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THE FIRST TRULY INDEPENDENT WATCHDOG FOR THOSE WORKING WITH NATURAL AROMATIC MATERIALS

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Cropwatch's Bibliography of Myrrh: *Commiphora myrrha* (Nees) Engl., & other related *Commiphora* spp.

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[to be progressively extended].

Cropwatch Introduction: The *Commiphora* genus contains up to 200 species of often thorny shrubs or small- to medium-sized dioecious trees with a peeling, papery bark distributed across Africa & the Arabian peninsula, with four species also found in India. Myrrh itself is the air-dried gum oleoresin principally obtained from the schizogenous gum-oleoresin cavities in the stem or branches of the small tree *Commiphora myrrha* (Nees) Engl. or *C. myrrha* (Nees) Engl. var. *molmol* (Fam. *Burseraceae*) and other *Commiphora* spp. such as *C. abyssinica* - (Berg.) Engl., *C. schimperi* (Berg.) Engl. These shrubs grow in sandy and rocky areas in Somalia, Sudan, Ethiopia, S. Arabia (Saudi Arabia, Yemen) and Kenya. Still other species yielding types of myrrh include *C. africana* (A. Rich) Engl., *C. mukul* (Hook ex Stocks) Engl. and *C. guidottii* (Chiov. ex Guidottii) which yields 'scented myrrh'.

General reference: Gillett, J.B. (1973). "*Commiphora* Jacq. (Burseraceae) - Englerian species which disappear." *Kew Bull.* **28**(1), 25-28.

Contents

Commiphora opobalsamum L.
Commiphora pseudopaoli JB Gillet
Commiphora schimperi (Berg.) Engl.
Commiphora sphaerocarpa Chiov. Chiovenda.
Commiphora tenuis. K. Vollesen
Commiphora wightii Arnott.

Commiphora africana (A. Rich) Engl.
syn *Commiphora pilosa* Engl.
Cropwatch comments: Source of "myrrh-like resin" (Gachathi 1997)

Ayedoun M.A. (1998) "Aromatic plants of Tropical West Africa. VI. alpha-Oxobisabolene as main constituent of the leaf essential oil of *Commiphora africana* (A. Rich.) Engl. from Benin." *Journal of Essential Oil Research* **10**(1), 105-107. Abstract. The leaf oil of *Commiphora africana* has been analyzed by GC, GC/MS coupling and 13C-NMR spectroscopy. The two major compounds identified in the oil were alpha-oxobisabolene (60%) and gamma-bisabolene (10%).

Banso A. & Mann A. (2006) "Antimicrobial alkaloid fraction from *Commiphora africana* (A. Rich)." *J of Pharmacy & Bioresources* **3**(2), 98-102. Abstract. An alkaloid fraction was isolated from *Commiphora africana* (Myrrh) and assayed against *Escherichia coli*, *Bacillus subtilis*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Streptococcus pyogenes* using the agar diffusion method. The fraction exhibited antimicrobial activities against all the test microorganisms *Bacillus subtilis* was the most susceptible to the alkaloids followed by *Staphylococcus aureus*, *Escherichia coli*, *Streptococcus pyogenes* and *Pseudomonas aeruginosa* respectively. The minimum inhibitory concentration ranged between 3.5mg/ml and 4.5mg/ml while the minimum bactericidal concentration ranged between 4.0mg/ml and 5.0mg/ml. The alkaloids fraction from *Commiphora africana* could be a potential source of chemotherapeutic agents.

Choudhury M.K., Johnson E.C. & Agbaji A.S. (2006) "I investigation of the bark of *Commiphora africana* (Burseraceae)." *Indian Journal of Pharmaceutical Sciences*. **62**(4), 311-2. Abstract. The methanolic extract of bark of the plant *Commiphora africana* (family:Burseraceae) gave a homogeneous product through chromatographic separation which after crystallization from methanol furnished needles (mp. 142-143 degree), characterized as dimethylterephthalate (benzene-1, 4-dicarboxylic acid dimethylester), C(10) H(10) O(4) (M+194) on the basis of spectral analysis (UV, IR, NMR, Mass) and comparison with the synthetic dimethylester prepared from terephthalic acid.

Gachathi F. N. (1997) "Recent advances on classification and status of main gum-producing species in the Family Burseraceae" available at http://www.fao.org/documents/show_cdr.asp?url_file=/docrep/X0098e/X0098e01.htm

Gbolade A.A. & Adeyemi A.A. (2008) "Anthelmintic activities of three medicinal plants from Nigeria." *Fitoterapia* **79**(3), 223-5. Abstract. Aqueous extracts of the leaf, stem bark and root bark from *Canna bidentata*, *Spondias mombin* and *Commiphora africana* were examined for anthelmintic activity against earthworm. All the extracts demonstrated a concentration-dependent activity at tested concentrations of 10-80 mg/ml. Higher activities were observed at the higher concentrations, 40-80 mg/ml for all the plant extracts. *C. bidentata* with a paralysis time of 3-5 min and death time of 5-18 min at these concentrations for the stem bark, and *S. mombin* which exhibited comparatively higher efficacy (34-44 min paralysis time and 105 min death time for the leaf) at lower concentrations of 10-20 mg/ml were adjudged the outstanding anthelmintics of plant origin accordingly.

Ma J., Jones S.H. & Hecht S.N. (2005) “A dihydroflavonol glucoside from *Commiphora africana* that mediates DNA strand scission” *Journal of Natural Products* 68(1),115-117. Abstract. A crude CH_2Cl_2–MeOH extract prepared from Commiphora africana was found to mediate Cu2+-dependent relaxation of supercoiled plasmid DNA. Bioassay-guided fractionation of this extract was carried out and was monitored by the use of an in vitro DNA strand scission assay. The dihydroflavonol glucoside phellamurin (1) was identified as the active principle responsible for the DNA cleavage activity of the crude extract.

***Commiphora caudata* (Wight & Arn.) Engl.**

Chandrasekar K., Rajan V., Raj C.D. Gowrishankar N.L. (2009) "Antiulcerogenic activity of *Commiphora caudata* bark extract against ethanol-induced gastric ulcer in rats." *Journal of Pharmacy Research* **2**(4), 701-703. Abstract. The ethanolic extract of *Commiphora caudata* bark extract was evaluated for their cytoprotective activity against ethanol-induced gastric lesions in rats. Four groups of male Sprague Dawley rats each consist of 6 animals. Group I animals were pretreated with phosphate buffer saline 5 ml/kg, p.o. as a control, whereas Group II and Group III rats were pretreated with 200 mg/kg, p.o. and 400 mg/kg p.o. of *Commiphora caudata* bark extracts respectively. Group IV rats were pretreated with cimetidine 50 mg/kg p.o. as reference. After 30 minutes, all animals were administered orally with 1 ml of absolute ethanol. After 15 minutes, all rats were sacrificed. Macroscopically, oral administration of absolute ethanol to rats pretreated with PBS significantly produced extensive hemorrhagic lesions of gastric mucosa, whereas animals pretreated with 200 mg/kg and 400 mg/kg ethanolic extract or cimetidine significantly reduced the formation of gastric lesions, when compared to control group. These results strongly document the beneficial cytoprotective effects of plant extract against ethanol-induced gastric ulcer in rats.

Latha S., Selvamani P., Pal T.K.., Gupta J.K. & Ghosh L.H. (2009) “Antibacterial Activity of *Commiphora caudata* and *Commiphora berryi* Leaves” Indian Drugs **40**(10), 696-698.

Latha S., Selvamani P., Pal T.K.., Gupta J.K. & Ghosh L.H. (2006) "macognostical studies on leaves of *Commiphora caudata* (Wight et Arn) Engl." *Ancient Science of Life* **26**(1/2), 19-25

Kannan C. (2009) "ulcerogenic activity of *Commiphora caudata* bark extract against ethanol-induced gastric ulcer in rats." *Journal of Pharmacy Research* **2**(4). Abstract. The ethanolic extract of *Commiphora caudata* bark extract was evaluated for their cytoprotective activity against ethanol-induced gastric lesions in rats. Four groups of male Sprague Dawley rats each consist of 6 animals. Group I animals were pretreated with phosphate buffer saline 5 ml/kg, p.o. as a control, whereas Group II and Group III rats were pretreated with 200 mg/kg, p.o. and 400 mg/kg p.o. of *Commiphora caudata* bark extracts respectively. Group IV rats were pretreated with cimetidine 50 mg/kg p.o. as reference. After 30 minutes, all animals were administered orally with 1 ml of absolute ethanol. After 15 minutes, all rats were sacrificed. Macroscopically, oral administration of absolute ethanol to rats pretreated with PBS significantly produced extensive hemorrhagic lesions of gastric mucosa, whereas animals pretreated with 200 mg/kg and 400 mg/kg ethanolic extract or cimetidine significantly reduced the formation of gastric lesions, when compared to control group. These results strongly document the beneficial cytoprotective effects of plant extract against ethanol-induced gastric ulcer in rats.

Nanthakumar R., Stephen Ambrose S., Sriram E., Babu G., Chitra K. and Uma maheswara Reddy C. (2009) "Effect of bark extract and gum exudate of *Commiphora caudata* on aspirin induced ulcer in rats." *Pharmacognosy Research* **11**(6), 375-380. Abstract. *Commiphora caudata* is used in Indian folk medicine as an antiulcerogenic agent. Despite of its promising use, there has been no scientific report present regarding its antiulcer activity. Therefore, this study was designed to evaluate the antiulcer activity of bark extract and gum exudate of *Commiphora caudata* on aspirin induced ulcer in rats. Acute toxicity study was performed and 200 mg/kg was selected as an effective dose. Four groups of Albino Swiss rats were included in this study. Aspirin suspended in 0.5 % carboxymethyl cellulose (CMC) was given orally to group 1 rats as a negative control group. Group 2 and group 3 animals received methanolic extract and gum exudate of *Commiphora caudata* respectively. Sucralfate was given orally to group 4 animals as a positive control. The methanolic extract of *Commiphora caudata* has been found to reduce total acidity as much as by sucralfate. However, it has not changed the fluid secretion. The gum preparation not only reduced the total acidity but also considerably reduce the gastric fluid secretion. In case of ulcer score sucralfate, methanolic extract and the gum have produced the low ulcer score compared to aspirin. Increased gastric mucosal protective mechanism by bark extract and gum exudate is probably due to the presence of some active principles present in the plant. However, further investigations are required to elucidate their exact mechanism of anti-ulcer activity.

Sivakumar T., Kannan K., Kannappan N. & Kathiresan K. (2009) "Antiinflammatory activity of *Commiphora caudata* [Wight and Arn]." *Asian Journal of Chemistry* **21**(5),4130-4132.

***Commiphora confusa* Vollesen.**
Cropwatch comments: Source of "myrrh-like resin" (Gachathi 1997).

Dekebo A., Dagne E., Curry P., Gautun O.R. & Aasen A.J. (2002) "Dammarane triterpenes from the resins of *Commiphora confusa*." *Bulletin of the Chemical Society of Ethiopia* 16(1),81-86(6). Abstract. The resin of *Commiphora confusa* afforded two new dammarane triterpenes, (3R,20S)-3,20-dihydroxydammar-24-ene and (3R,20S)-3-acetoxy-20-hydroxydammar-24-ene along with the known triterpenes, cabraleadiol 3-acetate and -amyrin.

Manguro L.O., Ugi I. & Lemmen P. (2003) "Dammarane triterpenes of *Commiphora confusa* resin." *Chem Pharm Bull* **51**, 483–486. Abstract. Fractionation of a steam distilled residue of *Commiphora confusa* resin has yielded four novel dammarane triterpenes characterised as (20S)-3beta-acetoxy-12beta,16beta-trihydroxydammar-24-ene, (20S)-12beta,16beta-trihydroxydammar-24-ene-3beta-O-beta-glucopyranoside, (20S)-3beta-acetoxy-12beta,16beta,25-tetrahydroxydammar-23-ene, and (20S)-3beta,12beta,16beta,25-pentahydroxydammar-23-ene. The known compounds beta-amyrin, 3beta-amyrinacetate, 2-methoxyfuranodienone, 2-acetoxyfuranodienone, (20R)-3beta-acetoxy-16beta-dihydroxydammar-24-ene, (20R)-3beta,16beta-trihydroxydammar-24-ene, 3beta-acetoxy-16beta-hydroxydammar-24-ene, 3beta-hydroxydammar-24-ene, 3beta-acetoxydammar-24-ene, and beta-sistosterol were also isolated from the same extract. The structures of the compounds were determined using spectroscopic, physical, and chemical methods.

Gachathi F. N. (1997) "Recent advances on classification and status of main gum-producing species in the Family Burseraceae" available at http://www.fao.org/documents/show_cdr.asp?url_file=/docrep/X0098e/X0098e01.htm

***Commiphora erythraea* (Ehrenb.) Engl. var *glabrescrens* Engl.**
Opoponax.
***Cropwatch comments*:** Source of opoponax.

Carroll J.F., Maradufu A. & Warthen Jr. J.D. (1989) "An extract of *Commiphora erythraea*: a repellent and toxicant against ticks." *Entomol. Exp. Appl.* **53**, 111-116. Abstract. A hexane extract of the gum of an African plant, *Commiphora erythraea* Engler (Burseraceae), has larvicidal and repellent activity against the lone star tick, *Amblyomma americanum* (L.) and the American dog tick, *Dermacentor variabilis* (Say). Adult deer ticks, *Ixodes dammini* Spielman, Clifford, Piesman and Corwin, were also repelled by the extract. Concentrations of 0.02 mg/cm 2 of the extract impregnated onto filter paper killed 96.15 (+ 3.56)% of *A. americanum* larvae exposed to it for 24 h. A concentration of 0.16

mg/cm 2 was needed to kill 80.3% of *D. variabilis* larvae. The extract was less effective as a larvicide against *A. americanum* and *D. variabilis* than permethrin. Less than 15.5% of *A. americanum* larvae and adults and *D. variabilis* and *L dammini* adults entered and remained for 2 or 3 min on areas of cloth strips treated with the extract at the rate of 0.2 mg/cm 2. However, 73.3 to 83.3% of the ticks tested entered and remained in areas treated with hexane. Permethrin was about 1 or 2 orders of magnitude more effective against *A. americanum* larvae as a repellent than the extract.

Lawrence B.M. (1983). “Opoponax oil *Commiphora erythraea* var. *glabrescens*” *Perfum. & Flav.* **8**, 27-28.

Lawrence B.M. (2004) *Progress in Essential Oils: Opoponax & Other Commiphora spp*. *Perf. & Flav.* **29**(7), 88-101.

Marcotullio M.C., Santi C., Mwankie G.N.O.-M. & Curini M. (2009) "Chemical Composition of the essential oil of *Commiphora erythraea*." *Natural Product Communications* **4**(12),1751-1754.

Maradufu A. (1982) “Furanosesquiterpenoids of *Commiphora erythraea* and *C. myrrh*.” *Phytochemistry* **21**, 677–680.

Wenninger J.A. & Yates R.L. (1969) *J. Assocn. of Anal. Chem*. **52**, 1155 through Khalid S.A. (1983) “Chemistry of the *Burseraceae*” *Ann. Proc. Phytochem. Soc. Europe* **22**, 281-299.

***Commiphora guidottii* Chiov. ex Guidottii.**
Scented Myrrh. Bissabol. Habak Hadi.

Ali A.Y. & Bowen I.D. (2005) "Antifeedant and molluscicidal activity of scented myrrh applied as a spray." *IOBC WPRS Bulletin* **28**(6),9-14.

Andersson M., Bergendorff O., Shan R.D., Zygmunt P. & Sterner O. (1997) *Planta Med* **63**, 251–254. Abstract. Minor components with smooth muscle relaxing properties from scented myrrh (*Commiphora guidottii*).

Claeson P., Andersson R. & Samuelsson G. (1991). T-cadinol: a pharmacologically active constituent of scented myrrh: introductory pharmacological characterization and high field 1H- and 13C-NMR data. *Planta Med*. **57**, 352-6.

Craveiro A., Corsano S., Proietti G. & Strappaghetti G. (1983) “Constituents of essential oil of *Commiphora guidottii*.” *Planta Med* **48**, 97–98. Abstract. From the essential oil of *Commiphora guidotti* seven sesquiterpene hydrocarbons and a furanosesquiterpenoid, furanodiene, were isolated.

Thulin M. & Claeson P. (1991) "The botanical origin of Scented Myrrh (Bissabol or Habak Hadi)." *Economic Botany* **45**(4), 487-494. Abstract. It is concluded that the botanical origin of scented myrrh (bissabol or habak hadi), a major article for export from Somalia since ancient times, is *Commiphora guidottii* (Burseraceae)

and not *C. erythraea* as generally has been presumed. The reasons for the previous confusion are discussed, and an updated synonymy and distribution map for *C. guidottii* are given.

Commiphora holtziana* ssp. *holtziana
syn. *Commiphora caerurea*
Gum haggar.
***Cropwatch comments**:* Source of opoponax.

Birkett M.A., Al Bassi S., Kröber T., Chamberlain K., Hooper A.M., Guerin P.M., Pettersson J., Pickett J.A., Slade R. & Wadhams L.J. (2008) "Antiectoparasitic activity of the gum resin, gum haggar, from the East African plant, *Commiphora holtziana*." *Phytochemistry* **69**(8), 1710-1715. Abstract. The mechanism of ixodid tick (Acari: Ixodidae) repellency by gum haggar, a resin produced by *Commiphora holtziana* (Burseraceae), was investigated by evaluating activity against the cattle tick, *Boophilus microplus*. In an arena bioassay, a hexane extract of the resin of *C. holtziana* exhibited a repellent effect lasting up to 5 h. The hydrocarbon fraction of the resin extract was shown to account for the repellent activity, and was analysed by coupled gas chromatography–mass spectrometry (GC–MS). Major sesquiterpene hydrocarbons were tentatively identified as germacrene-D, δ-elemene and β-bourbonene. The identity and stereochemistry of the former compound was confirmed as the (+)-isomer by peak enhancement using enantioselective GC, whereas the latter 2 compounds, which are most likely degradation products of germacrene-type precursors, were identified through isolation by preparative gas chromatography followed by microprobe-NMR spectroscopy. GC comparison of gum haggar with another resin, *C. myrrha*, which was inactive in the tick bioassay, showed that the latter contained much lower levels of these hydrocarbons. To assess the suitability of the gum haggar resin as a general acarine repellent, further tests were made on a major acarine pest of European and US animal husbandry systems, the red poultry mite, *Dermanyssus gallinae* (Acari: Dermanyssidae). Gum haggar extract, and the isolated hydrocarbon fraction, showed strong repellent effects in an olfactometer assay, and again gum myrrh showed no effect. These findings provide a scientific basis for the observed anti-tick properties of gum haggar, and demonstrate the potential for its development as a general acarine repellent for use in animal husbandry systems.

Cavanagh I.S., Cole M.D., Cavanagh J.S., Gibbons S., Gray A.I., Provan G.J & Waterman P.G. (1992) "A novel sesquiterpene, 1,2-epoxyfurano-10(15)-germacren-6-one, from the resin of *Commiphora holtziana* Engl." *Flav. & Frag. J.* **8**(1),39-41. Abstract. Three known and one novel furanogermacrenes have been isolated from the resinous exudate of *Commiphora holtziana* Engl. The structures of the known compounds were determined by comparison of 1H- and 13C-NMR spectra with those already published. The structure of the novel compound was determined as 1,2-epoxyfurano-10(15)-germacren-6-one (IV), using spectroscopic techniques. Some previous 13C-NMR assignments for the known compounds were corrected or clarified.

Manguro L.O.A., Opiyo S.A., Herdtweck E. & Lemmen P. (2009) "Triterpenes of *Commiphora holtziana* oleo-gum resin." *Canadian Journal of Chemistry* **87**(8),1173-1179. Abstract. Chemical analysis of the acetone extract of *Commiphora holtziana* gum resin has led to the isolation of triterpenes characterized as methyl 3-oxo-1α,19α,28-trihydroxyurs-12-en-24-oate (1), methyl 3β-acetyl-2α,11α,19α,28-tetrahydroxyurs-12-en-24-oate (2), methyl 3β,11α-diacetyl-1α,2α,28-trihydroxyurs-12-ene-24-oate (3), and 3β,28-diacetyl-1α,2α,25-trihydroxydammar-23-ene (4). The known compounds isolated from the same extract included cabraleadiol monoacetate (5), mansumbinol (6), 3β-acetylamyrin (7), 3α-acetylboswellic acid (8), 2-methoxy-8,12-epoxygermacra-1(10),7,11-trien-6-one (9), 2-methoxy-5-acetylfuranogermacra-1(10),7,11-trien-6-one (10), furadienone (11), 2-methoxy-5-acetyl-4-furanogermacra-1(10)Z-en-6-one (12), α-amyrin (13), sistosterol (14) and stigmasterol 3-O-acetate (15). Structural elucidation was carried out using spectroscopic and physical methods as well as by comparison with the literature data.

Provan G. J., Gray A. I. & Waterman P. G. (1987) "Monoterpene-rich Resins from some Kenyan Burseraceae" *Flav. Frag. J.* , **2,** 115-118. Abstract. Volatile oils obtained by the steam distillation of resins from *Boswellia neglecta, Commiphora africana, C. campestris* and *C. ogadensis* have been examined by capillary GC and GC-MS. In each case the oils were found to be entirely monoterpenoid in constitution. All four oils were generally characterized by large amounts of α-pinene. Other constituents that were important markers of individual species included α-thujene (*B. neglecta, C. africana*), sabinene (*C. campestris*), myrcene and car-3-ene (C. *ogadensis*) and *p*-cymene (*B. neglecta, C. africana*). ***Cropwatch comments***: According to Provan *et al*. (1987)The main constituents of the oil of *Commiphora holtiziana* are 1 (10),2-methoxy-8,12-epoxygermacra-1(10, 7, 11-trien-6-one, 5-acetoxy-2-methoxy-8,12-epoxygermacra-1(10),7,11-trien-6-one, 3-methoxy-8,12-epoxygermacra-1,7,10(15),11-tetraen-6-one, elemol, furanodiene, furanodienone, isofuranogermacrene, curzerenone, lindestrene, furanoeudesma-1,3-diene, furanoeudesma-1,4-diene-6-one, 1(10)Z, 4Z-furanodiene-6-one, 2-methoxy-furanodiene, 2-acetoxyfuranodiene, 4,5-dihydrofuranodiene-6-one.

***Commiphora incisa* Chiov.**.
syn. *C. candidula* Sprague.
Cropwatch comments: Source of "myrrh-like resin" (Gachathi 1997). Local use as masticatory gum.

Duwiejua M., Zeitlin I.J., Waterman P.G., Chapman J., Mhango G.J. & Provan G.J. (1993) "Anti-inflammatory activity of resins from some species of the plant family Burseraceae." *Planta Med*. **59**(1),12-6. Abstract. The anti-inflammatory activities of extracts from the resins of four species of the plant family Burseraceae, *Boswellia dalzielli*, *Boswellia carteri* (gum olibanum), *Commiphora mukul*, and *Commiphora incisa*, were studied. The aqueous extracts of the resins of *B. dalzielli*, *C. incisa*, and *C. mukul* significantly inhibited both the maximal edema response and the total edema response during 6 h of carrageenan-

induced rat paw edema. The octanordammarane triterpenes, mansumbinone and mansumbinoic acid, isolated from the resin of *C. incisa*, were separated and tested. Administered prophylactically, mansumbinone proved to be more than 20 times less potent than indomethacin and prednisolone in inhibiting carrageenan-induced rat paw edema. However, the molar potency of mansumbinoic acid was within one order of magnitude of those of indomethacin and prednisolone. The anti-inflammatory action of the acid on the carrageenan-induced edema was dose-related between 1.3 x 10(-5) and 2.5 x 10(-4) mol kg-1 when given before the inflammatory stimulus. The acid was able to reverse an established carrageenan-induced inflammatory response when administered 2 h after induction. Daily administration of mansumbinoic acid at a single dose level (1.5 x 10(-4) mol kg-1) significantly reduced joint swelling in adjuvant arthritis in rats. The results indicated that this compound is worthy of further investigation as an anti-inflammatory drug.

Gachathi F. N. (1997) "Recent advances on classification and status of main gum-producing species in the Family Burseraceae" available at http://www.fao.org/documents/show_cdr.asp?url_file=/docrep/X0098e/X0098e01.htm

Provan G.J. & Waterman P.G. (1988) "Major triterpenes from the resins of *Commiphora incisa* and *C. kua* and their potential chemotaxonomic significance." *Phytochemistry* **27**(12),3841-3843. Abstract. The resin obtained from *Commiphora incisa* has yielded two novel triterpenes which have been identified as 1α-acetoxy-9,19-cyclolanost-24-en-3β-ol and 29-norlanost-8,24-dien-1α,2α,3β-triol. No trace could be found of the octanordammaranes previously reported for this species and it now appears that these originate from the closely related *C. kua.*

Provan G.J. & Waterman P.G. (1985)"Piropolygamain: a new lignan from *Commiphora incisa*." *Planta Medica* **51**(3), 271-272. Abstract. The resin produced by *Commiphora incisa* has yielded two epimeric aryltetralin lignans which have been identified as the known polygamain (1 R, 2 R, 3 R) and its novel C-2 epimer to which the trivial name picropolygamain (1 R, 2 S, 3 R) has been assigned.

Provan G.J. & Waterman P.G. (1986) "The mansumbinanes: Octanordammaranes from the resin of *Commiphora incisa*." *Phytochemistry* **25**(4), 917-922. Abstact. The resin of *Commiphora incisa* (Burseraceae) has yielded three C22 compounds derived by loss of the C-17 side chain from a dammarane triterpene. They have been identified by spectral analysis and chemical modification as 4α,4β,8β,10β,14α-pentamethyl-5α-gon-16-en-3-one (mansumbinone), the corresponding 3-hydroxy compound (mansumbinol) and the derivative 3,4-seco-mansumbinoic acid in which the A-ring has opened between C-3 and C-4. A fourth compound was characterized as 16(S),20(R)-dihydroxydammar-24-en-3-one, a possible precursor of the mansumbinanes

***Commiphora kataf* (Forssk.) Engl.**

African Opoponax.
Cropwatch comments: Source of opoponax.
ANLAP data-base http://www.ics.trieste.it/EssentialOils/EssentialOil.aspx?ID=19
Cropwatch comments: This reports the following components confirmed by GC-MS and NMR in a Kenyan steam distillled essential oil of *C. kataf*: camphene (0.8%), γ-elemene (2.4%), β-elemene (14.4%), germacrene-D (15.5%), elmol (4.6%), furanogermacra-1, 10(15)-diene-6-one (16.7%).

Baser K.H.C., Demirci B., Dekebo A. & Dagne E. (2003) "Essential oils of some *Boswellia* spp, Myrrh and Opoponax" *Fl. & Frag. J.* **18**, 153-6. ***Cropwatch comments****:* Baser *et al.* indicate the presence of the following components in *C. kataf* oil: germacrene D, germacrene B, furanosesquiterpene and (1E)-8,12-epoxygermacra-1,7,10,11-tetraen-6-one.

***Commiphora kua* (R.Br. ex Royle) Vollesen.**
Kenya, Ethiopia, Somalia & Yemen

Awadh Ali N.A., Wurster M., Lindequist N.A.U. & Wessjohann L. (2008) "Essential oil composition from oleogum resin of Soqotraen *Commiphora kua*." *Rec. Nat. Prod.* **2:3** (2008), 70-75. Abstract. The major constituents of the essential oil obtained by hydrodistillation from the oleogum resin of *Commiphora kua* Vollesen were identified by GC-MS. Sixteen constituents were detected from the essential oil, which constituted about (90.5%) of the total amount. Major constituents of the oil were α- cadinol (33.0%), γ-cadinene (22.5%), δ-cadinene (17.0%), isocaryophyllene (3.7%), allo-aromadendrene (2.8%), α-muurolene (2.7%), and α-humulene (2.4%). The Oil of *Commiphora kua* showed moderate antifungal activity against *Cladosporium cucumerinum.*

Battu, G.R., Zeitlin, I.J. & Gray, A.I. (2000). "Anti-inflammatory activity of adjuvant-induced arthritis in rats of octanordammarane triterpenes from resin extracts of *Commiphora kua*." *Br. J. Pharmacol.* **133**, 199.

Battu, G.R., Zeitlin, I.J. and Gray, A.I. (2000). "Investigation of anti-inflammatory actions of molecules from Kenyan Myrrh, *Commiphora kua*." *J. Pharm. Pharmacol*. **52**, 309.

Battu, G.R., Zeitlin, I.J. & Gray, A.I. (2000). Anti-inflammatory activity of myeloperoxidase inhibitory molecules isolated from resin extracts of Commiphora kua. *Br. J. Pharmacol*. **131**, 187p.

Battu G.R., Zeitlin I.J., Gray A.I & Watermann P.G. (1999). "Inhibitory actions on rat myeloperoxidase of molecules isolated from antinflammatory extracts of *Commiphora kua*. " *Brit J. Pharmacol.* **128**, 274 Suppl. S.

Dekebo A., Dagne E., Hansen L.K., Gautun O.R. & Aasen A.J. (2002) "Two octanordammarane triterpenes from *Commiphora kua*." *Phytochemistry* **58**(4), 399-403. Abstract. The resin of *Commiphora kua* yielded two new octanordammarane triterpenes namely 15α-hydroxymansumbinone and 28-acetoxy-15α-hydroxymansumbinone, along with the four known compounds,

mansumbinone, mansumbinol, (16S, 20R)-dihydroxydammar-24-en-3-one and T-cadinol. These structures were elucidated by spectroscopic techniques, including 1D and 2D NMR spectroscopy, and X-ray analysis.

Manguro L.O.A., Ugi I. & Lemmen P. (2003) "Further bisabolenes and dammarane triterpenes of *Commiphora kua* resin." *Chem Pharm Bull*. **51**(5), 479-482. Abstract. From the resins of *Commiphora kua* a novel bisabolene; 6-hydroxy-2-methyl-5-(5'-hydroxy-1'(R),5'-dimethylhex-3'-enyl)-phenol together with two new dammarane triterpenes, 3.BETA.,16.BETA.,20(S),25-tetrahydroxydammar-23-ene and 3.BETA.-acetoxy-16.BETA.,20(S),25-trihydroxydammar-23-ene, have been isolated. In addition, being reported are known compounds identified as 2-methyl-5-(4'(S)-hydroxy-1'(R),5'-dimethylhex-5'-enyl)-phenol, 2-acetoxyfuranodienone, 2-methoxyfuranodienone, 3.BETA.,16.BETA.,20(R)-trihydroxydammar-24-ene and its acetate derivative, 3.BETA.-acetoxy-16.BETA.,20(R)-dihydroxydammar-24-ene, and .BETA.-amyrin and its acetate derivative. 2-Methyl-5-(4'(S)-hydroxy-1'(R),5'-dimethylhex-5'-enyl)-phenol displayed fungicidal activity against *Cladosporium cucumernum* on TLC assay.

Manguro L.O., Mukonyi K.M. & Githiomi J.K. (1996) "Bisabolenes and furanosesquiterpenoids of Kenyan *Commiphora kua* resin." *Planta Med*. **62**(1), 84-5. Abstract The isolation and structure determination of a new bisabolene, 2-methyl-5-(5'-hydroxy-1',5'-dimethyl-3'-hexenyl)phenol, together with known bisabolene, xanthorrhizol and furanosesquiterpenoids, 2- O-acetyl-8,12-epoxygermacra-1(10),4,7,11-tetraene and 2- O-methyl-8,12-epoxygermacra-1(10),4,7,11-tetraene, from gum exudate of *Commiphora kua* are reported.

***Commiphora madagascariensis* Jacq.**
syn. *Commiphora abyssinica* (Berg.) Engl.
syn. *Commiphora habessinica* (Berg) Engl.
***Cropwatch comments*:** Source of “myrrh-like resin” (Gachathi 1997)

Gachathi F. N. (1997) “Recent Advances on Classification and Status of Main Gum-Producing Species in the Family Burseraceae” available at http://www.fao.org/documents/show_cdr.asp?url_file=/docrep/X0098e/X0098e01.htm

***Commiphora merkeri* Engl.**

Zebrabark Myrrh
Fourie T.G. & Snyckers F.O. (1989) “A pentacyclic triterpene with anti-Inflammatory and analgesic activity from the roots of *Commiphora merkeri*.” *J. Nat Prod* **52**, 1129–1131.

***Commiphora molmol* Engl. ex Tschirch.**
syn *Commiphora myrrha* var *molmol*
True myrrh. Molmol (N.E. Kenya).

Al Faraj S. (2005) "Antagonism of the anticoagulant effect of warfarin caused by the use of *Commiphora molmol* as a herbal medication: a case report." *Annals of Tropical Medicine and Parasitology* **99**(2). 219-220.

Ashry K.M., El-Sayed Y.S., Khamiss R.M., El-Ashmawy I.M. (2009) "Oxidative stress and immunotoxic effects of lead and their amelioration with myrrh (*Commiphora molmol*) emulsion." *Food Chem Toxicol*. 2009 Oct 8. Abstract. The possible role of *Commiphora molmol* emulsion (CME) in protecting against lead (PbAc)-induced hepatotoxicity, oxidative stress and immunotoxicity in rabbits was assessed. Six groups of animals were used: groups I (control) and II (PbAc) were not supplemented with CME. Groups III (CME50) and IV (CME50+PbAc) were administered with CME in a dose rate of 50mg/kgbwt, while groups V (CME100) and VI (CME100+PbAc) were received 100mgCME/kg bwt daily p.o for successive 14weeks. Groups II, IV and VI were given 80mg PbAc/kg bwt/day orally for 6weeks starting from the 9th week. At the 12th week, animals were subjected to immunization by a single dose of sheep RBCs. The PbAc-group showed 220% increase in hepatic malondialdehyde levels, while glutathione, glutathione S-transferase and glutathione peroxidase levels decreased. Lead-acetate induced hypoproteinemia and hypoalbuminemia, and increased aminotransferases activity. It reduced the values of lymphocyte transformation test, phagocytic activity, phagocytic index and antibody titer against sheep SRBCs. Interestingly, pretreatment with CME attenuated these adverse effects in a dose-dependent protection. CME, therefore, is a potent antioxidant, and can protect against PbAc-induced hepatic oxidative damage and immunotoxicity by reducing lipid peroxidation and enhancing the antioxidant and immune defense mechanisms.

Haffor A.S. "Effect of myrrh (*Commiphora molmol*) on leukocyte levels before and during healing from gastric ulcer or skin injury." *J Immunotoxicol*. 2009 Dec 8. Abstract. Myrrh (*Commiphora molmol*) has been widely used as an anti-inflammatory and wound healing commercial product. As white blood cell (WBC)/leukocyte counts have been used as an indicator by clinicians to monitor progress of healing in patients, the purpose of this study was to examine effects of myrrh supplementation on blood WBC numbers before an injury and during healing. Male rats (7-8-wk-of-age) were randomly assigned to four groups. Group 1 (SIM) served as "skin injury treated + myrrh treatment (500 mg/kg/day)," Group 2 (SI) as "skin injury alone", Group 3 (GUM) as "gastric ulcer treated + myrrh treatment", and Group 4 (GU) as gastric ulcer only. Myrrh treatments (via drinking water) began 4 wk before induction of injury and continued for a 2 wk period post-injury. Baseline values for each WBC type were recorded before start of the myrrh treatments. Counts were performed again on Day 1 of the 5th wk (1-2 hr before injury) and post-injury on Days 4 and 7 of the 5th wk, and a final time on Day 4 of the 6th wk. Results showed that levels of all WBC types were significantly ($P < 0.05$) elevated before either injury in myrrh-treated rats (Groups 1 and 3) as compared with levels in rats in Groups 2 and 4. At all timepoints, there were neither significant differences between the values seen with rats in Groups 1 and 3, nor between those in Groups 2 and 4. Treatment with myrrh

also induced an initial increase in WBC levels that persisted through the post-injury healing period. Levels of most cell types only increased in the Group 2 and 4 rats once the injury was induced, but then declined over the healing period. Since myrrh enhanced WBC levels before injury, we conclude that myrrh likely contains substances that could induce an apparent antigen-driven response. As the myrrh also helped maintain elevated WBC levels throughout the healing period, this implied it was also able to induce maturation/differentiation/activation of both myeloid and lymphoid cell types during the effector phase of the immune responses involved in wound healing.

Massoud A. M., Kutkat M. A., Abdel-Shafy S., El-Khateeb R. M., Labib I.M. (2005) "Acaricidal efficacy of myrrh (*Commiphora molmol*) on the fowl tick *Argas persicus* (Acari: Argasidae). *J Egyptian Soc of Parasitology* **35**(2),667-686.

Rahman M.M.. Garvey M., Piddock L.J. & Gibbons S. (2008) "Antibacterial terpenes from the oleo-resin of *Commiphora molmol* (Engl.)." *Phytotherapy Research* **22**(10),1356-1360. Abstract. Two octanordammaranes, mansumbinone (1) and 3,4-seco-mansumbinoic acid (2), and two sesquiterpenes, beta-elemene (3) and T-cadinol (4) have been isolated from the oleo-resin of *Commiphora molmol* (Engl.). The structures of these compounds were established unambiguously by a series of 1D and 2D-NMR analyses. We have also unambiguously assigned all (1)H and (13)C NMR resonances for 2 and revised its (13)C data. The crude extract of the oleo-resin of C. molmol displayed potentiation of ciprofloxacin and tetracycline against S. aureus, several *Salmonella enterica* serovar Typhimurium strains and two K. pneumoniae strains. The antibacterial activity of terpenes 1-4 was determined against a number of *Staphylococcus aureus* strains: SA1199B, ATCC25923, XU212, RN4220 and EMRSA15 and minimum inhibitory concentration (MIC) values were found to be in the range of 4-256 microg/ml. The highest activity was observed by the seco-A-ring octanordammarane 2 with an MIC of 4 microg/ml against SA1199B, a multidrug-resistant strain which over-expresses the NorA efflux transporter, the major characterized antibiotic pump in this species. This activity compared favorably to the antibiotic norfloxacin with an MIC of 32 microg/ml. Compound 2 also displayed weak potentiation of ciprofloxacin and tetracycline activity against strains of *Salmonella enterica* serovar Typhimurium SL1344 and L10.

Tonkal A.M.D. & Morsy T.A. (2008) "An update review on *Commiphora molmol* and related species." *Egyptian Society of Parasitology* **18**(3),763-796. Abstract. The origins of myrrh and frankincense are traced to the Arabian Peninsula. According to Herodotus (5th century BC): "Arabia is the only country which produces frankincense, myrrh, cassia, and cinnamon.., the trees bearing the frankincense are guarded by winged serpents of small size and various colors." Diodorus Siculus wrote, in the second half of the first century BC, that "all of Arabia exudes a most delicate fragrance; even the seamen passing by Arabia can smell the strong fragrance that gives health and vigor." He also mentioned gold mines so pure that no smelting was necessary. The Magi, carrying myrrh, frankincense, and gold, came from the East: Arabia. The frankincense trade

route, with transport by donkeys and later by camel caravans, reached Jerusalem and Egypt from the Dhofar region of what is today Oman, through Yemen, turning north to follow the Red Sea coast. It is likely that the same or similar species of the resin-bearing plants grew across the Red Sea in the area that is now Somalia and Ethiopia, while the collection of the gum resins was initiated in Arabia. Myrrh contributed much in the human welfare. Schistosomiasis was known in ancient Egypt since remote times. Haematuria with urinary bladder disturbances was mentioned in four Papyrus papers dated back to 1950-1900 BC, and Schistosoma ova was detected in a cirrhotic liver of a mummy from 1200 BC (Ruffer, 1910). Also, Fasciola eggs were detected in a mummy (Looss, 1896). Fascioliasis infected over 17 million people worldwide causing marked morbidity and mortality (Haseeb et al., 2002). Schistosomiasis affected over 200 million people in 74 countries and territories worldwide (WHO, 1999) causing several chronic complications. Both were incriminated to predispose or accompanied human hepatitis and predisposed to HCV (Wahib et al., 2006). Most zoonotic helminthes induced immune response (Nutman, 2001) characterized by producing of type 2 cytokines, Ig G1, IgG2, IgE antibodies and eosinophil and mast cell activation (Hoffman et al., 2002). Treatment of fascioliasis required high or drug multiple doses with side effect (Farid et al., 1990). In schistosomiasis, praziquantel (PZQ) in use for > 20 years was faced with low efficacy (Leishout et al., 1998), or with increased resistance (Coles et al., 1986; Watt et al., 1988; Herrera et al., 1994; Ismail et al., 1994; 1999; Tonelli et al., 1995; Stelma et al., 1995; Fallon et al., 1997; Bennett et al., 1997; Boisier et al., 1998; Periera et al., 1998; Kusel and Hagan, 1999; Liang et al., 2000; King et al., 2000; N'Goran et al., 2003; Raso et al., 2004), potentiality of carcinogenicity, genotoxicity (Rosenkranz et al., 1995), mutagenicity (Montero et al., 1993), big dose lethality and enhanced clastogenicity of environmental pollutants (Anwar, 1994). On the other hand, Nomicos (2007) in USA reported that since antiquity, the genus *Commiphora* is composed of more than 200 species, and exploited as a natural drug to treat pain, skin infections, inflammatory conditions, diarrhea, and periodontal diseases. He added that in more recent history, products derived from *C. myrrha* and various other species of *Commiphora* are becoming recognized to possess significant antiseptic, anesthetic, and antitumor properties. Traditional practice and evidence-based research have supported that these properties are directly attributable to terpenoids (especially furanoses-quiterpenes), the active compounds present in myrrh essential oil. Very recently, current studies have focused on applying clinical trial methodologies to validate its use as an antineoplastic, an antiparasitic agent, and as an adjunct in healing wounds. Weeks and Simpson (2007) in USA presented the molecular phylogeny of *Commiphora*, a predominantly tropical African, arid-adapted tree genus to test the monophyly of its taxonomic sections and to identify clades to help direct future study of this species-rich and geographically widespread taxon. The multiple fossil calibrations of *Commiphora* phylogeny proved that it is sister to Vietnamese *Bursera tonkinensis* and that its crown group radiation corresponds with the onset of the Miocene. Auffray (2007) in France studied the impact of two types of

antioxidant on sebum squalene peroxidation by UV irradiation. The first type was free radical scavenger (Butyl hydroxyl toluene and an olive extract rich in hydroxytyrosol). The second type was the essential oil of *C. myrrha*, a singlet oxygen quencher. These properties were confirmed using the 2,2-diphenyl-1-picrylhydrazyl test for anti-radical capacity and 1,3-diphenylisobenzofuran test for the capacity to quench singlet oxygen. Also, the author extended an ex vivo method to classify the efficacy of cosmetics to protect squalene by collecting sebum in vivo and irradiating it in a controlled way. The squalene monohydroperoxide formation was monitored by high performance liquid chromatography. This method compared the efficiency of 3 antioxidants at 0.6% in a cosmetic formulation to protect squalene from photo oxidation. The data showed that essential oil of *C. myrrha* gave the best protection against squalene peroxidation, and that squalene peroxidation during solar exposure was mainly because of singlet oxygen and not due to free radical attack, and that sun care cosmetics should make use not only of free radical scavengers but also of singlet oxygen quenchers. This study aimed to review more than 70 out of hundreds papers (Pub-med-indexed for Medline) on the medical importance and safety of *Commiphora molmol* and other *Commiphora* species.

***Commiphora mukul* Hook ex Stocks.**
Guggal or Guggul
Cropwatch comments: Common adulterant of myrrh.

Amjad A.M. & Mashooda H. (1967) “Chemical investigation of *Commiphora mukul*.” *Pakistan J Sci Ind Res* **10**, 21–23.

Arora R.B., Kapoor V., Gupta S.K. & Sharma R.C. (1971) “Isolation of a crystalline steroidal compound from *Commiphora mukul* & its anti-inflammatory activity.” *Indian J Exp Biol* **9**, 403–404.

Arora R.B., Taneja V., Sharma R.C. & Gupta S.K. (1972) “Anti-inflammatory studies on a crystalline steroid isolated from *Commiphora mukul*.” *Indian J Med Res* **60**, 929–931.

Saeed M.A & Sabir A. W. (2004) "Antibacterial activities of some constituents from oleo-gum-resin of *Commiphora mukul*." *Fitoterapia* **75**(2), 204-208. Abstract. The essential oil, chloroform extract and seven sesquiterpenoids compounds newly isolated from the oleo-gum-resin of *Commiphora mukul* showed a wide range of inhibiting activity against both Gram (+) and Gram (-) bacteria.

Bajaj A.G. & Sukh D.S. (1982) “Chemistry of Ayurvedic crude drugs-V: Guggulu (resin from *Commiphora mukul*) -5 some new steroidal components and, stereochemistry of guggulsterol-I at C-20 and C-22.” *Tetrahedron* **38**, 2949–2954.

Bhati A. (1950) “Essential oil from the resin of *Commiphora mukul*.” *J Indian Chem Soc.* **27**, 436–440.

Bose S. & Gupta C. (1964) “Structure of *Commiphora mukul* gum: Part I – Nature of sugars present & the structure of the aldobiouronic acid.” *Indian J Chem* **2**, 57–60.

Bose S, & Gupta C. (1964) “Structure of *Commiphora mukul* gum: Part III – Methylation & periodate oxidation studies.” *Indian J Chem* **4**, 87–89.

Bose S, Gupta C. (1964) “Structure of *Commiphora mukul* gum: Part II – Structure of the degraded gum.” *Indian J Chem* **2**, 156–158.

Cornick C.L., Strongitharm B.H., Sassano G., Rawlins C., Mayes A.E., Joseph A.N., O'Dowd J., Stocker C., Wargent E., Cawthorne M.A., Brown A.L., Arch J.R.. (2009) "Identification of a novel agonist of peroxisome proliferator-activated receptors alpha and gamma that may contribute to the anti-diabetic activity of guggulipid in Lep(ob)/Lep(ob) mice." *J Nutr Biochem*. **20**(10), 806-15. Abstract.
The ethyl acetate extract of the gum of the guggul tree, *Commiphora mukul* (guggulipid), is marketed for the treatment of dyslipidaemia and obesity. We have found that it protects Lep(ob)/Lep(ob) mice from diabetes and have investigated possible molecular mechanisms for its metabolic effects, in particular those due to a newly identified component, commipheric acid. Both guggulipid (EC(50)=0.82 microg/ml) and commipheric acid (EC(50)=0.26 microg/ml) activated human peroxisome proliferator-activated receptor alpha (PPARalpha) in COS-7 cells transiently transfected with the receptor and a reporter gene construct. Similarly, both guggulipid (EC(50)=2.3 microg/ml) and commipheric acid (EC(50)=0.3 microg/ml) activated PPARgamma and both promoted the differentiation of 3T3 L1 preadipocytes to adipocytes. Guggulipid (EC(50)=0.66 microg/ml), but not commipheric acid, activated liver X receptor alpha (LXRalpha). E- and Z-guggulsterones, which are largely responsible for guggulipid's hypocholesterolaemic effect, had no effects in these assays. Guggulipid (20 g/kg diet) improved glucose tolerance in female Lep(ob)/Lep(ob) mice. Pure commipheric acid, given orally (960 mg/kg body weight, once daily), increased liver weight but did not affect body weight or glucose tolerance. However, the ethyl ester of commipheric acid (150 mg/kg, twice daily) lowered fasting blood glucose and plasma insulin, and plasma triglycerides without affecting food intake or body weight. These results raise the possibility that guggulipid has anti-diabetic activity due partly to commipheric acid's PPARalpha/gamma agonism, but the systemic bioavailability of orally dosed, pure commipheric acid appears poor. Another component may contribute to guggulipid's anti-diabetic and hypocholesterolaemic activity by stimulating LXRalpha.

Francis J.A., Raja S. N. & Nair M.G. (2004) "Bioactive terpenoids and guggulusteroids from *Commiphora mukul* gum resin of potential anti-Inflammatory Interest." *Chemistry and Biodiversity* **1**(11), 1842-1853.

Kakrani H.K. (1981) “Flavonoids from the flowers of *Commiphora mukul*. “ *Fitoterapia* **52**, 221–223.

Kakrani H.K. (1982) Physicochemical examination of seed oil from *Commiphora mukul* Hook ex Stocks." *Indian Drugs* **19**, 339–341.

Kumar V. & Dev S. (1987) "Chemistry of Ayurvedic crude drugs-VII: Guggulu (resin from *Commiphora mukul*). 6. Absolute stereochemistry of guggultetrols." *Tetrahedron* **43**, 5933–5948.

Mesrob B., Nesbitt C., Misra R. & Pandey R.C. (1998) High-performance liquid chromatographic method for fingerprinting and quantitative determination of E- and Z-guggulsterones in *Commiphora mukul* resin and its products. *J. Chromatogr B* **720**, 189–196.

Nohr LA, Rasmussen LB, Straand J (2008) "Resin from the mukul myrrh tree, guggul, can it be used for treating hypercholesterolemia? A randomized, controlled study." *Complement Ther Med.* **17**(1),16-22. Abstract. BACKGROUND: Guggul, herbal extract from resin of the *Commiphora mukul* tree, is widely used in Asia as a cholesterol-lowering agent based on Indian Ayurvedic medicine. Its popularity for this use is increasing in the US and Western Europe. Guggulsterones, the presumed bioactive compounds of guggul, may antagonise two nuclear hormone receptors involved in cholesterol metabolism, which is a possible explanation for hypolipidemic effects of these extracts. However, publications of efficacy data on the use of guggul extracts in Western populations are scarce. OBJECTIVE: To study the efficacy of a guggul-based formulation (short: guggul) on blood lipids in healthy adults with moderately increased cholesterol. METHODS: Double-blind, randomised, placebo controlled trial in Norwegian general practice. 43 women and men, age 27-70, with moderately increased cholesterol, randomised to use 2160mg guggul (4 capsules) daily, or placebo for 12 weeks. OUTCOME MEASURES: Mean change in total cholesterol, low-density lipoprotein cholesterol (LDL-C), triglycerides, high-density lipoprotein cholesterol (HDL-C) and total cholesterol/HDL-C ratio compared with baseline. Lipids were analysed at baseline, and at 6 and 12 weeks. In addition, unexpected events and adverse effects were recorded. RESULTS: Two dropouts, one withdrawal, and incomplete lab results for six persons left 34 participants to accomplish the trial (18-guggul, 16-placebo) with complete lab test data. After 12 weeks, mean levels of total cholesterol and HDL-C in the active group were significantly reduced compared with the placebo group. However, the mean levels of LDL-C, triglycerides, and total cholesterol/HDL-C ratio between the two groups did not change significantly. Ten guggul users (vs. four in the placebo group) reported side effects: mild gastrointestinal discomfort (n=7), possible thyroid problems (n=2), and generalized skin rash (n=1). The latter resulted in withdrawal from trial. CONCLUSIONS: Even if total cholesterol and HDL-C were significantly reduced, the clinical magnitude of this remains obscure. More and larger studies are needed to establish effects and safety of guggul-based formulations in the treatment for hypercholesterolemia.

Ojha S.K., Nandave M., Arora S., Mehra R.D., Joshi S., Narang R. & Arya D.S. (2008) "Effect of *Commiphora mukul* extract on cardiac dysfunction and

ventricular function in isoproterenol-induced myocardial infarction." *Indian J Exp Biol*. **46**(9), 646-52. Abstract. In present study, hydroalcoholic extract of *C. mukul* significantly improved the cardiac function and prevented myocardial ischemic impairment manifested in the form of increased heart rate, decreased arterial pressure, increased left ventricular end diastolic pressure, and altered myocardial contractility indices. *C. mukul* treatment additionally also produced a significant increase in lactate dehydrogenase levels and prevented decline of protein content in heart. *C. mukul* preserved the structural integrity of myocardium. Reduced leakage of myocyte enzyme lactate dehydrogenase and maintenance of structural integrity of myocardium along with favorable modulation of cardiac function and improved cardiac performance indicate the salvage of myocardium with *C. mukul* treatment. Guggulsterones which are considered to be responsible for most of the therapeutic properties of *C. mukul* may underlie the observed cardioprotective effect of *C. mukul* against cardiac dysfunction in isoproterenol-induced ischemic rats.

Patil V.D., Nayak U.R., Dev S. (1972) “Chemistry of Ayurvedic crude drugs-I: Guggulu (resin from *Commiphora mukul*) -1: Steroidal constituents.” *Tetrahedron* **28**, 2341–2352.

Patil V.D., Nayak U.R., Dev S. (1973) “Chemistry of Ayurvedic crude drugs-II: Guggulu (resin from *Commiphora mukul*) -2: Diterpenoid constituents.” *Tetrahedron* **29**, 341–348.

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Patil V.D., Nayak U.R, Dev S. (1973) “Chemistry of Ayurvedic crude drugs-III: Guggulu (resin from *Commiphora mukul*) - 3 long-chain aliphatic tetrols, a new class of naturally occurring lipids.” *Tetrahedron* **29**, 1595–1598.

Prasad R.S. & Dev S. (1976) “Chemistry of Ayurvedic crude drugs-IV: Guggulu (resin from *Commiphora mukul* - 4 absolute stereochemistry of mukulol.” *Tetrahedron* **32**, 1437–1441.

Purushothaman K.K. & Chandrasekharan S. (1976) “Gugulsterols from *Commiphora mukul* (Burseraceae).” *Indian J Chem, Sect B* 14B, 802–804.

Rücker G. (1972) "Über monocyclische Diterpene aus dem indischen Guggul-Harz (*Commiphora mukul*).“ *Arch. Pharm. (Weinheim)* **305**, 486–493.

Wang X., Greilberger J., Ledinski G., Kager G., Paigen B. & Juergen G. (2004). "The hypolipidemic natural product *Commiphora mukul* and its componentguggulsterone inhibit oxidative modification of LDL.” *Atherosclerosis*. **172**, 239-46.

Commiphora myrrha **(Nees) Engl. - Chemistry & Composition**
True Myrrh or Somalian Myrrh

Ahmed F., Ali M. & Singh O. (2006) "New compounds from *Commiphora myrrha* (Nees) Engl." *Pharmazie* **61**(8),728-731.

El-Ashry E.S., Rashed N., Salama O.M. & Saleh A. (2003) "Components, therapeutic value and uses of myrrh." *Pharmazie* **58**(3), 163-8. Abstract. Occurrence, constituents and medicinal use of myrrh, obtained from the stem of different *Commiphora* species are reviewed. The constituents of the volatile oil, the resin and the gum are outlined in detail. Myrrh has considerable antimicrobial activity and is medicinally used in a variety of diseases.

Baser K.H.C, Demirci B, Dekebo A, Dagne E. (2003) "Essential oils of some *Boswellia* spp., myrrh and opopanax." *Flavour Fragrance J* **18**, 153–156.

Brieskorn C.H. & Noble P. (1983) "Two furanoeudesmanes from the essential oil of myrrh." *Phytochemistry* **22**, 187–189.

Brieskorn C.H, & Noble P. (1983) "Furanosesquiterpenes from the essential oil of myrrh." *Phytochemistry* **22**, 1207–1211.

Brieskorn C.H. & Noble P. (1982) "Inhaltsstoffe des etherischen Öls der Myrrhe. II: Sesquiterpene und Furanosesquiterpene." *Planta Med* **44**, 87–90.

Brieskorn C.H. & Noble P. (1980) "Drei neue furanogermacrene aus myrrhe." *Tetrahedron Lett* **21**, 1511–1514.

Hanuš L.O., Rosenthal D., Ezanka T., Dembitsky V. M. & Moussaief A.(2008) "Fast and easy GC/MS identification of myrrh resins." *Pharmaceutical Chemistry Journal* c/c of *Khimitko-Farmatsevticheskii Zhurnal* **42**(12),719-720. Abstract. Extracts prepared from *Commiphora molmol* resins were analyzed by GC-MS. Twenty-two terpenoid compounds were identified in the hexane extract of the resin. Among them, 2-acetoxyfuranodiene (9.80%), furanoeudesma-1,3-diene (8.97%), isofuranogermacrene (6.71%), epicurzerenone (3.64%), 2-methoxyfuranodiene (2.97%), and lindestrene (2.74%) were the main compounds from the first myrrh resin (Tamar Ltd.), and furanoeudesma-1,3-diene (20.59%), isofuranogermacrene (17.94%), 2-acetoxyfuranodiene (8.80%), 2-methoxyfuranodiene (7.33%), and lindestrene (6.24%) from the second myrrh resin (Pamir Ltd)..

Hanus L.O., Řezanka T., Dembitsky V.M. & Moussaieff A. (2005) "Myrrh – *Commiphora* chemistry" *Biomed. Papers* **149**(1), 3–28. Abstract. Myrrh and opopanax has been used throughout history in incense and as a perfume. Since Bible times it has been used for the treatment of wounds. The first attempts to identify content compounds were almost 100 years ago. In this review we discuss the present state of knowledge in the chemistry of substances of *Commiphora* spp.
[Available at http://biomed.papers.upol.cz/pdfs/bio/2005/01/01.pdf]

Kimura I., Yoshikawa M., Kobayashi S., Sugihara Y., Suzuki M., Oominami H., Murakami T., Matsuda H/ & Doiphode VV. (2001) "New triterpenes, myrrhanol A and myrrhanone A, from guggulgum resins, and their potent anti-inflammatory effect on adjuvantinduced air-pouch granuloma of mice. *Bioorg Med Chem Lett* **11**, 985–989.

Ma X., Yu X., Zheng Z. & Mao J. (1992) “Investigation of volatile composition in frankincense and myrrh using analytical supercritical fluid extraction technique.” *Yaowu Fenxi Zazhi* **12**, 83–86.

Maradufua A. & Warthen Jr. J.D. (1998) "Furanosesquiterpenoids from *Commiphora myrrh* oil." *Plant Science* **57**(2), 181-184. Abstract. High-performance liquid chromatography has made possible the separation of furanosesquiterpenoids in *Commiphora myrrh* oil. Combined application of NMR, UV, and MS techniques have revealed that oil from *C. myrrh* gum resins contains isofuranogermacrene (1), lindestrene (2), furanoeudesma-1,3-diene (3), and furanodiene (4).

Marongiu B., Piras A., Porcedda S. & Scorciapino A. (2005) "Chemical Composition of the essential oil and supercritical CO2 extract of *Commiphora myrrha* (Nees) Engl. and of *Acorus calamus* L." *Journal of Agricultural and Food Chemistry* **53**(20), 7939-7943. Abstract. Volatile concentrates from the oleo-gum resin of *Commiphora myrrha* (Nees) Engl. and from the rhizomes of Acorus calamus were isolated by supercritical extraction with carbon dioxide. The volatile oil of myrrh was obtained at 9.0 MPa and 50 °C and at a CO2 flow of 1.5 kg/h. *Acorus calamus* was extracted at 9.0 MPa and 45 °C and at a CO2 flow of 1.6 kg/h. In both cases, an oil devoid of cuticular waxes was obtained with a single depressurization stage. The SFE myrrh oil had a yield, Y, of 3.2%. Its main components, identified and quantified by GC/MS, were furanoeudesma-1,3-diene, 34.9%; lindestrene, 12.9%; curzerene, 8.5%; and germacrone, 5.8%. The essential oils from the same starting material by hydrodistillation, HD, (Y = 2.8%) and by steam distillation, SD, (Y = 0.4%) were quite similar to the SFE extract. The main components of the SFE oil of A. calamus (Y = 3.5%) were acorenone, 13.4%; iso-acorone, 11.6%; (Z)-sesquilavandulol, 11.0%; dehydroxy isocalamendiol, 7.7%; and β-asarone, 5.5%. The comparison with hydrodistilled (Y = 1.8%) and steam distilled (Y = 1.0%) oils revealed large differences in the content of iso-acorone and crypto-acorone.

Monti D., Manitto P., Tagliapietra S., Dada G. & Speranza G. (1986) “The absolute stereochemistry of two furanogermacranes of myrrh as determined by the circular dichroism exciton chirality method.” *Gazz Chim Ital* **116**, 303–306.

Morteza-Semnani K, Saeedi M. (2003) “Constituents of the essential oil of *Commiphora myrrha* (Nees) Engl. var. *molmol*.” *J Essent Oil Res* **15**, 50–51.

Shen T. Wan W.Z., Wang X.N., Yuan H.Q., Ji M. & Lou H.X. (2009) "A triterpenoid and sesquiterpenoids from the resinous exudates of *Commiphora myrrha*." *Helevitica Chimica Acta* **92**(4),645-652.

El-Sherbini G.T., El Gozamy B.R., Abdel-Hady N.M. & Morsy T.A. (2009) "Efficacy of two plant extracts against vaginal trichomoniasis." *J Egypt Soc Parasitol.* **39**(1),47-58. Abstract. Trichomoniasis vaginalis is now an important worldwide health problem. Metronidazole has so far been used in treatment, but the metronidazole-resistant strains and unpleasant adverse effects have been

developed. Treatment of patients with metronidazole refractory vaginal trichomoniasis constitutes a major therapeutic challenge and treatment options are extremely limited. In the present study, 33 metronidazole-resistant T. vaginalis females were treated with a combined course of metronidazole and tinidazole. Those still resistant to the combined treatment were given *Commiphora molmol* (Myrrh) as two capsules for six to eight successive days on an empty stomach two hours before breakfast. Also, natural plant extract purified from (Roman) was in-vitro investigated for its efficacy against T. vaginalis on fresh Diamond media. The anti-trichomoniasis vaginalis activity of both P. granatum (in-vitro) and *C. molmol* (in-vivo) extracts gave promising results.

Wiendl R.M., Müller B.M. & Franz G. (1995) “Proteoglycans from the gum exudate of myrrh.” *Carbohyd Polym* **28**, 217–226.

Wiendl R.M. & Franz G. (1994) “Myrrh. New chemistry of an old plant drug.” *Dtsch Apoth Ztg* **134**, 27–29, 31–32.

Wilson R.A. & Mookherjee B.D. (1983) “Characterization of aroma donating components of myrrh.” *Proceedings of 9th International Congress of Essential Oils, Singapore, 13–17 March, paper no. 400, pp. 1– 10, Book 4. Singapore: Essential Oils Association of Singapore*.

Yang G.-C., Li Z.-L., Li W. & Hua H.-M. (2008) The structure of a franosesquiterpenoid extracted from myrrh elucidated by NMR Spectroscopy." *Chinese J of Magnetic Resonance* **25**(4), 548-553.

Yu X, Ma X, Ding X. (1993) “GC/ITD study of major constituents of the extracts of myrrh and *Curcuma zedoaria*.” *Fenxi Ceshi Xuebao* **12**, 8–13.

Zhu N., Sheng S., Sang S., Rosen R.T. & Ho C-T. (2003) “Isolation and characterization of several aromatic sesquiterpenes from *Commiphora myrrha*.” *Flavour Fragrance J*. **18**, 282–285.

Zhu N., Kikuzaki H., Sheng S., Sang S., Rafi M.M., Wang M., Nakatani N., DiPaola R.S., Rosen R.T, & Ho C.-T. (2001) "Furanosesquiterpenoids of *Commiphora myrrha*." Abstract. An investigation on the gum exudates of *Commiphora myrrha* has led to the isolation of six sesquiterpenoids. On the basis of spectroscopic data interpretation, they were determined as two new furanosesquiterpenoids, rel-1S,2S-epoxy-4R-furanogermacr-10(15)-en-6-one (1) and rel-2R-methyl-5S-acetoxy-4R-furanogermacr-1(10)Z-en-6-one (2), and four known furanosesquiterpenoids, rel-3R-methoxy-4S-furanogermacra-1E,10(15)-dien-6-one (3), rel-2R-methoxy-4R-furanogermacr-1(10)E-en-6-one (4), furanogermacra-1(10)Z,4Z-dien-6-one, and curzerenone [6,7-dihydro-5β-isopropenyl-3,6β-dimethyl-6-vinylbenzofuran-4(5H)-one]. This is the first report of the relative stereochemistry for the known compounds 3 and 4. Compound 1 exhibited weak cytotoxic activity against a MCF-7 breast tumor cell line in a clonogenic assay, while the other five compounds were inactive in this assay.

***Commiphora myrrha* (Nees) Engl. – Properties.**

True Myrrh or Somalian Myrrh.

Abdul-Ghani RA, Loutfy N, Hassan A. (2009) "Myrrh and trematodoses in Egypt: an overview of safety, efficacy and effectiveness profiles. *Parasitol Int.* **58**(3), 210-4. Abstract. Myrrh is an herbal product that has been used since ancient ages for traditional medication and other purposes. The revolution of myrrh as an antiparasitic agent in Egypt began in the 1990s through scientific evidence-based research. The human trematode infections in Egypt were the main focus of research with stories of success and disagreement, at times. The present paper reviewed the antiparasitary activity of myrrh with stress on its possible mode of action, its safety, efficacy and effectiveness on trematode infections in experimental studies and clinical trials in Egypt as well as its molluscicidal effects on the intermediate hosts of trematodes.

Bone, K. (2006) "Myrrh: A significant development in the treatment of parasites." *Townsend Letter for Doctors and Patients* **276**, 46-54.

Dolara P., Corte B., Ghelardini C., Pugliese A.M., Cerbai E., Menichetti S., Lo Nostro A. (2000) "Local anaesthetic, antibacterial and antifungal properties of sesquiterpenes from myrrh. *Planta Med* **66**, 356–358. Abstract. We extracted, purified and characterized 8 sesquiterpene fractions from *Commyphora molmol.* In particular, we focused our attention on a mixture of furanodiene-6-one and methoxyfuranoguaia-9-ene-8-one, which showed antibacterial and antifungal activity against standard pathogenic strains of *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Candida albicans*, with minimum inhibitory concentrations ranging from 0.18 to 2.8 micrograms/ml. These compounds also had local anaesthetic activity, blocking the inward sodium current of excitable mammalian membranes.

Dolara P., Luceri C., Ghelardini C., Monserrat C., Aiolli S., Luceri F., Lodovici M., Menichetti S. & Romanelli M.N. (1996) "Analgesic effects of myrrh." *Nature* **379**(6560), 29.

Lemenih M. & Teketay D. (2003) "Frankincense and myrrh resources of Ethiopia: II. Medicinal and industrial uses." *SINET: Ethiopian Journal of Science* **26**(2), 161-172(12). Abstract. Oleo-gum resins such as frankincense and myrrh are some of the economically and culturally valuable products obtained from trees and shrubs of the genera *Boswellia* and *Commiphora*, respectively. They are important natural plant products used in several industries that include pharmacology, food, flavour, liqueur and beverage, cosmetics, perfumery and others. Moreover, frankincense and myrrh have several local applications in medicinal, hygienic, and insecticide areas that could be developed through research. They are widely used in traditional medicines of several countries for treatments of a wide variety of ailments from embalming to cancer, leprosy, bronchitis, diarrhea, dysentery, typhoid, mouth ulcers, inflammatory complaints, viral hepatitis, female disorders, infections/wounds, coughs, tumour, and others. Although Ethiopia is one of the few countries that are endowed with large frankincense and myrrh resources, little proper exploitation of these resources

has been made so far. In this paper a review is presented on pharmacological and industrial applications of these valuable resources. The information is expected to prompt the enormous economic opportunity that these resources could provide both at national and local levels. Concurrently, this opportunity, if properly exploited, will contribute significantly towards the conservation and management of the vegetation resources that yield frankincense and myrrh as well as their ecosystems.

Lv L., Yan G.-Y., Zhao Y.-L., He X.-J., Jiang X., Zhuo Y.-Q., Wang Y.-L. Wang L. & Cen X.-B. (2009) "Investigation of the dermal sensitizing potential of traditional medical extracts in local lymph node assays." *Experimental Biology and Medicine* **234**, 306-313. Abstract. "Traditional medical extracts are commonly used as complex mixtures, which may contain naturally occurring contact sensitizers. In this investigation, the mice local lymph node assay (LLNA) was performed to evaluate the dermal sensitization potential of Myrrh, Borneolum, Olibanum, Moschus and Cassia Bark, which are widely used in topical traditional medication. In the radioactive LLNA, the stimulation index (SI) values were calculated for each medical extract. Myrrh, Borneolum, Olibanum and Moschus induced dose-dependent cell proliferation and SI was more than 3. Cassia Bark showed no positive response over the range of test concentrations. In the flow cytometry analysis, the total number of CD3+, CD4+, and CD8+ cells in local lymph nodes was increased in Moschus-, Olibanum-, Myrrh- and Borneolum-treated mice. The ratio of the B220+/CD3+ (B/T cell ratio) and the percentage of I-Ak+ cells that was also positive for the CD69 marker (I-Ak+/ CD69+) were increased in the Moschus-, Olibanum- and Myrrh-treated mice. However, no ofbvious change was observed in Borneolum-treated mice. Cassia Bark did not induce changes in the lymphocyte subpopulations. These results indicate that Moschus, Olibanum and Myrrh can be regarded as sensitizers, and Borneolum regarded as an irritant. Cassia Bark is neither a sensitizer nor an irritant. The combination of radioactive and flow cytometric LLNA can be used for the prediction of sensitizing potential of medical extracts which lead to allergic contact dermatitis in humans. "

Massoud A.M., El Ebiary F.H. & Abd El Salam N.F. (2004). "Effect of myrrh extract on the liver of normal and bilharzially infected mice. An ultrastructural study." *J Egypt Soc Parasitol*. **34,** 1-21.

Massoud A.M., Labib I.M. & Rady M (2001). "Biochemical changes of *Culex pipiens* larvae treated with oil and oleo-resin extracts of Myrrh *Commiphora molmol*." *J Egypt Soc Parasitol*. **31**, 517-29.

Mayer J.G. (2008) “[Gold, frankincense and myrrh]” *Dtsch Med Wochenschr.* **133** (51-52):2665-8.

Mincione E. & Lavarone C. (1972) “ Terpeni dalla *Commifera mirra* Arabica. Nota I.” *Chim Ind (Milan)* **54**, 424–425.

Nomicos E.Y. (2007) "Myrrh: medical marvel or myth of the Magi?" *Holist Nurs Pract*. **21**(6), 308-23. Abstract. Since antiquity, the genus *Commiphora* is composed of more than 200 species, and has been exploited as a natural drug to treat pain, skin infections, inflammatory conditions, diarrhea, and periodontal diseases. In more recent history, products derived from *Commiphora myrrha* and various other species of *Commiphora* are becoming recognized to possess significant antiseptic, anesthetic, and antitumor properties. Traditional practice and evidence-based research have supported that these properties are directly attributable to terpenoids (especially furanosesquiterpenes), the active compounds present in myrrh essential oil. More recently, current studies have focused on applying clinical trial methodologies to validate its use as an antineoplastic, an antiparasitic agent, and as an adjunct in healing wounds.

Pank F. (2009) "Incense and myrrh - incense between mysticism and medicine." *Zeitschrift fur Arznet und Gewurzpflanzen* **14**(4), 145-145.

Racine P. & Auffray B. (2005) "Quenching of singlet molecular oxygen by *Commiphora myrrha* extracts and menthofuran." *Fitoterapia* **76**(3-4), 316-23. Abstract. The quenching activity against singlet oxygen, an actor of lipid peroxidation and DNA degradation, of the essential oil and resinoid of *Commiphora myrrha* from Somalia has been studied and compared to DL-alpha-tocopherol using 1,3-diphenylisobenzofuran (DPBF) as a probe. To insure that the furan ring was the site of the reaction, experiments were conducted with menthofuran. The essential oil and menthofuran show a higher activity than DL-alpha-tocopherol, suggesting their potential usefulness to neutralise this deleterious form of molecular oxygen.

Saeed M.A. & Sabir A.W. (2004) “Irritant potential of some constituents from oleo-gum-resin of *Commiphora myrrha*.” *Fitoterapia* **75**(1), 81-4.

Shen T. & Lou HX. (2008) "Bioactive constituents of myrrh and frankincense, two simultaneously prescribed gum resins in Chinese traditional medicine." *Chem Biodivers*. **5**(4), 540-53.

Su SL, Duan JA, Tang YP, Zhang X, Yu L, Jiang FR, Zhou W, Luo D, Ding AW (2009) "Isolation and biological activities of neomyrrhaol and other terpenes from the resin of *Commiphora myrrha*". *Planta Med*. **75**(4), 351-5. Abstract. A new cycloartane-type triterpene named cycloartane-1alpha,2alpha,3beta,25-tetraol (neomyrrhaol) (1), along with four known terpenes, sandaracopimaric acid (2), abietic acid (3), 2-methoxy-5-acetoxyfruranogermacr-1(10)-en-6-one (4), and dehydroabietic acid (5) have been isolated from the resin of COMMIPHORA MYRRHA. Their structures were elucidated by means of 1D, 2 D NMR and HR-mass spectroscopy. Compounds 2-5 are known compounds but not previously isolated from the resin of C. Myrrrha. Compounds 4 and 5 exhibited significant aromatase inhibiting activity with IC50 values at 0.2 microM and 0.3 microM, respectively. As shown in the MTT assay, 2, 3, 4, and 5 had inhibitory effects on HUVEC growth with IC50 values of 0.122 microM (2), 0.125 microM (3), 0.069 microM (5). Compounds 1-5 did not inhibit contraction of the isolated uterine and

did not protect HUVEC from damage induced by H2O2 at the tested concentration.

Tipton D.A., Lyle B., Babich H. & Dabbous M.Kh. (2003) "In vitro cytotoxic and anti-inflammatory effects of myrrh oil on human gingival fibroblasts and epithelial cells." *Toxicol In Vitro*. **17**(3), 301-10.

Tucker A.O. (1986) "Frankincense and Myrrh." *Econ Bot* **40**, 425–433. Abstract. While frankincense and myrrh have been harvested from a multitude of species, certain species have predominated in history. *Boswellia carteri* and *B. frereana* are the main sources of frankincense today, while *B. papyrifera* was the principal source of antiquity and *B. sacra* was the principal species of classical times. *Commiphora myrrha* is the chief source of myrrh today, but *C. erythraea* was the principal source of ancient and classical times. Each of these oleo-gum-resins has a characteristic odor that is predominately due to a mixture of complex sesquiterpenes.

***Commiphora opobalsamum* L.**
syn. *Commiphora gileadensis* (L.) C. Chr.
Balm of Gilead or Mecca Balsam.
Cropwatch comments: Do not confuse with *Cedronella canariensis* syn. *Cedronella triphylla*, (Canary Balm) native to the Canary Islands and of marketed by European plant nurseries as Balm of Gilead, or with exudates or extracts of poplar buds (*Populus balsamifera* Moench). which are also offered as Balm of Gilead (but also sold as Tacamahac or Gum Tacamahac, a term previously applied to the fragrant resin from *Bursera gummifera* L.).

Abbas F. A., Al-massarany S. M., Khan S., Al-howiriny T.A., Mossa J. S. & Abourashed E.A. (2007) "Phytochemical and biological studies on Saudi *Commiphora opobalsamum* L." *Natural Product Research* **21**(5).383-391,

Abdul-Ghani A.S. & Amin R. (1997) "Effect of aqueous extract of *Commiphora opobalsamum* on blood pressure and heart rate in rats." *J Ethnopharmacol* **57**, 219–222. Abstract. The cardiovascular effects of aqueous extracts from the branches of *Commiphora opobalsamum* tree were investigated. The intravenous administration of 4 mg/kg of the aqueous extract depressed systemic arterial blood pressure by 20% ($P<0.01$) and reduced heart rate of anaesthetised rats by 14% ($P<0.05$). The hypotensive and the bradycardiac effects were immediate and in a dose related manner. The hypotensive effect of C. opobalsamum was inhibited by the pretreatment with atropine sulfate (1–4 mg/kg). These results suggest that the hypotensive effect of *C. opobalsamum* is due to the activation of muscarinic cholinergic receptors.

Al-Howiriny T., Al-Sohaibani M., Al-Said M., Al-Yahya M., El-Tahir K., Rafatullah S. (2005) "Effect of *Commiphora opobalsamum* (L.) Engl. (Balessan) on experimental gastric ulcers and secretion in rats." *Journal of Ethnopharmacology* 98(1),287-294. Abstract. The ulcer protective potential of an ethanol extract of *Commiphora opobalsamum* (L.) Engl. (Burseraceae) 'Balessan' was assessed against different acute gastric ulcer models in rats induced by necrotizing agents

(80% ethanol, 0.2 M NaOH and 25% NaCl), hypothermic restraint stress, pyloric ligation (Shay) and indomethacin. Balessan, 250 and 500 mg/kg administered orally (intraperitoneally in Shay rat model) showed a dose-dependent ulcer protective effects in all the above ulcer models. Besides, the extract offered protection against ethanol-induced depletion of stomach wall mucus and reduction in nonprotein sulfhydryl (NP-SH) concentration. Ethanol treatment also caused histopathological lesions of the stomach wall. Pretreatment with Balessan extract provided a complete protection of gastric mucosa through supporting both the offensive and defensive factors. Balessan extract was also showed a large margin of safety without any apparent adverse effects in rats.

Al-Howiriny T.A., Al-Sohaibani M.O., Al-Said M.S., Al-Yahya M.A., El-Tahir K.H. & Rafatullah S. (2004). "Hepatoprotective properties of *Commiphora opobalsamum* ("Balessan"), a traditional medicinal plant of Saudi Arabia." *Drug.Exp Clin Res* **30**, 213-20.

Al-Massarany S.M., Abbas F.A., Demirci B., Baser K.H.C., Khan S.I., Al-Rehaily A.J., Mossa J.S. & Abourashed E.A. (2007) "Chemical composition and biological evaluation of the essential oil of *Commiphora opobalsamum* L." *Journal of Herbs Spices and Medicinal Plants* **13**(4),111-122. Abstract. The chemical composition of three essential oil samples (stored aerial parts, fresh aerial parts, and fresh flowering tops) of *Commiphora opobalsamum* L., obtained by hydrodistillation, was determined using GC-MS analysis. The identified constituents represented 69.5 to 84.4 percent of the total chemical compounds of the three samples. The major components were -cadinol in the stored aerial parts, -calacorene in the fresh aerial parts, and terpinen-4-ol in the fresh flowering tops. The essential oil from the fresh aerial parts exhibited antimicrobial activity against *Bacillus subtilis*, *Staphylococcus aureus*, *Candida glabrata*, *C. krusei*, *Cryptococcus neoformans*, and *Mycobacterium intracellulare*. The same oil sample was non-selectively cytotoxic to four tumor cell lines: SK-MEL, KB, BT549 and SK-OV3. Weak antioxidant activity of the oil from the fresh aerial sample was demonstrated in a DPPH free-radical scavenging assay.

Chaudhary & Al Jowaid (1999) *Vegetation of the Kingdom of Saudi Arabia* pub. Ministry of Agric. & Water, Kingdom of Saudi Arabia 1999. *Cropwatch comments*: Authors say of *C. giladensis* ""more valuable than frankincense."

Shen T., Yuan H.-Q.,Wan W-Z. , Wang X.-L., Wang X.-N., Ji M. & Lou H.-X. (2008) "Cycloartane-Type triterpenoids from the resinous exudates of *Commiphora opobalsamum*." *J. Nat. Prod.,* **71**(1), 81–86. Abstract. Eight new cycloartane-type triterpenoids, cycloartan-24-ene-1α,2α,3α-triol (1), 3β-acetoxycycloartan-24-ene-1α,2α-diol (2), 1α-acetoxycycloartan-24-ene-2α,3β-diol (3), 3β-isovaleroyloxycycloartan-24-ene-1α,2α-diol (4), cycloartan-24-ene-1α,3β-diol (5), cycloartan-23E-ene-1α,2α,3β,25-tetrol (6), and an epimeric mixture of 24R,25-epoxycycloartane-1α,2α,3β-triol (7) and 24S,25-epoxycycloartane-1α,2α,3β-triol (8), together with one known compound, cycloartan-24-ene-1α,2α,3β-triol (9), were isolated from the resinous exudates of Commiphora opobalsamum. Their structures were established on the basis of mass

spectrometry and multidimensional NMR spectroscopy. The cytotoxicity of compounds 1–9 was evaluated against the PC3 and DU145 human prostate tumor cell lines. All of the compounds except 1 and 5 exhibited moderate cytotoxicity against PC3 or DU145 cells with IC50 values ranging from 10.1 to 37.2 µM.

Shen T., Wan W.-Z., Wang X.-N., Sun L.-M., Yuan H.-Q., Wang X.-L., Ji M., & Lou H.-X. (2008) "Sesquiterpenoids from the resinous exudates of *Commiphora opobalsamum* (Burseraceae)." *Helvetica Chimica Acta* **91**(5), 881-887.

Shen T., Wan W., Yuan H., Kong F., Guo H., Fan P. & Lou H. (2007) "Secondary metabolites from *Commiphora opobalsamum* and their antiproliferative effect on human prostate cancer cells." *Phytochemistry* **68**(9),1331-1337. Abstract. A cycloartane-type triterpenoid (1), an aliphatic alcohol glycoside (2), an eudesmane-type sesquiterpenoid (3), and a guaiane-type sesquiterpenoid (4) were isolated from the resinous exudates of Commiphora opobalsamum along with six known sesquiterpenoids (5–10). Their structures were established by extensive analysis of their 1D and 2D NMR spectroscopic data and chemical methods. The isolated compounds 1–3 and 5–9 were tested against human prostate cancer cell PC 3 and LNCaP. Among them, 1 and 2 showed moderate antiproliferative effects on human prostate cancer cell lines with IC50 values ranging from 5.7 to 23.6 µM; they were also able to inhibit the expression of androgen receptor (AR) in LNCaP cells. The six sesquiterpenoids were inactive in the bioassays.

***Commiphora pseudopaoli* JB Gillet**
syn. *Commiphora paolii* Chiov.
Cropwatch comments: Source of opoponax (Gachathi 1997).

Gachathi F. N. (1997) "Recent advances on classification and status of main gum-producing species in the Family Burseraceae" available at http://www.fao.org/documents/show_cdr.asp?url_file=/docrep/X0098e/X0098e01.htm

***Commiphora schimperi* (Berg.) Engl.**
syn. *Commiphora buraensis.*
Cropwatch comments: Source of "myrrh-like resin" (Gachathi 1997); Frequent adulterant of gum myrrh - Dekebo *et al.* (2002).

Dekebo A., Dagne E. & Sterner O. (2002) "Furanosesquiterpenes from *Commiphora sphaerocarpa* and related adulterants of true myrrh." *Fitoterapia – Milano* **73**(1), 48-55.

Gachathi F. N. (1997) "Recent advances on classification and status of main gum-producing species in the Family Burseraceae" available at http://www.fao.org/documents/show_cdr.asp?url_file=/docrep/X0098e/X0098e01.htm

Paraskeva M.P., van Vuuren S.F., van Zyl R.L., Davids H. & Viljoen A.M. (2008) "The in vitro biological activity of selected South African *Commiphora* species." J *Ethnopharmacol*. **119**(3),673-9. Abstract. Ten South African *Commiphora* (Burseraceae) species were investigated to validate their use in traditional healing rites. The leaf and stem extracts of each species were analysed for the anti-oxidant (ABTS and DPPH assays), antimicrobial (MIC and death kinetic assays), anti-inflammatory (5-LOX assay), anticancer (SRB assay) properties, as well as the cytotoxic effects (tetrazolium-based assay). The best anti-oxidant activity (ABTS assay) was observed for the stem extracts of *Commiphora tenuipetiolata* IC(50)=5.10 microg/ml), *Commiphora neglecta* (IC(50)=7.28 microg/ml) and *Commiphora mollis* (IC(50)=8.82 microg/ml). Extracts generally exhibited poor anti-oxidant activity in the DPPH assay, with the exception of *Commiphora schimperi* (stem), *Commiphora neglecta* (stem), *Commiphora tenuipetiolata* (stem and leaf), and *Commiphora edulis* (stem), with IC(50) values ranging between 7.31 and 10.81 microg/ml. The stem extracts exhibited moderate to good 5-LOX inhibitory activity with *Commiphora pyracanthoides* (stem) displaying the greatest inhibitory effect (IC(50)=27.86+/-4.45 microg/ml). For the antimicrobial (MIC) assay, a greater selectivity was exhibited by the extracts against the Gram-positive bacteria (0.01-8.00 mg/ml) and the yeasts (0.25-8.00 mg/ml) than against the Gram-negative bacteria (1.00-8.00 mg/ml). Using death kinetic studies (time-kill studies), the rate at which *Commiphora marlothii* (stem) kills *Staphylococcus aureus* over a 24h period was determined. Mostly, a concentration-dependent antibacterial activity was observed beginning after ca. 30 min. All concentrations exhibited antibacterial activity, with complete bactericidal effect achieved by the 24(th) hour. The most active *Commiphora* species against the HT-29 cells (SRB anticancer assay) were *Commiphora* glandulosa (leaf and stem) and *Commiphora marlothii* (leaf). The MCF-7 cells (SRB anticancer assay) exhibited the highest sensitivity to indigenous *Commiphora* species, with *Commiphora edulis* (leaf and stem), *Commiphora glandulosa* (leaf and stem), *Commiphora marlothii* (leaf), *Commiphora pyracanthoides* (leaf and stem), Commiphora schimperi (stem), and *Commiphora viminea* (stem) all possessing a percentage inhibition greater than 80% at 100 microg/ml. *Commiphora glandulosa* (leaf and stem) and *Commiphora pyracanthoides* (leaf and stem) were the two most active species against the SF-268 cells (SRB anticancer assay), with IC(50) values ranging between 68.55+/-2.01 and 71.45+/-1.24 microg/ml. The majority of the *Commiphora* extracts were largely non-cytotoxic against Graham human kidney epithelial cells when investigated in the MTT assay.

***Commiphora sphaerocarpa* Chiov. Chiovenda.**

Dekebo A., Dagne E. & Sterner O. (2002) "Furanosesquiterpenes from *Commiphora sphaerocarpa* and related adulterants of true myrrh." *Fitoterapia* **73**(1),48-55. Abstract. A new furanosesquiterpene, (1E)-8,12-epoxygermacra-1,7,10,11-tetraen-6-one (3), was isolated from the resin of *Commiphora sphaerocarpa* together with the known compounds curzerenone (1), furanodienone (2), (1E)-3-methoxy-8,12-epoxygermacra-1,7,10,11-tetraen-6-one

(4), (1(10)E,2R*,4R*)-2-methoxy-8,12-epoxygermacra-(10),7,11-trien-6-one (5), and dihydropyrocurzerenone (6). Hydrodistillates of the resins of C. sphaerocarpa, *C. holtziana*, *C. kataf* and *C. myrrha* were analysed. The identifications were aided by NMR, GC and GC-MS.

Dekebo A., Dagne E., Hansen L.K. Gautun O.R. & Aasen A.J. (2000) "Crystal structures of two furanosesquiterpenes from *Commiphora sphaerocarpa*" *Tetrahedron Letters* **41**(50), 9875-9878. Abstract. The relative stereochemistry of a furanosesquiterpene, reported previously from myrrh, but isolated here from Commiphora sphaerocarpa is determined for the first time as (1(10)E,2R*,4R*)-2-methoxy-8,12-epoxygermacra-1(10),7,11-trien-6-one. Likewise the stereochemistry of furanodienone was established by NMR and X-ray crystallography as (1(10)E,4E)-8,12-epoxygermacra-1(10),4,7,11-tetraen-6-one

***Commiphora tenuis* K. Vollesen.**

Asres K., Tei A., Moges G., Sporer F. & Wink M. (1998). "Terpenoids composition of the wound – induced bark exudate of *Commiphora tenuis* from Ethiopia." *Planta Med*. **64**, 437-475. Abstract. The bark of *Commiphora tenuis* Vollensen exudes a translucent, free-flowing odoriferous liquid upon wounding which was analysed by capillary GLC and GLC-MS. 42 mono- and sesquiterpenes were detected and 37 identified. The main components of the monoterpenoid fraction were alpha-pinene (60.8%), beta-pinene (8.8%), sabinene (6.3%), alpha-thujene (8.9%), limonene (5.5%), 3-carene (3.7%), beta-myrcene (1.8%), and beta-elemene (1.1%) constituting 97% of the oil. Identified sesquiterpenoid components constituted approximately 1.6% of the oil. Oleanolic acid acetate was isolated and identified as the main triterpene from the resin by 1H- and 13C-NMR. Three other triterpenes of the olean-12-ene group were also detected using GC-MS. The essential oil exhibited antibacterial activities against *Staphylococcus aureus*. *Proteus mirabilis* and *E. coli* with MIC between 0.5 and 1%.

***Commiphora wightii* Arnott.**
syn. *Commiphora. mukul* (Hook ex Stocks)
Guggal or Indian Bdellium

Bai S. & Jain M. (2008) "1H and 13C assignments of five cembrenes from guggul." *Magn Reson Chem*. **46**(8), 791-3. Abstract. Chemical shift assignments of (1)H and (13)C of five cembrene compounds isolated from the hexane extract of guggul, the resin of Commiphora mukul, are reported. Using (1)H, (13)C, and 2D NMR methods their structures were determined as cembrene (1-isopropyl-4,8,12-trimethyl-cyclotetradeca-2,4,7,11-tetraene), cembrene A (1-isopropenyl-4,8,12-trimethyl-cyclotetradeca-4,8,12-triene), cembrenol (1-isopropyl-4,8,12-trimethyl-cyclotetradeca-3,7,11-trienol), mukulol (1-isopropyl-4,8,12-trimethyl-cyclotetradeca-3,7,11-trienol), and verticillol (4,8,12,15,15-pentamethyl-bicyclo[9.3.1]pentadeca-3,7-dien-12-ol).

Bhatt J.R., Nair M.N.B. & Ram H.Y.M. (1989) "Enhancement of oleo-gum resin production in *Commiphora wightii* by improved tapping technique." *Current Science* **58**(7), 349-357.

Coulter J. (1987) *Market study for frankincense and myrrh from Somalia* (unpubl). Study undertaken for the European Association for Cooperation. Chatham, UK: Natural Resources Institute.

Fatope M.O. *et al.* (2003) "Muscanone: a 3-O-(1", 8", 14"-trimethylhexadecanyl)naringenin from *Commiphora wightii*." *Phytochemistry* 62(8),1251-1255. Abstract. A new antifungal flavanone, muscanone (1), was isolated along with known naringenin (2) from *Commiphora wightii* (Arn.) Bhandari (Burseraceae) by directing the fractionation of an EtOH extract of the air-dried trunk of C. wightii with microbial sensitivity assay. The structures of 1 and 2 were determined from EIMS, HREIMS, DEPT, 1H–1H COSY, HSQC and HMBC spectral data. Muscanone (1) was identified as 3-O-(1″, 8″,14″-trimethylhexadecanyl)naringenin and was found to be active against *Candida albicans*. The isolation, structure elucidation, NMR spectral assignments, and bioactivities of 1 and 2 are reported.

Haque I, Bandopadhyay R, Mukhopadhyay K.(2010) "Population genetic structure of the endangered and endemic medicinal plant *Commiphora wightii*." *Mol Biol Rep.* 37(2), 847-54 Abstract. *Commiphora wightii* is a medicinally important endangered species endemic to the Thar Desert of Rajasthan, India and adjoining areas of Pakistan. The populations of this species are declining sharply because of its extensive use as a natural herb. Random amplified polymorphic DNA analysis was conducted to find the genetic variation among 7 populations of *C. wightii*. Of the 100 random primers screened, 44 primers yielded 220 loci. Statistical analysis indicated low genetic diversity (H (pop) = 0.0958; I = 0.1498; mean polymorphic loci = 14.28%), and high genetic differentiation among the populations (G (ST) = 0.3990; AMOVA Phi (ST) of 0.3390; Bayesian theta ((II)) = 0.3002). The low genetic diversity may be due to geographic isolation and restricted gene flow (N (m) = 0.7533) between the fragmented populations. Unsustainable utilization of the plant has fragmented the population continuum which served the purpose of genetic exchange between populations. Mantel's test was performed which revealed a highly significant positive correlation between genetic and geographic distance (r (2) = 0.614, P = 0.023) among the populations studied. Low variation can also be attributed to poor seed setting and the slow growth pattern of the species, which is also an apomict. In UPGMA dendrogram the *Commiphora wightii* samples were divided into two major and one minor cluster. These findings can serve as a guide to preserving the genetic resources of this medicinal plant species.

Meselhy M.R. (2003) "Inhibition of LPS-induced NO production by the oleogum resin of *Commiphora wightii* and its constituents." *Phytochemistry* **62**(2), 213-218 Abstract. Three new (1–3) and five known compounds (4–8) were isolated from the oleogum resin of *Commiphora wightii* (Arnott.) Bhanol. Their structures were elucidated by spectroscopic and chemical methods. The MeOH extract and the

EtOAc-sol. fraction were found to demonstrate significant inhibition of NO formation in lipopolysaccharide (LPS)-activated murine macrophages J774.1 in vitro (IC50 values of 16.4 and 12.8 µg/ml, respectively). When compared with curcumin (IC50 value of 12.3 µM), Z- and E-Guggulsterones (4 and 5, respectively) were the most potent inhibitors of NO production (IC50 values of 1.1 and 3.3 µM, respectively), followed by myrrhanol A (7) and myrrhanone A (8) (IC50 values of 21.1 and 42.3 µM, respectively). Guggulsterone-M (1) and its didehydro derivative (2) were weak inhibitors, while guggulsterols I (6) and Y (3) were inactive (IC50 >500 µM).

Raut A.A., Sunder S., Sarkar S., Pandita N.S. & Vaidya A.D. (2008) "Preliminary study on crystal dissolution activity of *Rotula aquatica*, *Commiphora wightii* and *Boerhaavia diffusa* extracts." *Fitotherapia* 79(7-8), 544-7. Abstract. Several Ayurvedic plants are known to have activity against diverse urinary crystals. The traditional knowledge of Ayurveda, collective clinical experience in arthritis and the earlier experimental studies on urinary crystals led to the selection of three plants, viz. *Rotula aquatica*, *Commiphora wightii* Bhandari syn. *C.mukul*. and *Boerhaavia diffusa* for screening anticrystal activity against basic calcium phosphate (BCP), calcium pyrophosphate (CPPD) and monosodium urate monohydrate (MSUM). The effects of each plant were assayed on microcrystals in 24-well microplates in vitro. Our results show that the aqueous extracts of only *R. aquatica* and *C. wightii* have shown crystal dissolving activity against MSUM.

Salavert M, Amarger S, Le Bouedec MC, Roger H, Souteyrand P, D'incan M. (2007) "Allergic contact dermatitis to guggul in a slimming cream." *Contact Dermatitis*. **56**(5), 286-7.

Satyavati G.V. (1991) Guggulipid: A promising hypolipidaemic agent from gum guggul (*Commiphora wightii*). *Economic and Medicinal Plant Research*, ***5****. Plants and Traditional Medicine,* 47–82.

Satyavati G.V. (1988) "Gum guggul (Commiphora mukul)-the success story of an ancient insight leading to a modern discovery." *Indian J Med Res*. **87**,327-35.

Shishodia S, Harikumar K.B., Dass S, Ramawat K.G., Aggarwal B.B.. (2008) "The guggul for chronic diseases: ancient medicine, modern targets." *Anticancer Res*. **28**(6A),3647-64. Abstract. Identfication of active principles and their molecular targets from traditional medicine is an enormous opportunity for modern drug development. Gum resin from *Commiphora wightii* (syn *C. mukul*) has been used for centuries in Ayurveda to treat internal tumors, obesity, liver disorders, malignant sores and ulcers, urinary complaints, intestinal worms, leucoderma (vitiligo), sinuses, edema and sudden paralytic seizures. Guggulsterone has been identified as one of the major active components of this gum resin. This steroid has been shown to bind to the farnesoid X receptor and modulate expression of proteins with antiapoptotic (IAP1, XIAP, Bfl-1/A1, Bcl-2, cFLIP, survivin), cell survival, cell proliferation (cyclin D1, c-Myc), angiogenic, and metastatic (MMP-9, COX-2, VEGF) activities in tumor cells. Guggulsterone mediates gene expression through regulation of various transcription factors,

including NF-kappaB, STAT-3 and C/EBPalpha, and various steroid receptors such as androgen receptor and glucocorticoid receptors. Modulation of gene expression by guggulsterone leads to inhibition of cell proliferation, induction of apoptosis, suppression of invasion and abrogation of angiogenesis. Evidence has been presented to suggest that guggulsterone can suppress tumor initiation, promotion and metastasis. This review describes the identification of molecular targets of guggulsterone, cellular responses to guggulsterone, and animal studies and clinical trials of guggulsterone in cancer and other diseases.