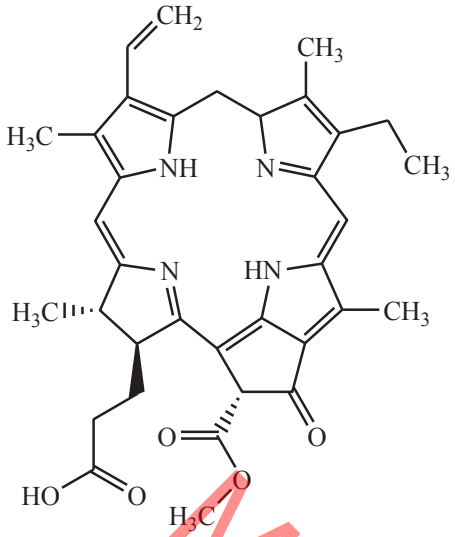
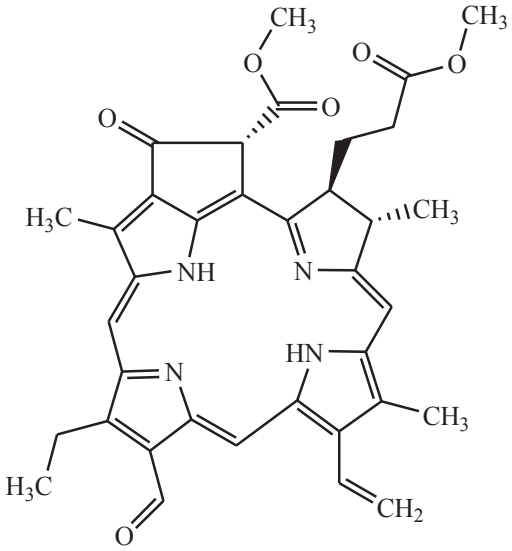


160 **Pheophorbide A**



161 **Methyl pheophorbide B**

Folk Medicine, Pharmacological and Biological Activities

The trees from the family Burseraceae exude a resin widely used for both cosmetics and perfumes and in folk medicine, for the treatment of many diseases (Rüdiger *et al.*, 2009).

The oldest written document, which mentions frankincense as drug is the papyrus Ebers. Oleogum resins from *Boswellia* species are used in traditional medicine in India and African countries for the treatment of a variety of diseases. Animal experiments showed anti-inflammatory activity of the extract. The mechanism of this action is due to some boswellic acids. It is different from that of non-steroidal anti-inflammatory drugs and is related to components of the immune system. Clinical studies, so far with pilot character, suggest efficacy in some autoimmune diseases including rheumatoid arthritis, Crohn's disease, ulcerative colitis and bronchial asthma. Side effects are not severe when compared to modern drugs used for the treatment of these diseases (Ammon, 2006). Zhang *et al.* (2013) reviewed the pharmacological details mainly on anti-inflammatory, anti-carcinogenic, anti-bacterial and apoptosis-regulating activities of individual triterpenoids isolated from *Boswellia species.*

The essential oil of frankincense is one of the most commonly used oils in aromatherapy practice. The oil is very good for respiration, eases breathing and is therefore useful for asthma patients. It has a soothing action in colds, cough, bronchitis and laryngitis. It has excellent actions on skin for removing scars and stretch marks. Frankincense oil produced contraction of phrenic-nerve diaphragm muscle (skeletal muscle) and inhibition of twitch response to nerve stimulation and exhibited a spasmogenic effect on smooth muscle *in vitro.* The oil exhibited anti-bacterial and antifungal activities (Mikhaeil *et al.*, 2003). The frankincense essential oil exhibits antibacterial, antifungal and immunomodulatory activities（Al-Harrasi and Al-Saidi, 2008).

1. *Aucoumea klaineana* Pierre: The roots and leaves are used in Gabon, to treat fever, constipation, malaria diarrhea and jaundice. The resin of the plant is used to purify water and as disinfectant. The essential oil, obtained from the resin, showed antioxidant and weak DPPH radical scavenging activities and it displayed the inhibition of lipid peroxidation (Koudou *et al.*, 2009).
2. *Boswellia ameero* Balf. f: The essential oil from oleogum resin showed antioxidant activity (Ali *et al.*, 2008a).
3. *Boswellia carterii* Birdw.: The dried gum resin of *B. carterii*, has been used in traditional Chinese medicine to alleviate pain and inflammation for thousands of years. The acetone extract of the gum resin has significant anti-arthritic and anti-inflammation effects and suggest that these effects may be mediated via the suppression of pro-inflammatory cytokines (Fan *et al.*, 2005). The oil, obtained from oleogum resin exhibited a strong immunostimulant (Mikhaeil *et al.*, 2003) and antifungal (Camarda *et al.*, 2007) activities. The plant extract showed inhibitory effect on hepatitis C virus protease (Hussein *et al.*, 2000), antiviral (anti-herpes) and cytotoxic (Badria *et al.*, 2003) activities. Cancer chemopteventive effects and cytotoxic activities activities of the triterpene acids, from the resin were reported (Akihisa *et al.*, 2006). All the triterpenes, isolated from the resin, exhibited marked anti-inflammatory activity (Banno *et al.*, 2006).
4. *Boswellia dalzielii* Hutch: The stem bark is used in Nigeria, to treat fever and rheumatism and for gastrointestinal troubles. The root and bark are used as antidote to snake bite and arrow poison. The decoction of the leaves and stem bark is used in and for the treatment of fever and rheumatism and gastrointestinal troubles. The stem bark extracts possess antispasmodic, antimicrobial (Adelakun *et al.*, 2001; Nwinyi *et al.*, 2004; Olukemi *et al.*, 2005; Hassan *et al.*, 2009) and hepatoprotective (Aliyu *et al.*, 2007a) activities which justifies its use traditionally in alleviating gastrointestinal disorders. The hepatoprotective effect of the leaf extract was also reported (Onoriose *et al.*, 2012).
5. *Boswellia elongata* Balf. f: The essential oil from oleogum resin showed antioxidant activity (Ali *et al.*, 2008a).
6. *Boswellia papyrifera*: The essential oil of the oleagum resin exhibited antifungal activity (Camarda *et al.*, 2007). The stilbene glycosides, isolated from the stem bark, exhibited significant inhibition of phosphodiesterase I and xanthine oxidase. Some of the triterpenes (e.g. 11-keto-β-boswellic acid, β-elemonic acid, 3α-acetoxy-11-keto-β-boswellic acid, β-boswellic acid and others) exhibited prolyl endopeptidase inhibitory activities (Atta-ur-Rahman *et al*. (2005).
7. *Boswellia rivea*: The essential oil showed antifungal activity and in particular against *Candida albicans* (Camarda *et al.*, 2007).
8. *Boswellia serrata*: Historically, it is recommended for osteoarthritis, juvenile, rheumatoid arthritis, soft tissue fibrosis and spondilytis without any side effect (Upaganlawar and Ghule, 2009). The essential oil from the gumoleoresin showed juvenomimetic activity on *Dysdercus similis* V instar nymphs (Dennis *et al.*, 1999). The extracts of the gum or the plant showed antidiarrhoeal (Borrelli *et al.*, 2006), anti-asthmatic, hypolipidemic, hepatoprotective activity, anti-ulcer, antioxidant,

anticancer, diuretic, antihyperglycemic, immunomodulatory, anti-inflammatory, analgesic and sedative effects (Upaganlawar and Ghule, 2009; Bansal *et al.*, 2013).

9. *Boswellia socotrana* Balf. f: The essential oil from oleogum resin showed antioxidant and acetylcholinesterase inhibitory activities (Ali *et al.*, 2008a).
10. *Bursera ariensis* (Kunth) McVaugh and Rzed. The plant extracts induced apoptosis in PC-3 cells (Acevedo *et al.*, 2015).
11. *Bursera bicolor* Engl.: Though the plant extracts lack cytotoxic activity on normal fibroblasts HFS-30, yet they exert high cytotoxic activity against cancer cell lines. The chloroform extract showed outstanding selective cytotoxicity against PC-3 cancer cell line (SI=153.85) (Acevedo *et al.*, 2015).
12. *Bursera excelsa* Engl.: The plant extracts exert anti-inflammatory activity (Acevedo *et al.*, 2015).
13. *Bursera fagaroides* (La Llave) Rez., Claderón and Medina: In Mexican traditional medicine, a taxa complex of three *Bursera fagaroides* varieties (*Bursera fagaroides* var. *fagaroides*, *Bursera fagaroides* var. *elongata* and *Bursera fagaroides* var. *purpusii*) had been reputed to possess antitumor activity (Rojas-Sepúlveda *et al.*, 2012). The lignan, β-peltatin A-methylether, isolated from the plant showed antitumor activity (Bianchi *et al.*, 1969).
14. *Bursera fagaroides* var. *fagaroides*: The seven lignans isolated from the stem bark, showed potent cytotoxic activity in the cell lines tested, especially 5′-desmethoxy-β-peltatin A-methylether, which exhibited greater activity than camptothecin and podophyllotoxin against PC-3 (ED50 = 1.0×10^{-5}µg/mL), and KB (ED50 = 1.0×10^{-5} µg/mL) (Rojas-Sepúlveda *et al.*, 2012).
15. *Bursera galeottiana* Engl.: Though the plant extracts lack cytotoxic activity on normal fibroblasts HFS-30, yet they exert high cytotoxic activity against cancer cell lines. The extracts also exhibited anti-inflammatory activity comparable to the control indomethacin (Acevedo *et al.*, 2015).
16. *Bursera glabrifolia*: It was reported that while the plant collected in Oaxaca was toxic against HF-6 and MCF-7 cell lines, the population of this species collected in Morelos was non-toxic against the tested cancer cell lines. This variation indicates different chemical profiles between both populations, possibly related to geographical, climatic or soil conditions (Acevedo *et al.*, 2015).
17. *Bursera graveolens* Triana & Planch: It is widely used in folk medicine for stomachache, as sudorific, and as liniment for rheumatism. The essential oil inhibited the growth of MCF-7 breast tumor cells, as well as amastigotes of *Leishmania amazonensis*, with IC_{50} values of 48.9±4.3 and 36.7±4.7 µg/mL, respectively. In addition, the cytotoxicity of the oil was 103.9±7.2µg/mL against peritoneal macrophages from BALB/c mice (Monzote *et al.*, 2012). The alcoholic extract of the aerial parts of the plant showed antimicrobial and anti-inflammatory activities (Robles *et al.*, 2005a). The methanol extract of the stems and the isolated lignans (burseranin and picropolygamain) exhibited cytotoxic activity (Nakanishi *et al.*, 2005).
18. *Bursera kerberi*: The plant extract showed important selective cytotoxicity against HF-6 (SI=37.74) and PC-3 (SI= 40.82) cancer cell lines (Acevedo *et al.*, 2015).

19. *Bursera klugii*: The two triterpenes, sapelins A and B, isolated from the leaves, showed activity against two test systems, the P-388 lymphocytic leukemia (3PS) and the human epidermoid carcinoma of the nasopharynx (9KB) (Jolad *et al.*, 1977).
20. *Bursera lancifolia* Engl.: The volatile fraction from the bark exhibited anti-inflammatory about half as active as indomethacin (Zúñiga*et al.*, 2005).
21. *Bursera lunanii* (black birch): The fruit essential oil exhibited antibacterial activity (Junor *et al.*, 2007).
22. *Bursera morelensis* Ramírez: The plant is used by folk medicine in Mexico for wound healing. The results obtained from an experimental study suggest that the combination of the biological properties shown by the extract (antiinflammatory, analgesic and antioxidant) could be related to this medicinal effect (Parrales *et al.*, 2012).
23. The lignin, deoxypodophyllotoxin, isolated from the exudate showed high cytoxic activity in the KB and PS test systems (Jolad *et al.*, 1977b).
24. *Bursera penicillata* (Sesse & Moc. Ex. Dc.) Engl.: The essential oil from the husk exhibited a broad spectrum of antimicrobial activity against bacteria strains *viz. Bacillus megatherius, B. subtilis, Micrococcus luteus, M. roseus, Staphylococcus aureus, Pseudomonas aeruginosa, Escherichia coli, Streptoccus pneumonia* and fungal strains namely *Candida albicans* and *C. tropicalis* (Jayaveera *et al.*, 2008). The leaf showed antimicrobial activity against pathogenic bacteria *Staphylococcus aureus, Escherichia coli, Proteus vulgaris, Klebsiella pneumoniae, Staphylococcus saprophyticus, Enterococcus faecalis* and *Enterobacter cloacae* (Ashok *et al.*, 2015).
25. *Bursera schlechtendalii*: The plant extracts showed antitumor activity against the 9KB (adenocarcinoma of nasal pharynx) test system (McDoniel and Cole, 1972) and anti-inflammatory activity (Acevedo *et al.*, 2015).
26. *Bursera simaruba* (L.) Sarg. (red birch): The plant is used in to treat wounds, insect bites, and skin sores; leaves are used as a bath to treat fever, a leaf decoction is taken in Cuba as a carminative, and the leaf decoction is used in the Bahamas to treat poisonwood (*Metopium toxiferum*) dermatitis (Setzer, 2014). The leaf essential oil showed anticancer activity against human lung carcinoma cell line A-549 and human colon adenocarcinoma cell line, DLD-1 (Sylvestre *et al.*, 2007). The hexane leaf extract exhibited potent anti-inflammatory activity (Abad *et al.*, 1996).
27. *Bursera tomentosa* (Jacq) Tr & Planch: The fruit oil showed antibacterial activity against *Staphylococcus aureus, Enterococcus faecalis and Salmonella typhi* (Moreno *et al.*, 2010).
28. *Bursera tonkinensis* Guill.: The main constituents of the leaf and fruit oils were α-phellandrene (70.1%), β-phellandrene (8.4%) and α-pinene (7.6%) (Hoi *et al.*, 2004). The lignan, 4′-demethyldesoxypodophyllotoxin, isolated from the roots, exhibited significant cytotoxic activities against KB, Col2 and LNCaP cell lines (Jutiviboonsuk *et al.*, 2005).
29. *Canarium album*: The two isolated triterpenes, urs-12-ene-3α, 16β-diol and olean-2-ene-3α,16β-diol, exhibited hepatoprotective activity in primary cultured rat

hepatocytes intoxicated with D-galactosamine (Tamai *et al.*, 1989). The flavonoids o the plant had good antioxidation to the hydroxyl free radical and the oxygen free radicals (Li *et al.*, 2007).

30. *Canarium benghalense* Roxb.: The isolated polyphenolic compounds were reported as cell cycle inhibitors (Du *et al.*, 2003).
31. *Canarium patentinervium* Miq: Extracts of the leaves and barks showed significant antitumor activities and in particular against breast cancer cell line, MDA 468 (Mogana *et al.*, 2011).
32. *Canarium schweinfurthii* Eng: The rhizhomes and leaves are used as stimulant and against fever, constipation, malaria, diarrhoea, sexual infections, post-partum pain and rheumatism (Obame *et al.*, 2007a). The plant exhibited anticancer activity against prostate cancer (Atawodi, 2011). The essential oil showed antioxidant, antimicrobial (Obame *et al.*, 2007a) and anti-inflammatory (Dongmo *et al.*, 2010) activities.
33. *Canarium subulatum* Guillaumin: β-Amyrin and (-)-cubebin, isolated from the bark, showed moderate antiherpetic activity, whereas 3,4-dihydroxybenzoic acid, 3,3'-di-*O*-methylellagic acid-4'-*O*-*α*-L-rhamnopyranoside exhibited recognizable DPPH free radical scavenging potential (Sritularak *et al.*, 2013).
34. *Dacryodes buettneri* H. J. Lam.: In Gabon, the plant is used to treat fever, constipation, jaundice, malaria, microbial infections, diarrhoea; the resin is used as disinfectant and astringent. The essential oil, obtained from the resin, showed antioxidant and antibacterial activities (Obame *et al.*, 2007b).
35. *Dacryodes edulis*: The plant is used to treat headache, fever and malaria (Tee *et al.*, 2014). The plant extracts showed antiplasmodial activity, which justifies its use in the treatment of malaria (Zofou *et al.*, 2011), as well as antioxidant activity (Atawodi *et al.*, 2009; Kong *et al.*, 2011). The essential oil of the resin exhibited antibacterial activity (Koudou *et al.*, 2008). The leaf extract is helpful in postponing the onset of diabetic retinopathy and type 2 diabetes mellitus (Moise *et al.*, 2012).
36. *Dacryodes klaineana*: The root is used to treat skin diseases (Tee *et al.*, 2014). The stem bark exhibited antitrypanosomal activity (Kamanzi *et al.*, 2004).
37. *Garuga pinnata* Roxb.: The leaf juice and stem juice are used for the treatment of asthma, and in curing opacities of the conjunctiva, respectively. In addition, decoction of the roots is used in the treatment of pulmonary affections while fruit acts as a stomachic and expectorant (Khatun *et al.*, 2013). The plant extracts of the different parts (mainly stem bark) exhibited antidiabetic (Shirwaikar *et al.*, 2006), antibacterial, anticancer (Wongsinkongman *et al.*, 2002; Thupurani *et al.*, 2013a), anti-inflammatory (Thupurani *et al.*, 2013b), anti-ulcer (Sachan *et al.*, 2014), and antioxidant (Thupurani *et al.*, 2012) activities.
38. *Protium confusum*: The essential oil of the plant exhibited antibacterial and larvicidal (against *Aedes aegypti*) activities (Santana *et al.*, 2009).
39. *Protium kleinii*: The ether fraction and the triterpenes (brein and others), isolated from the plant exhibited antinociceptive action (Otuki *et al.*, 2001; Lima *et al.*, 2005).

40. *Protium heptaphyllum* (Aubl.) Marchand: The plant is used in Brazil as an analgesic and anti-inflammatory agent (Lima *et al.*, 2014). The resin is used for skin diseases, healing of ulcers, scirrhus and as an analgesic (Susunaga *et al.*, 2001). Cytotoxicity was observed in fractions enriched with α- and β-amyrin. The resin and fractions elicited antiproliferative activity, increased activity of caspase-3 and angiotensin converting enzyme (ACE), and a decrease in the tumor necrosis factor alpha level(TNF-α) (Lima *et al.*, 2014). The essential oil from the leaves and fruits showed acaricidal actibity. The fruit oil was found to be more effective against the two spotted spider mite (*Tetranychus urticae*) when compared to the leaf oil. Both showed mortality properties and oviposition deterrence in higher concentration (10 Fl.l-1 air), but only the essential oil from fruits induced repellence on *T. urticae* (Pontes *et al.*, 2007). The essential oil, from the resin exhibited antinociceptive activity (Rao *et al.*, 2007). The antiobese potential of the resin has been reported (Carvalho *et al.*, 2015).
41. *Protium javanicum*: A toxicity study revealed that the essential oil obtained from old leaves were more toxic with LC_{50} of 15.85 compared to the essential oil of young leaves whose LC_{50} was 25.12 ppm (Setianingsih *et al.*, 2013).
42. *Protium kleinii* Cuatrecas: The ether soluble portion of the resin, brein (Otuki *et al.*, 2001), as well as the mixture of α-amyrin and β-amyrin triterpenes (Otuki *et al.*, 2005), obtained from the resin showed antinociceptive activity.
43. *Santiria trimera* (Oliv.) Aubrév:The essentials oils from the leaves and bark exhibited antimicrobial activity. The Gram-negative bacteria were the less sensitive to the leaf essential oil, which was effective against *Bacillus cereus* and *Enterococcus faecalis*. The bark essential oil was more active and, in particular, exhibited significant antimicrobial activity against *Proteus mirabilis*, which was resistant to the leaf oil. A weak anticandidal effect of both essential oils was observed (Bikanga *et al.*, 2010).
44. *Trattinickia rhoifolia* Willd.: It is used in the Venezuelan Folk Medicine for the treatment of throat affections, teeth ache and, thorns and splinters removal from skin (Rosquete *et al.*, 2010).

The family Burseraceae is represented in Egypt by one genus and two species (Boulos, 2000).

22.1. *COMMIPHORA*

Carbohydrates

D-Galactose, L-arabinose and 4-methyl D-glucuronic acid were identified from the oleogum resin of *Commiphora myrrha* Holmes **(**Hanuš *et al.*, 2005).

Amino Acids

1. *Commiphora mukul* Hook ex Stocks: The amino acids, histidine, lysine, arginine, aspartic acid, serine, glutamic acid, threonine, alanine, proline, tyrosine, tryptophan, valine, leucine and isoleucine were detected in the plant (Ali and Hasan, 1967).