

CHAPTER II

HISTORICAL

1. Chemical constituents of the genus *Polyalthia*

According to previous phytochemical studies, the alkaloids (isoquinoline, azaanthracene, azafluorene, indolosesquiterpenoids), diterpenoids (clerodane, halimane, labdane), triterpenoids (lanostane), acetogenins, flavonoids, steroids, polyacetylene derivatives and benzopyran derivatives have been found in the genus *Polyalthia*.

The chemical constituents of the genus *Polyalthia* are summarized in Table 1.

Table 1. Chemical constituents of plants in the genus *Polyalthia*

| Chemical type / Chemical compounds | Plant | Plant part | References |
|------------------------------------|-----------------------|---------------|------------------------------|
| Alkaloids | | | |
| Isoquinoline alkaloids | | | |
| Benzylisoquinoline alkaloids | | | |
| polysignine (1) | <i>P. insignis</i> | bark | Lee, Chuah and Goh, 1997 |
| methoxypolysignine (2) | <i>P. insignis</i> | bark | Lee, Chuah and Goh, 1997 |
| Bisbenzylisoquinoline alkaloids | | | |
| dauricin (3) | <i>P. nitidissima</i> | not specified | Jossang <i>et al</i> , 1983 |
| N,N'-dimethylindoldhamine (4) | <i>P. nitidissima</i> | not specified | Jossang <i>et al</i> , 1983 |
| daurisoline (5) | <i>P. nitidissima</i> | not specified | Jossang <i>et al</i> , 1983 |
| isodaurisoline (6) | <i>P. nitidissima</i> | not specified | Jossang <i>et al</i> , 1983 |
| lindoldhamine (7) | <i>P. nitidissima</i> | not specified | Jossang <i>et al</i> , 1983 |
| O-methyl-7- lindoldhamine (8) | <i>P. nitidissima</i> | not specified | Jossang <i>et al</i> , 1983 |
| O-methyl-7'- lindoldhamine (9) | <i>P. nitidissima</i> | not specified | Jossang <i>et al</i> , 1983 |
| Protoberberine alkaloids | | | |
| cheilanthifoline (10) | <i>P. insignis</i> | bark | Lee, Chuah and Goh, 1997 |
| cerasodine (11) | <i>P. cerasoides</i> | stem bark | González <i>et al</i> , 1997 |
| cerasonine (12) | <i>P. cerasoides</i> | stem bark | González <i>et al</i> , 1997 |

Table 1. Chemical constituents of plants in the genus *Polyalthia* (continued)

| Chemical type / Chemical compounds | Plant | Plant part | References |
|------------------------------------|--|-------------------|------------------------------------|
| Protoberberine alkaloids | | | |
| (-)-8-oxopolyalthiaine (13) | <i>P. longifolia</i> var. <i>pendula</i> | leaves | Chen <i>et al</i> , 2000 |
| stepholidine (14) | <i>P. nitidissima</i> | not specified | Jossang <i>et al</i> , 1983 |
| pendulamine A (15) | <i>P. longifolia</i> var. <i>pendula</i> | root | Faizi <i>et al</i> , 2002 |
| pendulamine B (16) | <i>P. longifolia</i> var. <i>pendula</i> | root | Faizi <i>et al</i> , 2002 |
| Aporphine alkaloids | | | |
| Monomeric aporphine alkaloids | | | |
| (-)-3-hydroxynornuciferine (17) | <i>P. acuminata</i> | leaves, bark | Musa, Zarga and Shamma, 1982 |
| liriodenine (18) | <i>P. insignis</i> | bark | Lee, Chuah and Goh, 1997 |
| | <i>P. longifolia</i> | leaves | Wu <i>et al</i> , 1990 |
| | <i>P. nitidissima</i> | not specified | Jossang <i>et al</i> , 1983 |
| | <i>P. oliveri</i> | leaves, stem bark | Hamonnière, Leboeuf and Cavé, 1977 |
| | <i>P. suberosa</i> | stem bark | Ferdous, Islam and Hasan, 1992 |
| | <i>P. oliveri</i> | leaves, stem bark | Hamonnière, Leboeuf and Cavé, 1977 |
| lanuginosine (19) | <i>P. oliveri</i> | leaves, stem bark | Hamonnière, Leboeuf and Cavé, 1977 |
| anonaine (20) | <i>P. oliveri</i> | leaves, stem bark | Hamonnière, Leboeuf and Cavé, 1977 |

Table 1. Chemical constituents of plants in the genus *Polyalthia* (continued)

| Chemical type / Chemical compounds | Plant | Plant part | References |
|------------------------------------|------------------------------------|-------------------|--|
| Monomeric aporphine alkaloids | | | |
| oliveridine (21) | <i>P. oliveri</i> | leaves, stem bark | Hamonnière, Leboeuf and Cavé, 1977; Quevauviller and Hamonnière, 1977 |
| noroliveridine (22) | <i>P. oliveri</i> | leaves, stem bark | Hamonnière, Leboeuf and Cavé, 1977 |
| oliveroline (23) | <i>P. oliveri</i> | leaves, stem bark | Hamonnière, Leboeuf and Cavé, 1977 |
| noroliveroline (24) | <i>P. longifolia</i> | leaves | Wu <i>et al</i> , 1990 |
| oliverine (25) | <i>P. oliveri</i> | leaves, stem bark | Hamonnière, Leboeuf and Cavé, 1977 |
| pachypodanthine (26) | <i>P. oliveri</i> | leaves, stem bark | Hamonnière, Leboeuf and Cavé, 1977 |
| polysuavine (27) | <i>P. suaveolens</i> | bark | Cavé <i>et al</i> , 1978 |
| Bisaporphine alkaloids | | | |
| beccapoline (28) | <i>P. cauliflora var. beccarii</i> | stem | Jossang, Leboeuf and Cavé, 1984 |
| polybeccarine (29) | <i>P. cauliflora var. beccarii</i> | stem | Jossang, Leboeuf and Cavé, 1984 |
| bidebiline A (30) | <i>P. debilis</i> | not specified | Kanokmedhakul <i>et al</i> , 2003 |
| bidebiline B (31) | <i>P. debilis</i> | not specified | Kanokmedhakul <i>et al</i> , 2003 |
| bidebiline C (32) | <i>P. debilis</i> | not specified | Kanokmedhakul <i>et al</i> , 2003 |
| bidebiline D (33) | <i>P. debilis</i> | not specified | Kanokmedhakul <i>et al</i> , 2003 |

Table 1. Chemical constituents of plants in the genus *Polyalthia* (continued)

| Chemical type / Chemical compounds | Plant | Plant part | References |
|--|--|------------|---------------------------------|
| Bisdehydroaporphine alkaloids | | | |
| 7,7'-bisdehydro- <i>O</i> -methylisopiline (34) | <i>P. bullata</i> | stem bark | Connolly, Haque and Kadir, 1996 |
| 7-dehydronornuciferinyl-7'-dehydro- <i>O</i> -methylisopiline (35) | <i>P. bullata</i> | stem bark | Connolly, Haque and Kadir, 1996 |
| urabaine (36) | <i>P. bullata</i> | stem bark | Connolly, Haque and Kadir, 1996 |
| Azaanthracene alkaloids | | | |
| kalasinamide (37) | <i>P. suberosa</i> | stem | Tuchinda <i>et al</i> , 2000 |
| Azafluorene alkaloids | | | |
| darienine (38) | <i>P. longifolia</i> | leaves | Wu <i>et al</i> , 1990 |
| <i>O</i> -acetyldarienine (39) | <i>P. longifolia</i> | leaves | Wu <i>et al</i> , 1990 |
| isooncodine (40) | <i>P. longifolia</i> | leaves | Wu <i>et al</i> , 1990 |
| <i>O</i> -acetylisooncodine (41) | <i>P. longifolia</i> | leaves | Wu <i>et al</i> , 1990 |
| polyfothine (42) | <i>P. longifolia</i> | leaves | Wu <i>et al</i> , 1990 |
| isoursuline (43) | <i>P. longifolia</i> var. <i>pendula</i> | root | Faizi <i>et al</i> , 2002 |
| penduline (44) | <i>P. longifolia</i> var. <i>pendula</i> | root | Faizi <i>et al</i> , 2002 |
| polylongine (45) | <i>P. longifolia</i> | leaves | Wu <i>et al</i> , 1990 |

Table 1. Chemical constituents of plants in the genus *Polyalthia* (continued)

| Chemical type / Chemical compounds | Plant | Plant part | References |
|---|--|---|---|
| Indolosesquiterpene alkaloids polyveoline (46) | <i>P. suaveolens</i> | stem bark | Hocquemiller <i>et al</i> , 1981; Kunesch <i>et al</i> , 1985; Okorie <i>et al</i> , 1981 |
| polyalthenol (47) | <i>P. suaveolens</i> | stem bark | Hocquemiller <i>et al</i> , 1981 |
| Diterpenoids Clerodane diterpenoids 16 α -hydroxycleroda-3,13(14)Z-dien- 15,16-olide (48) | <i>P. barnesii</i> <i>P. cheliensis</i> <i>P. longifolia</i> <i>P. longifolia</i> <i>P. longifolia</i> var. <i>pendula</i> <i>P. longifolia</i> | stem bark stem bark stem bark stem bark stem bark leaves | Ma <i>et al</i> , 1994 Hao <i>et al</i> , 1995 Zhao <i>et al</i> , 1991 Hara <i>et al</i> , 1995 Hasan, Hossain and Rashid, 1995 Phadnis <i>et al</i> , 1988 |
| 16 α -hydroxycleroda-4(18),13(14)Z- dien-15,16-olide (49) | <i>P. cheliensis</i> | stem bark | Hao <i>et al</i> , 1995 |
| 3 β ,16 α -dihydroxycleroda-4(18),3,(14)Z- dien-15,16-olide (50) | <i>P. barnesii</i> | stem bark | Ma <i>et al</i> , 1994 |

Table 1. Chemical constituents of plants in the genus *Polyalthia* (continued)

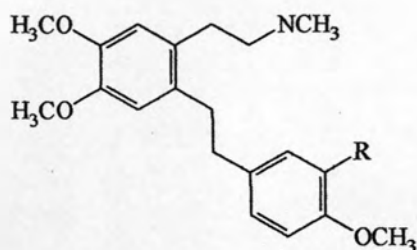
| Chemical type / Chemical compounds | Plant | Plant part | References |
|--|--|------------------------|---|
| Clerodane diterpenoids | | | |
| 4 β ,16 α -dihydroxycleroda-13(14)Z-en-15,16-olide (51) | <i>P. barnesii</i> | stem bark | Ma <i>et al</i> , 1994 |
| cleroda-3,13(14)E-dien-15-oic acid (52) | <i>P. cheliensis</i> | stem bark | Hao <i>et al</i> , 1995 |
| cleroda-4(18),13(14)E-dien-15-oic acid (53) | <i>P. cheliensis</i> , <i>P. longifolia</i> | stem bark stem bark | Hao <i>et al</i> , 1995 Hara <i>et al</i> , 1995 |
| 3,12E-kolavadien-15-oic acid -16-al (54) | <i>P. viridis</i> | bark | Kijjoa <i>et al</i> , 1993 |
| 16-oxocleroda-3,13-dien-16-oic acid (55) | <i>P. longifolia</i> | stem bark | Hara <i>et al</i> , 1995 |
| Halimane diterpenoids | | | |
| <i>ent</i> -halima-1(10),13E-dien-16-oic acid (56) | <i>P. longifolia</i> | stem bark | Hara <i>et al</i> , 1995 |
| <i>ent</i> -halima-5(10),13E-dien-16-oic acid (57) | <i>P. longifolia</i> | stem bark | Hara <i>et al</i> , 1995 |
| 3 β ,5 β ,16 α -trihydroxyhalima-13(14)-en-15,16-olide (58) | <i>P. longifolia</i> var. <i>pendula</i> | leaves | Chen <i>et al</i> , 2000 |
| Labdane diterpenoids | | | |
| (4S,9R,10R)methyl-18-carboxy- labda-8,13(E)-diene-15-oate (59) | <i>P. macropoda</i> | stem bark | Richomme <i>et al</i> , 1991 |

Table 1. Chemical constituents of plants in the genus *Polyalthia* (continued)

| Chemical type / Chemical compounds | Plant | Plant part | References |
|--|--|--------------------------------|---|
| Triterpenoids | | | |
| Lanostane triterpenoids | | | |
| 24-methylenelanosta-7,9(11)-dien-3 β ,15 α -diol (suberosal) (60) | <i>P. suberosa</i> , <i>P. lancilimba</i> | leaves, stem bark stem bark | Li <i>et al</i> , 1993 Lue <i>et al</i> , 1998 |
| polycarpol (61) | <i>P. oliveri</i> , <i>P. lancilimba</i> | not specified stem bark | Hamonnière, Leboeuf and Cavé, 1977 Lue <i>et al</i> , 1998 |
| 24-methylenelanosta-8-en-2 β ,3 β ,21-triol (62) | <i>P. lancilimba</i> | stem bark | Lue <i>et al</i> , 1998 |
| Acetogenins | | | |
| plagionicin-A (63) | <i>P. plagioneura</i> | not specified | Zafra-Polo <i>et al</i> , 1998 |
| Flavonoids | | | |
| rutin (64) | <i>P. longifolia</i> | leaves | Seetharaman, 1986 |
| hyperoside (65) | <i>P. longifolia</i> | leaves | Seetharaman, 1986 |
| Steroids | | | |
| β -sitosterol | <i>P. longifolia</i> var. <i>pendula</i> | leaves | Chen <i>et al</i> , 2000 |
| stigmasterol | <i>P. longifolia</i> var. <i>pendula</i> | leaves | Chen <i>et al</i> , 2000 |

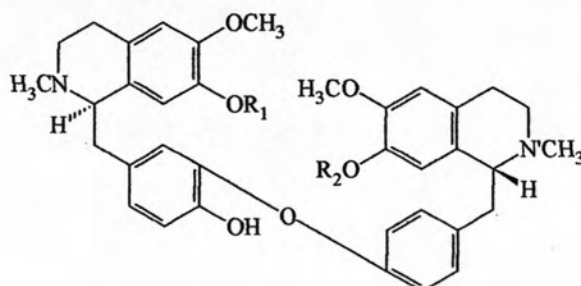
Table 1. Chemical constituents of plants in the genus *Polyalthia* (continued)

| Chemical type / Chemical compounds | Plant | Plant part | References |
|--|--|------------|---|
| Polyacetylene derivatives | | | |
| 21-furan-heneicosa-5,7-diyne acid (evectic acid) (66) | <i>P. evecata</i> | root | Kanokmedhakul <i>et al</i> , 1998 |
| 1-(2-furyl)pentacosa-16,18-diyne (67) | <i>P. suberosa</i> | stem | Tuchinda <i>et al</i> , 2001 |
| 23-(2-furyl)tricoso-5,7-diyne acid (68) | <i>P. suberosa</i> | stem | Tuchinda <i>et al</i> , 2001 |
| Benzopyran derivatives | | | |
| polycerasoidin (69) | <i>P. cerasoides</i> , <i>P. sclerophylla</i> | stem bark | González <i>et al</i> , 1996; Zafra-Polo <i>et al</i> , 1996 |
| polycerasoidol (70) | <i>P. cerasoides</i> , <i>P. sclerophylla</i> | stem bark | González <i>et al</i> , 1996; Zafra-Polo <i>et al</i> , 1996 |
| polycerasoidin methyl ester (71) | <i>P. cerasoides</i> | stem bark | González <i>et al</i> , 1996; Zafra-Polo <i>et al</i> , 1996 |
| polyalthidin (72) | <i>P. cerasoides</i> | stem bark | González <i>et al</i> , 1996; Zafra-Polo <i>et al</i> , 1996 |



polysignine (1) R = H

methoxypolysignine (2) R = OCH₃



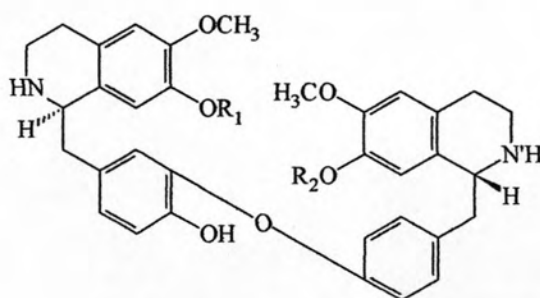
R₁ R₂

dauricin (3) CH₃ CH₃

N,N'-dimethylindoldhamine (4) H H

daurisoline (5) H CH₃

isodaurisoline (6) CH₃ H



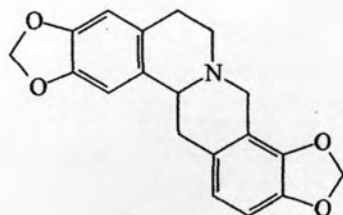
R₁ R₂

lindoldhamine (7) H H

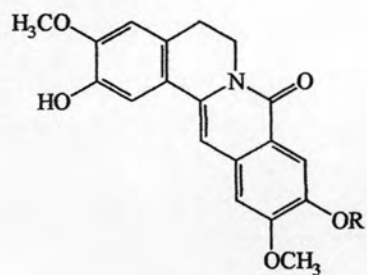
O-methyl-7- lindoldhamine (8) CH₃ H

O-methyl-7'-lindoldhamine (9) H CH₃

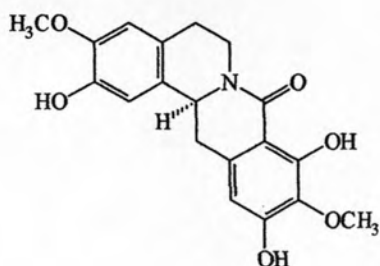
Figure 2. Chemical constituents of plants in the genus *Polyalthia*



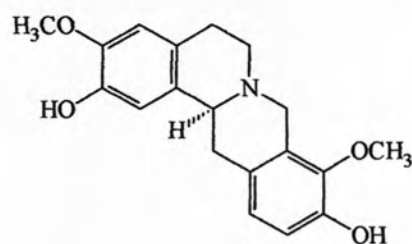
cheilanthifoline (10)



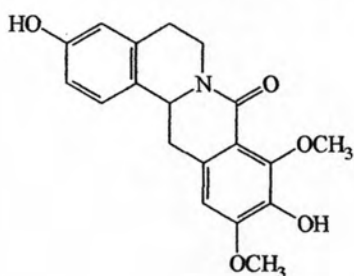
cerasodine (11) R = H

cerasonine (12) R = CH₃

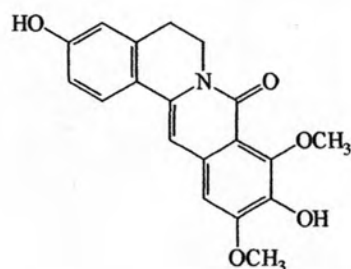
(-)-8-oxopolyalthiaine (13)



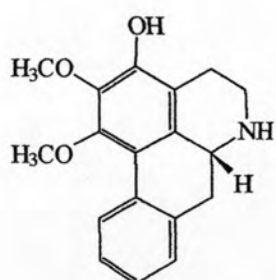
stepholidine (14)



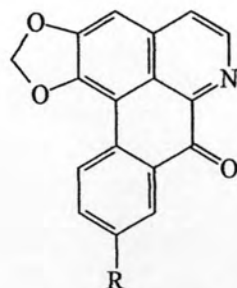
pendulamine A (15)



pendulamine B (16)

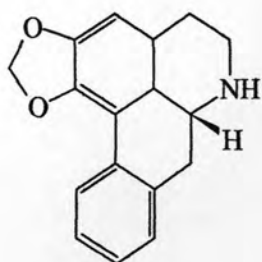


(-)-3-hydroxynornuciferine (17)

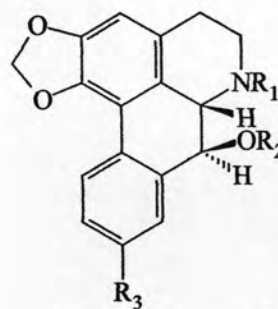


liriodenine (18) R = H

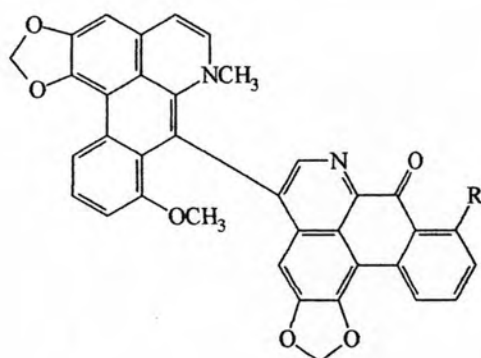
lanuginosine (19) R = OCH₃Figure 2. Chemical constituents of plants in the genus *Polyalthia* (continued)



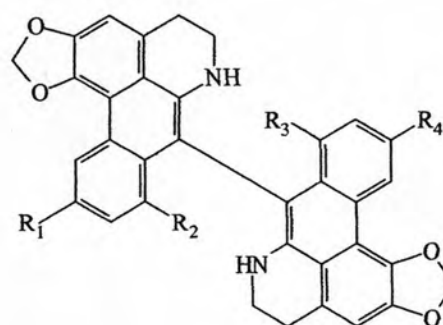
anonaine (20)



| | R ₁ | R ₂ | R ₃ |
|----------------------|------------------|-----------------|------------------|
| oliveridine (21) | OCH ₃ | H | OCH ₃ |
| noroliveridine (22) | H | H | OCH ₃ |
| oliveroline (23) | OCH ₃ | H | H |
| noroliveroline (24) | H | H | H |
| oliverine (25) | CH ₃ | CH ₃ | OCH ₃ |
| pachypodanthine (26) | H | H | CH ₃ |
| polysuavine (27) | OH | CH ₃ | CH ₃ |

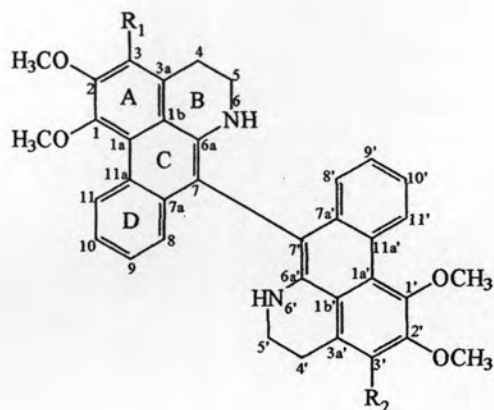
beccapoline (28) R = OCH₃

polybeccarine (29) R = H



| | R ₁ | R ₂ | R ₃ | R ₄ |
|-------------------|------------------|------------------|------------------|------------------|
| bidebiline A (30) | H | H | H | H |
| bidebiline B (31) | H | H | OCH ₃ | H |
| bidebiline C (32) | H | OCH ₃ | OCH ₃ | H |
| bidebiline D (33) | OCH ₃ | H | H | OCH ₃ |

Figure 2. Chemical constituents of plants in the genus *Polyalthia* (continued)

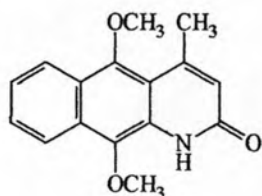


7,7'-bisdehydro-*O*-methylisopiline (34)

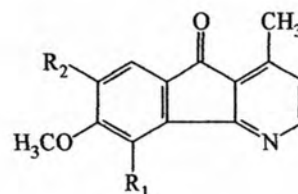
7-dehydronormuciferinyl-7'-dehydro-*O*-methylisopiline (35)

urabaine (36)

| R_1 | R_2 |
|---------|---------|
| OCH_3 | OCH_3 |
| H | OCH_3 |
| H | H |



kalasinamide (37)



darienine (38)

O-acetyldarienine (39)

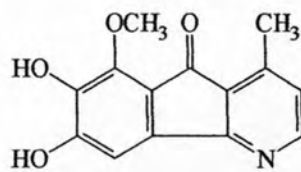
isooncodine (40)

O-acetylisooncodine (41)

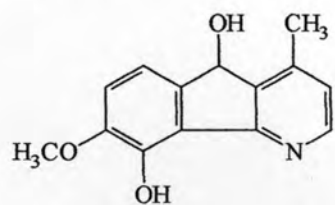
polyfothine (42)

isoursuline (43)

| R_1 | R_2 |
|---------|-----------|
| OCH_3 | OH |
| OCH_3 | $OCOCH_3$ |
| H | OH |
| H | $OCOCH_3$ |
| H | OCH_3 |
| OH | H |

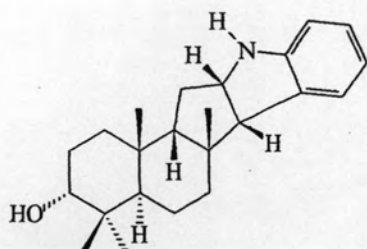


penduline (44)

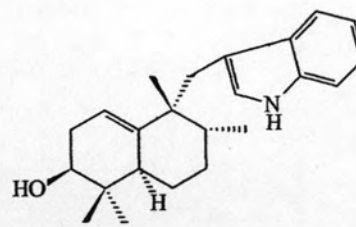


polylongine (45)

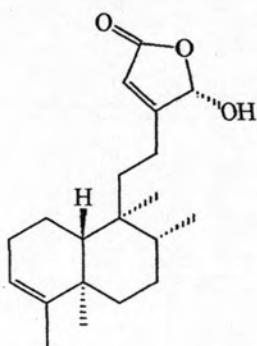
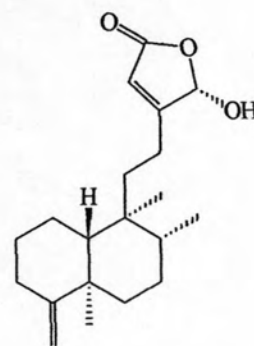
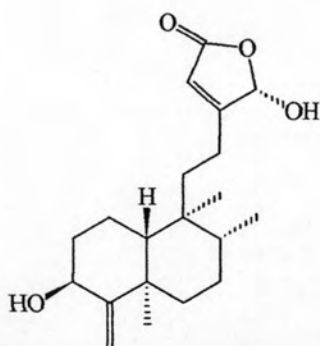
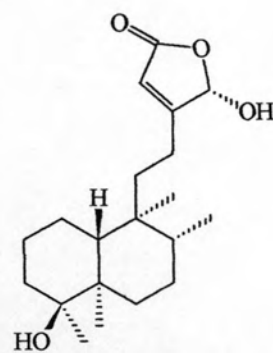
Figure 2. Chemical constituents of plants in the genus *Polyalthia* (continued)

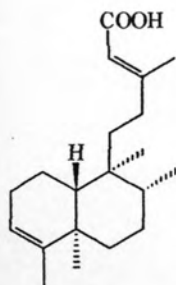
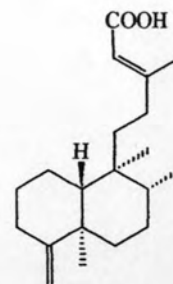
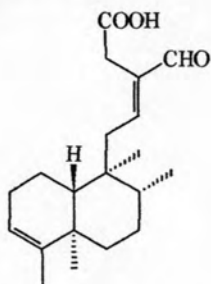
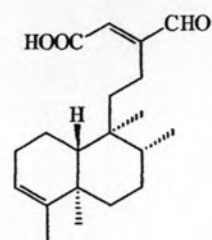


polyveoline (46)

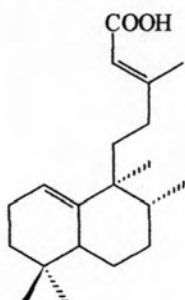
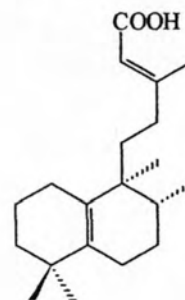
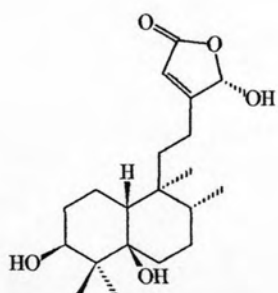
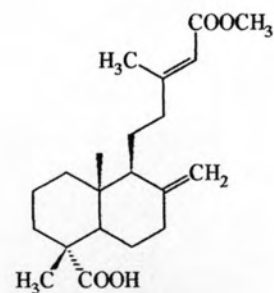


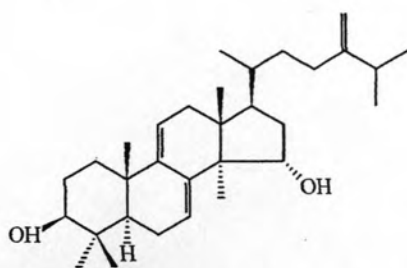
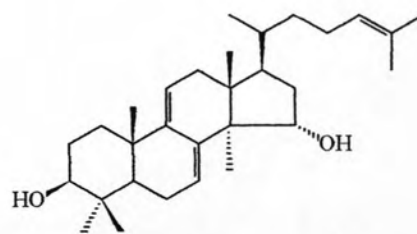
polyalthenol (47)

16 α -hydroxycyclocleroda-3,13(14)Z-dien-15,16-olide (48)16 α -hydroxycyclocleroda-4(18),13(14)Z-dien-15,16-olide (49)3 β ,16 α -dihydroxycyclocleroda-4(18),13(14)Z-dien-15,16-olide (50)4 β ,16 α -dihydroxycyclocleroda-13(14)Z-en-15,16-olide (51)Figure 2. Chemical constituents of plants in the genus *Polyalthia* (continued)

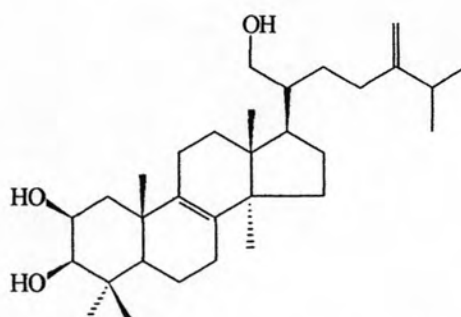
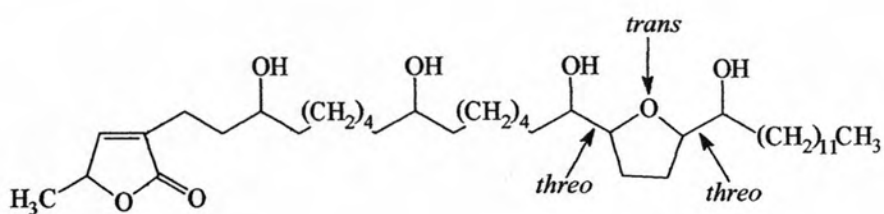
cleroda-3,13(14)*E*-dien-15-oic acid (52)cleroda-4(18),13(14)*E*-dien-15-oic acid (53)3,12*E*-kolavadien-15-oic acid -16-al (54)

16-oxocleroda-3,13-dien-16-oic acid (55)

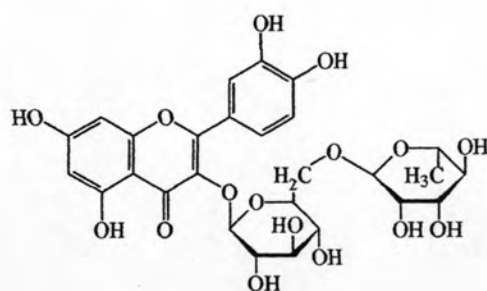
*ent*-halima-1(10),13*E*-dien-16-oic acid (56)*ent*-halima-5(10),13*E*-dien-16-oic acid (57)3 β ,5 β ,16 α -trihydroxyhalima-13(14)-en-15,16-olide (58)(4*S*,9*R*,10*R*)methyl 18-carboxy-labda-8,13(*E*)-dien-15-oate (59)Figure 2. Chemical constituents of plants in the genus *Polyalthia* (continued)

24-methylenelanosta-7,9(11)-dien-3 β ,15 α -diol (60)

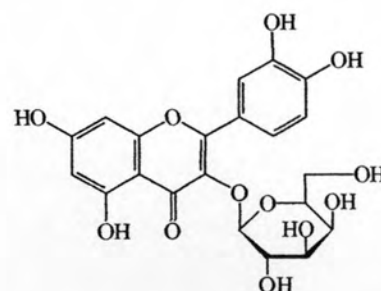
polycarpol (61)

24-methylenelanosta-8-en-2 β ,3 β ,21-triol (62)

plagionicin-A (63)

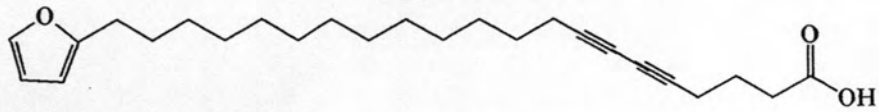


rutin (64)

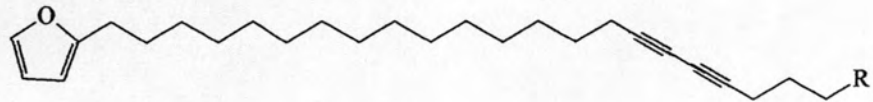


hyperoside (65)

Figure 2. Chemical constituents of plants in the genus *Polyalthia* (continued)

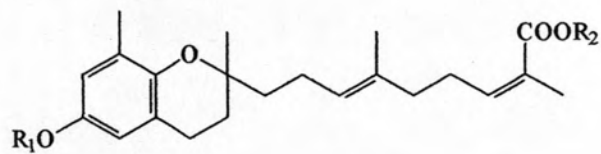


21-furan-heneicoso-5,7-diynoic acid (evectic acid) (66)

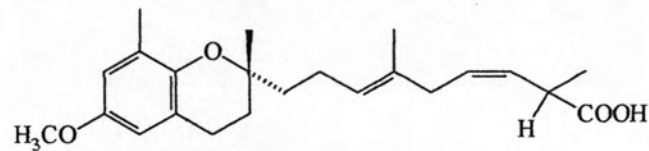


1-(2-furyl)pentacoso-16,18-diyne (67) $R = (CH_2)_2CH_3$

23-(2-furyl)tricoso-5,7-diynoic acid (68) $R = COOH$



| | R_1 | R_2 |
|----------------------------------|--------|--------|
| polycerasoidin (69) | CH_3 | H |
| polycerasoidol (70) | H | H |
| polycerasoidin methyl ester (71) | CH_3 | CH_3 |



polyalthidin (72)

Figure 2. Chemical constituents of plants in the genus *Polyalthia* (continued)

2. Biological Activity of the genus *Polyalthia*

The biological activities of isolated compounds from *Polyalthia* plants are summarized in Table 2.

Table 2. Biological Activities of the genus *Polyalthia* species

| Plant | Compound | Biological Activity | References |
|--|---|--|-----------------------------------|
| <i>P. barnesii</i> | 16 α -hydroxycleroda-3,13(14)Z-dien-15,16-olide (48), 3 β ,16 α -dihydroxycleroda-4(18),13(14)Z-dien 15,16-olide (50) and 4 β ,16 α -dihydroxycledora-13(14)Z-en-15,16-olide (51) | Cytotoxic against human cancer cell lines | Ma <i>et al</i> , 1994 |
| <i>P. cerasoides</i> (กะเจียน) | polyalthidin (72) | Inhibitor of mammalian mitochondrial respiratory chain | Zafra-Polo <i>et al</i> , 1996 |
| <i>P. cheliensis</i> | 16 α -hydroxycleroda-3,13(14)Z-dien-15,16-olide (48), 16 α -hydroxycleroda-4(18),13(14)Z-dien-15,16-olide (49), cleroda-3,13(14)E-dien-15-oic acid (52) and cleroda-4(18),13(14)E-dien-15-oic acid (53) | Cytotoxic against KB cell | Hao <i>et al</i> , 1995 |
| <i>P. debilis</i> (กล้วยเต่า) | bidebiline C (32) and bidebiline D (33) | Antimalarial | Kanokmedhakul <i>et al</i> , 2003 |
| <i>P. evecta</i> (นมน้อย) | 21-furan-heneicosa-5,7-diynoic acid (66) | Antifungal against plant pathogen | Kanokmedhakul <i>et al</i> , 1998 |
| <i>P. longifolia</i> (อโศกเขน-คาบเรียล) | 16 α -hydroxycleroda-3,13(14)Z-dien-15,16-olide (48) and 16-oxocleroda-3,13-dien-15-oic acid (55) | Antifeedant | Phadnis <i>et al</i> , 1988 |
| | liriodenine (18), oliveroline (23) and noroliveroline (24) | Cytotoxic against KB cell line | Wu <i>et al</i> , 1990 |

Table 2. Biological Activities of the genus *Polyalthia* species (continued)

| Plant | Compound | Biological Activity | References |
|---|--|---|------------------------------------|
| <i>P. longifolia</i> var. <i>pendula</i> . | pendulamine A (15), pendulamine B (16) and penduline (44) | Antibacterial | Faizi <i>et al</i> , 2002 |
| <i>P. longifolia</i> var. <i>pendula</i> . | anonaine (20), 16 α -hydroxy-cleroda-3,13(14)Z-dien-15,16-olide (48), 3 β ,5 β ,16 α -trihydroxy-halima-13(14)-en-15,16-olide (58) and 5-hydroxy-6-methoxyonychine | Cytotoxic against human cancer cell lines | Chen <i>et al</i> , 2000 |
| <i>P. macropoda</i> | (4S,9R,10R) methyl-18-carboxylabda-8,13(E)-diene-15-oate (59) | Leishmanicidal | Richomme <i>et al</i> , 1991 |
| <i>P. oliveri</i> | oliveroline (23) | Antiparkinsonism | Hamonnière, Laboeuf and Cavé, 1977 |
| | oliveridine (21) | Vasodilator | |
| <i>P. suberosa</i> (กึ่งกล่อม) | 24-methylenelanosta-7,9(11)-dien-3 β ,15 α -diol (60) | Anti-HIV | Li <i>et al</i> , 1993 |