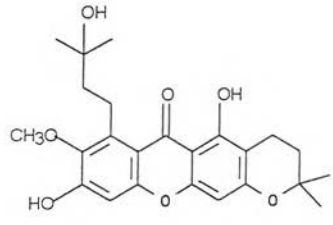
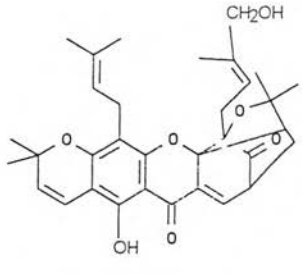
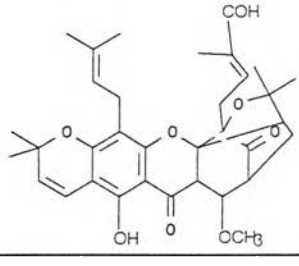
Chemical compound	Source	Reference
1-Isomangostin hydrate 	*G. mangostana*	Mahabusarakam, Wiriyachitra and Taylor, 1987
3-Isomangostin hydrate 	*G. mangostana*	Mahabusarakam, Wiriyachitra and Taylor, 1987
Isomorellinol 	*G. hanburyi*	Asano *et al.*, 1996
Isomorellin B 	*G. hanburyi*	Asano *et al.*, 1996

Table 3 (Continued)

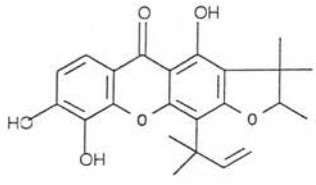
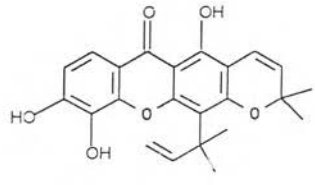
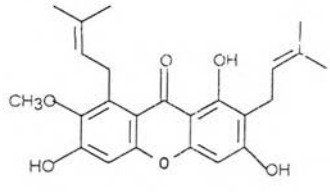
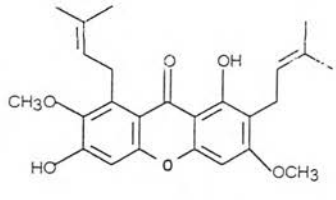
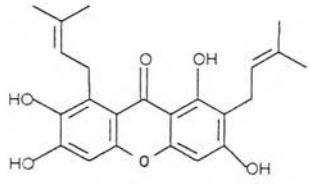
Chemical compound	Source	Reference
Isorheediaxanthone B 	*G. polyantha*	Ampofo and Waterman, 1986
Macluraxanthone 	*G. opaca* *G. ovalifolia*	Goh *et al.*, 1992 Waterman and Crichton, 1980
α-Mangostin 	*G. mangostana*	Mahabusarakam, Wiriyachitra and Taylor, 1987
β-Mangostin 	*G. mangostana*	Mahabusarakam, Wiriyachitra and Taylor, 1987
γ-Mangostin 	*G. mangostana*	Mahabusarakam, Wiriyachitra and Taylor, 1987

Table 3 (Continued)

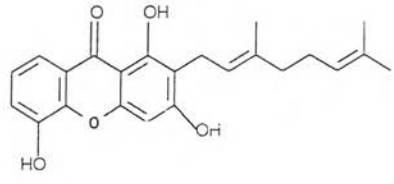
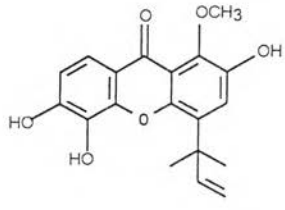
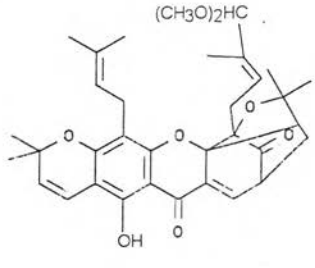
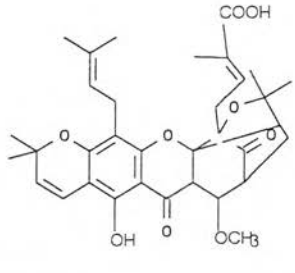
Chemical compound	Source	Reference
Mangostinone 	*G. mangostana*	Asai *et al.*, 1995
1-*O*-Methylsymphoxanthone 	*G. subelliptica*	Minami *et al.*, 1996
Morellin dimethyl acetal 	*G. hanburyi*	Asano *et al.*, 1996
Moreollic acid 	*G. hanburyi*	Asano *et al.*, 1996

Table 3 (Continued)

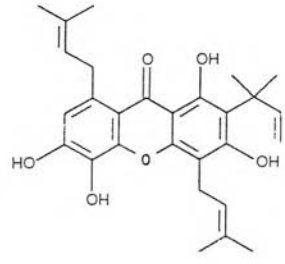
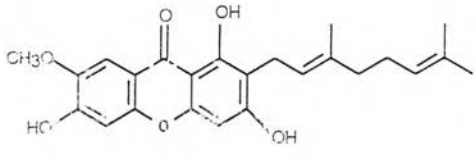
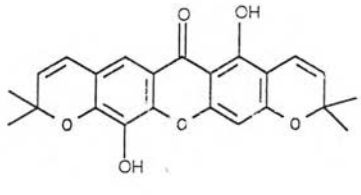
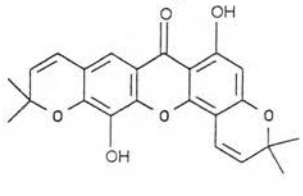
Chemical compound	Source	Reference
Nervosaxanthone 	*G. nervosa*	Ampofo and Waterman, 1986
Norcowanin 	*G. cowa*	Na Pattalung *et al.*, 1994
Pyranojacareubin 	*G. densivenia* *G. forbesii*	Waterman and Crichton, 1980 Harrison *et al.*, 1993
Rheediaxanthone A 	*G. staudtii*	Waterman and Hussain, 1982

Table 3 (Continued)

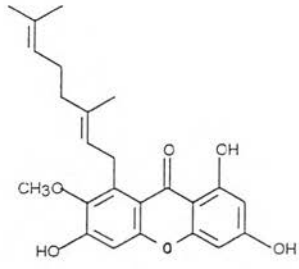
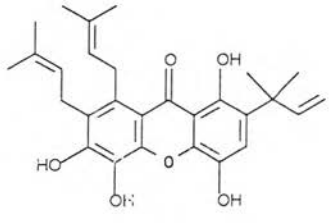
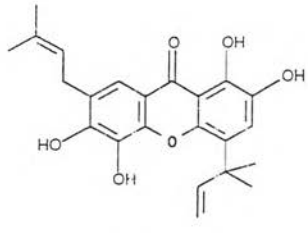
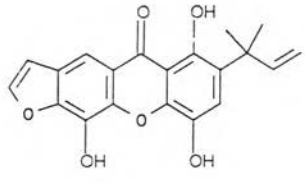
Chemical compound	Source	Reference
Rubraxanthone 	*G. nervosa* *G. pyrifera*	Ampofo and Waterman, 1986 Ampofo and Waterman, 1986
Subelliptenone A 	*G. subelliptica*	Iinuma *et al.*, 1994
Subelliptenone B 	*G. subelliptica*	Iinuma *et al.*, 1995
Subelliptenone C 	*G. subelliptica*	Iinuma *et al.*, 1995

Table 3 (Continued)

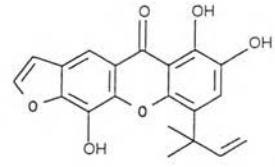
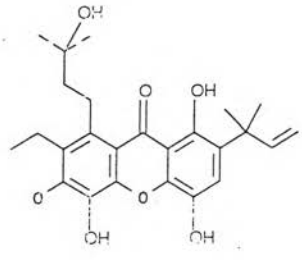
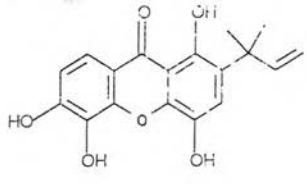
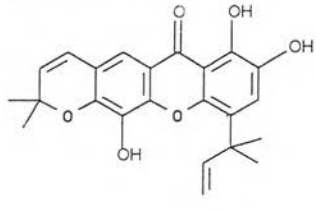
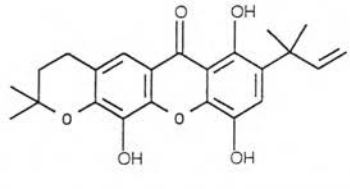
Chemical compound	Source	Reference
Subelliptenone D 	*G. subelliptica*	Iinuma *et al.*, 1995
Subelliptenone E 	*G. subelliptica*	Iinuma *et al.*, 1995
Subelliptenone F 	*G. subelliptica*	Iinuma *et al.*, 1995
Subelliptenone H 	*G. subelliptica*	Iinuma *et al.*, 1995
Subelliptenone I 	*G. subelliptica*	Iinuma *et al.*, 1995

Table 3 (Continued)

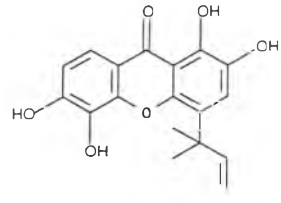
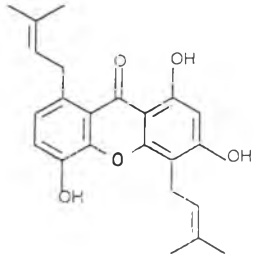
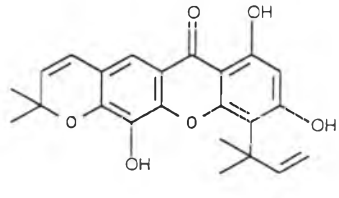
Chemical compound	Source	Reference
Symphoxanthone 	*G. subelliptica*	Minami *et al.*, 1996
1,3,5-Trihydroxy-4,8-di(3,3-dimethyl allyl)xanthone 	*G. quadrifaria*	Waterman and Hussain, 1982
1,3,5-Trihydroxy-6',6'-dimethyl pyrano (2',3': 6,7)-4-(1,1-dimethyl prop-2-enyl)xanthone 	*G. opaca*	Goh *et al.*, 1992

Table 3 (Continued)

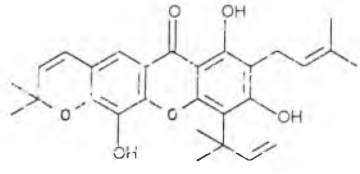
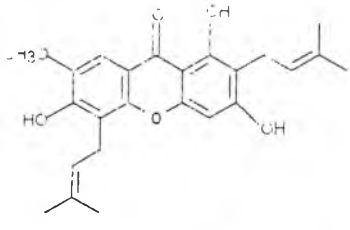
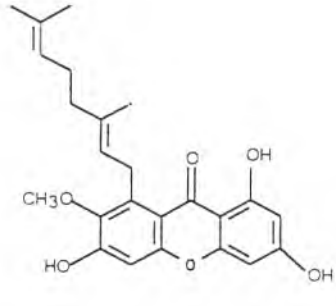
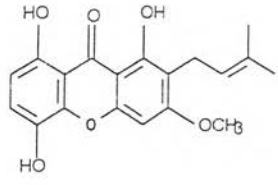
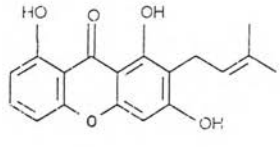
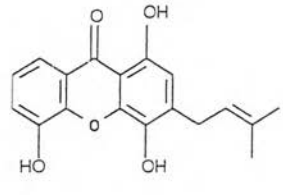
Chemical compound	Source	Reference
1,3,5-Trihydroxy-6',6'-dimethyl pyrano (2',3': 6,7)-2-(3-methylbut-2-enyl)-4(1,1-dimethylprop-2-enyl) xanthone 	*G. opaca*	Goh *et al.*, 1992
1,3,6-Trihydroxy-7-methoxy-2,5-bis (3-methyl-2-butenyl)xanthone 	*G. cowa*	Na Pattalung *et al*.,1994
1,3,6-Trihydroxy-7-methoxy-8-(3,7-dimethyl-2,6-octadienyl)xanthone 	*G. cowa*	Lee and Chan, 1977

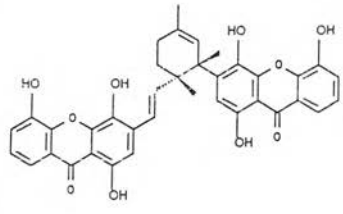
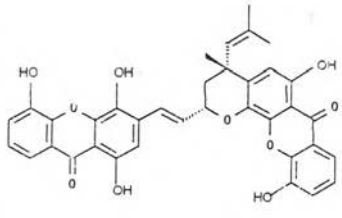
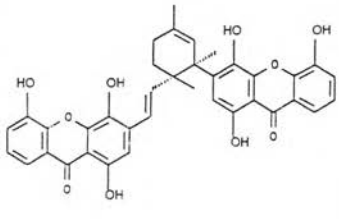
Table 3 (Continued)

Chemical compound	Source	Reference
1,5,8-Trihydroxy-3-methoxy-2 (3-methyl-2-butenyl)xanthone 	*G. mangostana*	Sakai *et al.*, 1993
1,3,7-Trihydroxy-2-(3-methylbut-2-enyl)xanthone 	*G. forbesii*	Harrison *et al.*, 1993
1,4,5-Trihydroxy-3-(3-methylbut-2-enyl)-9H-xanthone-9-one 	*G. livingstonei*	Sordat-Diserens, Hamburger *et al.*, 1992

3. Dimeric xanthone

In the genus *Garcinia* has been found only in *G. livingstonei.*

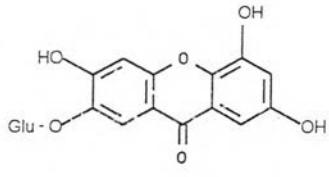
Table 4 Dimeric xanthones of the genus *Garcinia*

Chemical compound	Source	Reference
Garcilivin A 	*G. livingstonei.*	Sordat-Diserens, Hamburger *et al.*, 1992
Garcilivin B 	*G. livingstonei.*	Sordat-Diserens, Hamburger *et al.*, 1992
Garcilivin C 	*G. livingstonei.*	Sordat-Diserens, Hamburger *et al.*, 1992

4. Xanthone glycosides

In the genus *Garcinia* has been found only in *G. mangostana.*

Table 5 Xanthone glycosides of the genus *Garcinia*

Chemical compound	Source	Reference
1,3,6,7-Tetrahydroxyxanthone-O-D-glucoside 	*G. mangostana*	Holloway and Scheinmann, 1975