REVIEW

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Components, therapeutic value and uses of myrrh

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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.

1. Introduction

Myrrh is one of the oldest known medicines which has been widely used by ancient Egyptians and it was one of the three gifts believed to have been offered to the infant Jesus by Magi [1]. The name myrrh is derived from the Arabic and Hebrew word mur, which means bitter. Meetiga is the trade name for Arabian myrrh. The various reports on the therapeutic value and uses of myrrh attracted our attention to write this review.

Myrrh is an oleo-gum-resin obtained from the stem of different species of *Commiphora*. It is a reddish brown mass, covered with a brownish yellow dust. It has a bitter and acrid taste and a balsamic odor. With water it forms an emulsion [2, 3].

2. Occurrence of myrrh

Different species of myrrh have been found in different countries as shown in the Table.

3. Constituents

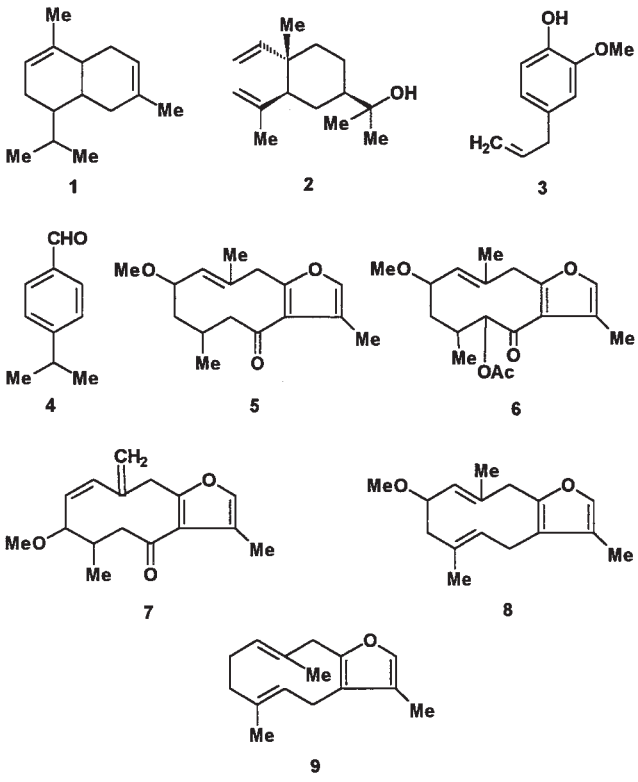
Myrrh contains a 2–8% volatile oil (myrrhol), 23–40% resin (myrrhin), 40–60% gum, and a bitter principle 10–25% [2, 3].

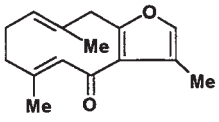
Table: Occurrence of the different species of *Commiphora*

Species	Country
C. molmol Engler	Ethiopia, Somalia, Arabia
C. mukul Engler	Somalia, India
C. guidotti Chiov.	Somalia
C. abyssinica Engler	China, East Africa, Ethiopia
C. incisa Chiov.	India, East Africa, Ethiopia
C. pyracanthoides Engler	East Africa
C. rostrata Diels	Arabia
C. gileadensis Engler	Djibouti, Ethiopia, Kenya, Somalia, Sudan
C. wightii Engler	Pakistan, India
C. guillauminiperr Engler	Sudan, Kenia
C. erythraea (Var.) Engler	India, Somalia
C. opobalsamum Engler	Near Cairo "at mataria"

3.1. Volatile oils

The volatile oil from *Commiphora molmol* is thick. It has a pale yellow color which upon exposure to the vapour of bromine or fumes from nitric acid gave a violet color [2, 4]. The constituents of essential oil in two kinds of myrrh were analyzed by GC/MS and identified with their percent contents [5]. The components from *Commiphora molmol* were detected chromatographically [6] with a simple colorimetric determination method using vanillin-sulfuric acid reagent to form a stable violet colored reaction product with a maximum absorption at 518 nm [7]. It contains cadinene (**1**), elemol (**2**), eugenol (**3**), cuminaldehyde (**4**), numerous furanosesquiterpenes including furanogerma-





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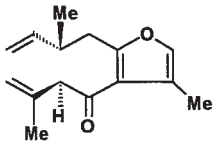

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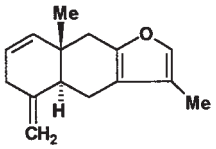

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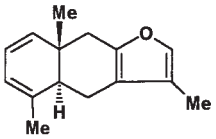

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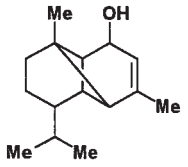
cranes (**5**–**8**), furanodiene (**9**), furanodienone (**10**), curzerenone (**11**), lindestrene (**12**), as well as furanoeudesma-1,3-diene (**13**) [3, 8, 9].

The three furanogermacrens **5**–**7** and the two furanoeudesmanes **12** and **13** have been isolated from the n-hexane extract of the essential oil of *Commiphora molmol* [8, 9]. They give positive Ehrlich color test with *p*-dimethylaminobenzaldehyde reagent indicating the presence of a furan ring. The structures were confirmed with different spectral analyses. The main component was furanoeudesma-1,3-diene (**13**). It is a colorless, unstable liquid which can be rapidly auto-oxidized in air to give a resinous substance. The α-copaene-8-ol (**14**), furanodiene (**15**), and β-elemene (**16**) were also isolated from the hexane extract. The ether fractions contained trans furanodien-6-one (**10**), curzerenone (**11**), and furanoeudesma-1,4-dien-6-one (**17**).



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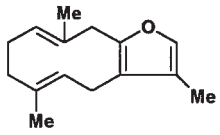

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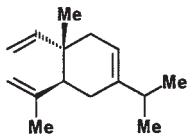

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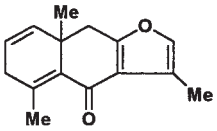

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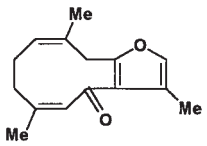
Three furanogermacranes (**18**–**20**) and 2-methoxyfuranoguaia-9-ene-8-one (**21**) were also isolated from the fractionated essential oil of myrrh from *Commiphora molmol* with a mixture of *n*-hexane/ether [10]. 1(10)*Z*,4*Z*-Furanodien-6-one (**18**) and 4,5-dihydrofuranodien-6-one (**20**) were isolated as colorless liquids, while 2-acetoxyfuranodiene (**19**) as a colorless wax.



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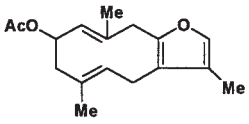

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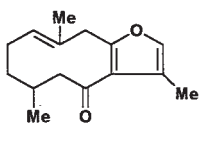

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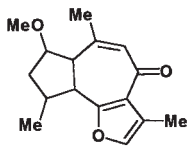

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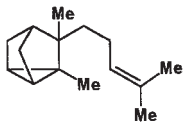
The essential oil of *Commiphora guidotti,* which was isolated by steam distillation of its oleo-gum-resin, contains seven sesquiterpene hydrocarbons: α- and β-santalene, epi-β-santalene, β-bergamotene, β-farnesene, α- and β-bisabolene and the furanosesquiterpenoid furanodiene. The most abundant components of the oil which could be isolated in pure form, were α-santalene (**22**), α-bisabolene (**23**) and furanodiene (**9**) [11].



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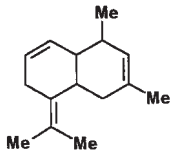

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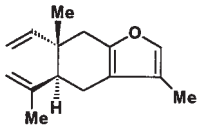

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From the ether extract of Somaliland myrrh, nonacosane $C_{29}H_{60}$ has been isolated [12]. On the other hand, from the essential oil of *Commiphora abyssinica* nine sesquiterpenoide hydrocarbons, β- and δ-elemene, α-copaene, β-bourbonene, δ-germacrene, caryophyllene, humulene, γ- and δ-cadinene, the sesquiterpene alcohol elemol (**2**), and five furanosesquiterpenoids, furanodiene (**9**), furanodienone (**10**), curzerenone (**11**), lindestrene (**12**), as well as isofuranogermacrene (**24**) were isolated [13].

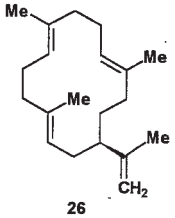
3.2. Resins

The chemistry of myrrh resin is uncompletely elucidated. It is generally classified into a bigger ether soluble fraction and a smaller insoluble fraction. The ether soluble fraction consists of α-, β- and γ-commiphoric acid, esters of a resin acid, commiphorinic acid, and two phenolic resins, α- and β-heerabomyrrhol. The ether insoluble fraction contains α- and β-heerabomyrrholic acids [2, 3]. It shows a fluorescent spot on the TLC due to the probable formation of dehydroabietic acid [14]. From the gum-resin of *Commiphora mukul* long chain aliphatic tetrols **25** were isolated and were found to be a mixture of homologues of octadecan-1,2,3,4-tetrol (50%), nonadecan-1,2,3,4-tetrol (7%) and eicosan-1,2,3,4-tetrol (40%) [15].

$$CH_3-(CH_2)_n-CH(OH)-CH(OH)-CH(OH)-CH_2OH$$

25 n = 13, 14, 15

The chromatography of the petroleum ether soluble fraction of the gum resin from *Commiphora mukul* gave a diterpene hydrocarbon "cembrene-A" (**26**), diterpene alcohol "mukulol" (**27**), (+)sesamin, cholestrol and two isomeric steroids which were formulated as 4,17(20)-(*trans*)–pregnadiene-3,16-dione "*E*-guggulsterone" (**28**) and the *cis* isomer "*Z*-guggulsterone" (**29**) [16–19].



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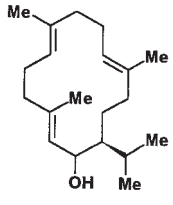

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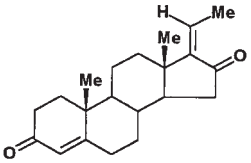
The geometry of the double bonds and the absolute configuration at C_{14} of cembrene-A (**26**) and mukulol (**27**) were established. The ethyl acetate fraction of the resin from *Commiphora mukul* was proven to contain three new



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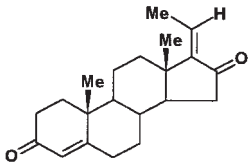

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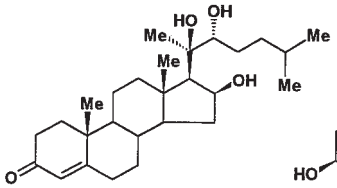
sterols **30**–**32** beside the pregnadienes **28** and **29** [16, 20]. The stereochemistry at C_{20} and C_{22} of the sterol **30** was assigned as the (R)-configuration based on biogenetic considerations. It has been found that all of the hydroxyl groups are intramolecularly hydrogen bound to each other [20].



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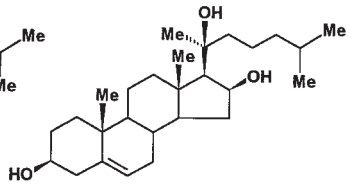

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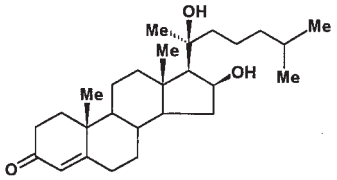

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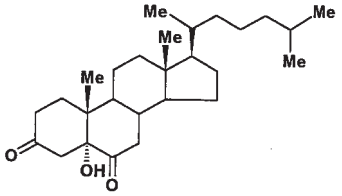
The guggulsterols **33** and **34** were isolated from the neutral fraction after saponification of the chloroform extract of *Commiphora mukul* [21].



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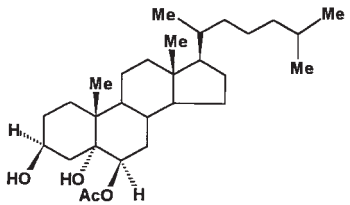

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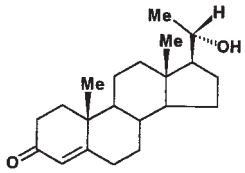
The alcoholic extract of *Commiphora mukul* was partitioned between water and diethyl ether. The ether fraction gave two crystalline compounds identified as myricyl alcohol and β-sitosterol [22]. The aqueous fraction was chromatographed to give the amino acids cystine, histidine, lysine, threonine, alanine, proline, arginine, aspartic acid, serine, glutamic acid, tyrosine, tryptophan, valine, leucine and isoleucine.

Four new steroidal components **35**–**38** have been isolated from an extract of the gum resin of *Commiphora mukul* with methyl alcohol [23].



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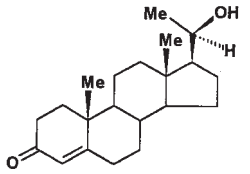

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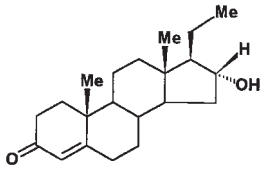

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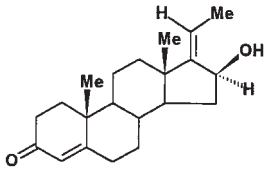

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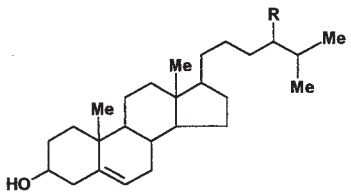
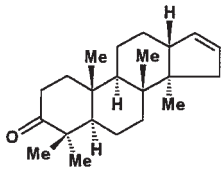
A colorimetric assay procedure for the quantitative estimation of the steroidal guggulsterone using betamethasone as a standard has been reported. The reaction involved the reduction of the blue tetrazolium salt to the highly colored formazan. This is due to the presence of Δ^4-3-keto-conjugation in the *E*- and *Z*-guggulsterone [24].

The steroidal fraction from *Commiphora abyssinica* has been found to contain cholest-5-ene-3β-ol (**39**, R=H, 86%), Δ^5-campestan-3β-ol (**40**, R=Me, 9%) and Δ^5-sitostan-3β-ol (**41**, R=Et, 5%) [25].



39 R = H
40 R = Me
41 R = Et

The resin of *Commiphora incisa* has yielded three C_{22} compounds identified by spectral analysis and chemical modification as mansumbinone (4α,4β,8β,10β,14α-pentamethyl-5α-gon-16-en-3-one) (**42**), the corresponding 3-hydroxy compound mansumbinol **43** and 3,4-*seco*-mansumbinoic acid (**44**) [26].



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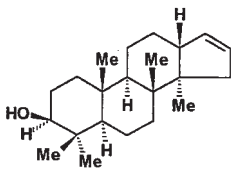

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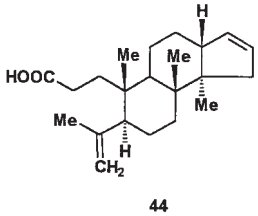

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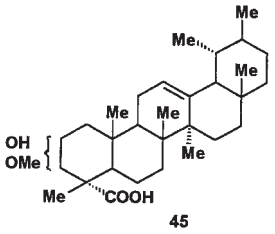
The mass spectra of the methyl esters of the commic acids **45**–**49** isolated from *Commiphora pyracanthoides* were reported by Thomas et al. [27–29].



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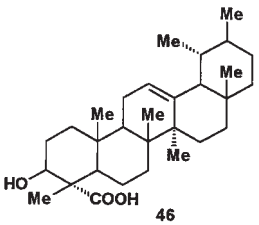

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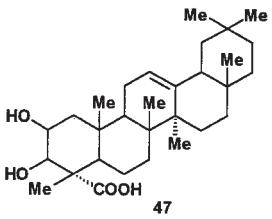

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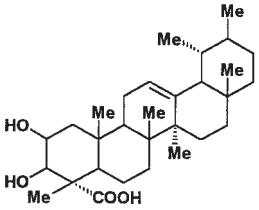

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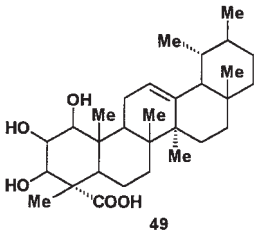

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The resin from *Commiphora rostrata* was analyzed by gas chromatography and mass spectra and was found to contain twenty-two oxygenated alkanes with the major components 2-decanone (65%), 2-undecanone (24%), 2-dodecanone (5%) and hexadecanal (1.5%) [30].

3.3. Gums

The crude gum from the alcohol insoluble matter of *Commiphora molmol* contains 18% protein and 64% carbohydrates as galactose, arabinose and glucuronic acid. The gum is associated with an oxidase enzyme [3]. It is apparently allied to *Acacia* gum and contains an oxidase enzyme whose activity was destroyed at 100 °C [2]. The structure **50** of the gum was established by Wiendle and Franz [31].

4-OCH_3-α-$GlcA_p$-(1 → 4)-β-Gal_p-(1 → 3)-βGal_p-
[(1 → 2)-4-OCH_3-α-$GlcA_p$-(1 → 4)-β-Gal_p]$_6$-(1 → 4)-α-Ara_f-(1 → 3)-
Ara_f-(1 → 2)-Ara_f-(1 → 4)-DL-Hyp

50

$GlcA_p$ = D-Glucopyranosyluronic acid
Gal_p = D-Galactopyranose
Ara_f = L-Arabinofuranose
Hyp = 4-Hydroxypyroline

D-Gal_p 1 → 6 D-Gal_p 1 → 6 D-Gal_p 1 → 6 D-Gal_p 1 → 6 D-Gal_p 1 → 6 D-Gal_p
3 ↑ 1 | 3 ↑ 1 | 3 ↑ 1
D-Gal_p 3 → 1 L-Aar_f | D-Gal_p 3 → 1 L-Aar_f | D-Gal_p 3 → 1 L-Aar_f
6 ↑ 1 | 5 ↑ 1 | 6 ↑ 1 | 5 ↑ 1 | 6 ↑ 1 | 5 ↑ 1
4-OCH_3GPA | D-Gal_p | 4-OCH_3GPA | D-Gal_p | 4-OCH_3GPA | D-Gal_p

51

Gal_p = D-Galactopyranose
Ara_f = L-Arabinofuranose
4-OCH_3GPA = 4-O-methyl-D-glucopyranosyluronic acid

4. Medicinal actions and uses

Commiphora molmol is the most important species of myrrh which has been used as an effective antimicrobial agent, it is one of the most effective herbal medicines in the world for sore throats, canker sores and gingivitis [1]. It is useful for the treatment of acne, boils and arthritis [1, 34]. Myrrh has local stimulant and antihealing, antiseptic properties for wounds and abrasions. It is used as a mouth wash and as a uterine stimulant and emmenagogue [2, 3]. It is used in the treatment of infections in the mouth as mouth ulcers, pyorrhea as well as catarrhal problems of pharyngitis and sinusitis [1]. It is excellent in sore mouth and extreme ulceration of mercurial ptyalism.

The extract of myrrh (gum) effectively decreases the absolute increment of blood glucose above the fasting concentration at all times of the oral glucose tolerance test in both normal and diabetic rats [35] and may prove to be a useful therapeutic agent in the treatment of non-insulin dependent diabetes mellitus [36]. It is used also in cosmetic preparations for treatment of hair and scalp [37].

Tincture of myrrh is used for the therapy of apthous ulcers (Stomatitis aphthosa) [38]. Myrrh reduces cholesterol and triglycerides [39] and may terminate pregnancy [40]. It exhibits strong antithrombotic activity [41].

Extract of myrrh is used as digestive aid drug, and it is approved by the FDA for the use in food and oral health care drug products . It was given GRAS status as a flavor ingredient by FEMA [42].

Myrrh is used in traditional Chinese medicine to relieve pain and swelling due to traumatic injury [43]. It is used as a hypolipidaemic agent [44]. Myrrh is useful in chronic gastritis and atomic dyspepsia with full pale tongue and membrane, as well as frequent mucous stouts accompanied by flatulence [1]. It helps in the treatment laryngitis and respiratory complains.

The petroleum ether extract of myrrh from *Commiphora molmol* produced significant inhibition of carrageenan-induced inflammation and cotton pellet granuloma. It also showed significant antipyretic activity in mice [45, 46]. Recently the cytotoxic and antitumor activity of myrrh has proved to be equivalent to those of the standard cytotoxic drug cyclophosphamide [47]. Thus treatment with myrrh (250 and 500 mg/kg/day) was found to be cytotoxic in Ehrlich carcinoma tumor cells in mice [48]. The *Commiphora molmol* treatment (125–500 mg/kg) showed no mutagenicity. It caused a highly significant and dose-dependent mitodepressant effect in the femoral cells as well as reduction of RNA levels in hepatic cells as compared with the control (cyclophosphamide) [49]. Myrrh from *Commiphora molmol* pretreatment, at doses of 250–1000 mg/kg, provided dose dependent protection against the ulcerogenic effect of different necrotizing agent used [50]. It also offered protection against mucosal damage caused by indomethacin [50].

Treatment with the essential oil of myrrh significantly improved childhood atopic eczema. This may be due to a strong allergic contact dermatitis possibly provoked by the essential oils themselves [51–53].

The sesquiterpene fractions from *Commiphora molmol*, in particular furanodien-6-one and methoxyfuranoguaia-9-en-8-one, showed antibacterial and antifungal activity against standard pathogenic strains of *Escherichia coli, Staphylococcus aureus* and *Pseudomonas aeruginosa*, with minimum inhibitory concentrations ranging from 0.18 to 2.80 mg/ml. These compounds also have local anaesthetic activity blocking the inward sodium current of excitable mammalian membranes [54].

The botanical extract of myrrh could be used alone or in combination with sublethal doses of certain insecticides to control the cotton leafworm [55].

Histological examination of mosquito larvae treated with myrrh showed significant pathological effects on their fat, muscles, gut and nervous tissues [56].

Recently, a purified myrrh extract from methyl alcohol has been formulated as soft gelatin capsules, suppositories and emulsion known commerically as Mirazid which is considered a new safe antibilharzial drug with potential effects against *Schistosoma mansoni* and *Schistosoma haematopium* [7, 57–59]. In addition it is a potent fasciolicidal drug with a success rate of 94.1% [60].

Evaluation of the molluscicidal activity of mrryh from *C. molmol* on *Biommphalaria alexandrina* snails was studied, and it was proved that the activity is due to the oil extract rather than to the oleo resin [61–63]. Fractionation of the oil extract led to the isolation of a bioactive component with molluscicidal activity (LC_{50} 4.45 and 3.55 ppm) against the snails for exposure periods of 24 and 48 h, respectively [63].

The petroleum ether extract of myrrh from *Commiphora mukul* "guggul gum" decreased serum cholesterol, phospholipids, triglycerides and lipids in experimental hypercholesterolemic chicken, while ethyl acetate extract had less anticholesterolemic activity in rats [64, 65], and it was effective as an hypolipidemic agent in dogs and monkeys [65–72]. It was also used in the treatment of rheumatoid arthritis and obesity [73, 74]. The steroid which was isolated from *Commiphora mukul* showed antiinflammatory activity [74–76]. It showed a marked inhibition of ADP, adrenaline and serotonin induced platelet aggregation [77]. It also showed a strong thyroid stimulatory action when administered to albino rats [73, 78]. It is used as expectorant, antispasmodic, uterine stimulant and emmenagogue. It is successfully used in chronic bronchitis, bronchial asthma, and pulmonary tuberculosis, and also in amenorrhia and menorrhagia to regulate menses [79]. The ethyl acetate extract of myrrh from *Commiphora mukul*, in albino rats, significantly prevented a rise in serum cholesterol and serum triglyceride levels caused by atherogenic diet [80]. The essential oil was found to be fungistatic or fungicidal to some ubiquitous molds, depending on the concentration [81]. The resin of *Commiphora guidotti* is widely used in treatment of stomach complains, wounds and diarrhoea in Somalia [82–85]. T-Cadinol, the pharmacologically active sesquiterpene of scented *Commiphora guidotti* was shown to have a dose dependent smooth muscle relaxing effect on the isolated guinea pig ileum and a similar inhibitory effect on cholera toxin-induced intestinal hypersecretion in mice [86]. It caused bacterial lysis and subsequent fatal loss of intracellular components in *Staphylococcus aureus* [82]. The resinous exudate from *Commiphora abyssinica* is sometimes applied as a plaster and used for spasms and fever [87]. The washed bark, mixed with salt, is applied to snake-bites and the plant has been used as a stomachic and eye remedy. *Commiphora abyssinica* extract exhibited a potent cytotoxic activity against KA31T cell line (10 μg/ml). The IC_{50} of this extract was 100 μg/ml against NIH3T3 cell line [88]. The aqueous extract of the resin of *Commiphora incisa* significantly inhibited both the maximal edema response and the total edema response during 6 h of carrageenan-induced rat paw edema [76]. The resin of *Commiphora rostrata* was found to be effective against predators and fungal pathogens [30]. The bark and resin of *Commiphora gileadensis* are used as a cosmetic, soothing agent and to treat dog bites [89]. The guggulipid of *Commiphora wightii* was shown to have hypocholesterolemic, antiseptic, antipathogenic, antiparasitic properties, and helps against nonspecific diarrhoea and dysentery [90].

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References

1 Chevallier, A. Ed.: "The Encyclopedia of Medicinal Plants", 4th ed., 84 (1996)
2 Wallis, T. E. Ed.: "Text book of Pharmacognosy", 5th ed., 497 (1967)
3 Trease, G. E.; Evans, W. C. : "Pharmacognosy", 13th ed., 474 (1989)
4 Pharmacopoeia Helvetica, 6th ed., 903 (1975)
5 Tian, J. G.; Shi, S. M.: J. Chin. Mater. Med. **21**, 235 (1996); Int. Pharm. Abstr. **33**, 3407554 (1996)
6 Atal, C. K.; Shah, K. C.: Indian J. Pharm. **28**, 162 (1966); C.A. **65**, 15155 (1966)
7 Abdel-Hay, M. H.; Saleh, A.; El Ashry, E. S. H.; Rashed, N.; Salama, O.: Spectroscopy Lett. **35**, 183 (2002)
8 Brieskorn, C. H.; Noble, P.: Tetrahedron Lett. **21**, 1511 (1980)
9 Brieskorn, C. H.; Noble, P.: Phytochemistry **22**, 187 (1983)
10 Brieskorn, C. H.; Noble, P.: Phytochemistry **22,** 1207 (1983)
11 Craveiro, A.; Corsano, S.; Proietti, G.; Strappaghetti, G.: Planta Med. **48**, 97 (1983)
12 Trost, F.; Doro, B.: Ann. Chim. Applicata **25**, 227 (1935) ; C. A. **29**, 6359 (1935)
13 Brieskorn, C. H.; Noble, P.: Planta Med. **44**, 87 (1982)
14 Wisneski, H. H.; Demers, F. X.; Dolinsky, M.: Proc. Joint Conf. Cosmet. Sci. 131 (1968); C.A. **70**, 109100 (1969)
15 Patil, V. D.; Nayak, U. R.; Dev, S.: Tetrahedron **29**, 1595 (1973)
16 Patil, V. D.; Nayak, U. R.; Dev, S.: Tetrahedron **28**, 2341 (1972)
17 Patil, V. D.; Nayak, U. R.; Dev, S.: Tetrahedron **29**, 341 (1973)
18 Prasad, R. S.; Dev, S.: Tetrahedron **32**, 1437 (1976)
19 Roy, S. K.; Pal, R.; Sarin, J. P. S.: Ind. J. Pharm. Sci. **51**, 251 (1989)
20 Bajaj, A. G.; Dev, S.: Tetrahedron Lett. **22**, 4623 (1981)
21 Purushothaman, K. K.; Chandrasckharan, S.: Ind. J. Chem. Sect. B **14**, 802 (1976); C. A. **87**, 6263 (1977)
22 Ali, M. A.; Hassan, M. M.: Pakistan J. Sci. Ind. Res. **10**, 21 (1967); C. A. **68**, 47009 (1968)
23 Bajaj, A. G.; Dev, S.: Tetrahedron **38**, 2949 (1982)
24 Rangari, V. D.; Donglikar, M. M.: Ind. J. Pharm. Sci. **56**, 110 (1994)
25 Nera, C. B.; Paolo, C.; Pietro, D.: Ann. Chim. **58**, 541 (1968); C. A. **69**, 52407 (1968)
26 Provan, G. J.; Waterman, P. G.: Phytochemistry **25**, 917 (1986)
27 Thomas, A. F.; Keusler, K.; Muller, J. M.: Tetrahedron **16**, 264 (1961)
28 Thomas, A. F.: Tetrahedron **15**, 212 (1961)
29 Thomas, A. F.; Willhalm, B.: Tetrahedron Lett. 3177 (1964)
30 Mc Dowell, P. G.; Lwande, W.; Deans, S. G.; Waterman, P. G.: Phytochemistry **27**, 2519 (1988)
31 Wiendle, R. M.; Franz, G.: Dtsch. Apoth. Ztg. **134**, 27 (1994); Int. Pharm. Abstr. **32**, 3201469 (1995)
32 Bose, S.; Gupta, K. C.: Ind. J. Chem. **4**, 87 (1966); C.A. **64**, 19737 (1966)
33 Baveja, S. K.; Ranga Rao, K. V.; Arora, J.: Ind. J. Pharm. Sci. **51**, 115 (1989)
34 Vander Zanden, J. A; Fitzpatrick, R. B.: Minn. Pharm. **35**, 8 (1980); Int. Pharm. Abstr. **18**, 1640 (1981)
35 Al Awadi, F. M.; Gumaa, K. A.: Acta Diabetol. Lat. **24**, 37 (1987)
36 Al Awadi, F. M.; Fatania, H.; Shamte, U.: Diabetes Res. **18**, 163 (1991)
37 Kubec, F.; Knap, J.; Juchelka, J.: Czech. CS Pat. 244387; C.A. **109**, 236732 (1988)

38 Pesko, L. J.: Am. Drug. **202**, 90 (1990); Int. Pharm. Abstr. **28**, 4186 (1990)
39 Michie, C. A.; Cooper, E.: J. Roy. Soc. Med. **84**, 602 (1991)
40 Thomas, T. A.; Galizia, E. J.; Wensley, R. T.: Brit. Med. J. **1,** 375 (1975); Int. Pharm. Abstr. **12**, 3568 (1975)
41 Olajide, O. A.: Phytother. Res. **13**, 231 (1999)
42 Ford, R. A.; Api, A. M.; Letizia, C. S.: Food & Chem. Toxicol. **30** (Suppl.), 91S (1992)
43 Lee, T. Y.; Lam, T. H.: Contact Dermatitis **28**, 89 (1993)
44 Jain, S. K.: Ciba Found. Symp. **185**, 153 (1994)
45 Tariq, M.; Ageel, A. M.; Al Yahya, M. A.; Mossa, J. S.; Al Said, M. S.; Parmar, N. S.: Agents Actions **17**, 381 (1986)
46 Atta, A. H.; Alkofahi, A.: J. Ethnopharmacol. **60**, 117 (1998)
47 Qureshi, S.; Al Harbi, M. M.; Ahmed, M. M.; Raza, M.; Giangreco, A. B.; Shah, A. H.: Cancer Chemother. Pharmacol. **33**, 130 (1993); C.A. **121**, 169918 (1994)
48 Al Harbi, M. M.; Qureshi, S.; Raza, M.; Ahmed, M. M.; Giangreco, A. B.; Shah, A. H.: Chemotherapy **40**, 337 (1994)
49 Al Harbi, M. M.; Qureshi, S.; Ahmed, M. M.; Rafatullah, S. Shah, A. H.: Am. J. Chin. Med. **22**, 77 (1994)
50 Al Harbi, M. M.; Qureshi, S.; Raza, M.; Ahmed, M. M.; Afzal, M.; Shah, A. H.: J. Ethnopharmacol. **55**, 141 (1997)
51 Anderson, C.; Lis-Balchin, M.; Kirk-Smith, M.: Phytother. Res. **14**, 452 (2000)
52 Gallo, R.; Rivara, G.; Cattarini, G.; Cozzani, E.; Guarrera, M.: Contact Dermatitis **41**, 230 (1999)
53 Al-Suwaidan, S. N.; Gad El Rab, M. O.; Al-Fakhiry, S.; Al-Hoqail, I. A.; Al-Maz, A.; Sherif, A. B.: Contact Dermatitis **39**, 137 (1998)
54 Dolara, P.; Corte, B.; Chelardini, C.; Pugliese, A. M.; Cerbai, E.; Menichetti, S.; Nostro, A.: Planta Med. **66**, 356 (2000)
55 Shonoda, M. L.; Farrag, R. M.; Salama, O. M.: J. Environ. Sci. Health B. **35**, 347 (2000)
56 Massoud, A. M.; Labib, I. M.: J. Egypt. Soc. Parasitol. **30**, 101 (2000)
57 Massoud, A.; Salama, O.; Galal, M.; Bennett, J.: The third conference for the Egyptian Society of Tropical Medicine, Infectious and Parasitic Diseases (ESTIP), Alex. Egypt. June 26−27, P02 (1997)
58 Badria, F.; Abou Mohamed, G.; El-Mowafy, A.; Massoud, A.; Salama, O.; Pharm. Biology **30**, 127 (2001)
59 Massoud, A.; Salama, O.; Bennett, J. L.: 9th International Congress of Parasitology, Makuhari Messe Chiba, Japan, August 24−27, 619 (1998)
60 El Gohary, Y.; Massoud, A.; Helmi, M.; Kassem, M.; Abdo, A.; Hanno, A.; salama, O.: Alex. Med. J. **41,** 12 (1999)
61 Massoud, A. M.; Fawzy, S. M.; Salama, O. M.: Egypt. J. Aquat. Biol. Fish **4**, 251 (2000)
62 El Zemity, S. R.; Mohamed, S. A.; Radwan, M. A.; Sherby, S. M.: Alex. J. Pharm. Sci. **15**, 67 (2001)
63 El Ashry, E. S. H.; Rashed, N.; Soliman, A. S.; Salama, O. M.: Unpublished results
64 Arora, R. B.; Das, D.; Kapoor, S. C.; Sharma, R. C.: Ind. J. Exp. Biol. **11**, 166 (1973); C. A. **81**, 109 (1974)
65 Dixit, V. P.; Joshi, S.; Sinha, R.; Bharvava, S. K.; Varma, M.: Biochem. Exp. Biol. **16**, 421 (1980)
66 Ahuja, M. M. S.; Malhotra, S. C.; Tandon, H. D.: Ind. J. Exp. Biol. **15**, 143 (1977); C. A. **86**, 165344 (1977)
67 Satyavati, G. V.: Ind. J. Med. Res. **87**, 327 (1988); C. A. **109**, 11601 (1988)
68 Arya, V. P.: Drugs Today **24**, 561 (1988)
69 Singh, R. B.; Niaz, M. A.; Ghosh, S.: Cardiovasc. Drugs Ther. **8**, 659 (1994)
70 Tripathi, S. N.; Gupta, M.; Sen, S. P.; Udupa, K. N.: Ind. J. Exp. Biol. **13**, 15 (1975); C. A. **83**, 405 (1975)
71 Tripathi, S. N.; Gupta, M.; Sen, S. P.; Udupa, K. N.: Quart. J. Surg. Sci. **10**, 158 (1974); C. A. **83**, 188662 (1975)
72 Tripathi, S. N.; Gupta, M.; Dwivedi, L. D.; Sen, S. P.: J. Res. Ind. Med. **10**, 11 (1975); C. A. **85**, 256 (1976)
73 Wijesekera, R. O. B.: "The Medicinal Plant Industry" (1984)
74 Narain Sharma, J.; Nath Sharma, J.: Arzneim. Forsch./Drug Res. **27**, 1455 (1977)
75 Arora, R. B.; Kapoor, V.; Gupta, S. K.; Sharma, R. C.: Ind. J. Exp. Biol. **9**, 403 (1971); C. A. **75**, 143946 (1971)
76 Duwiejua, M.; Zeitlin, I. J.; Waterman, P. G.; Chapman, J.; Mhango, G. J.; Provan, G. J.: Planta Med. **59**, 12 (1993)
77 Mester, L.; Mester, M.; Nityanand, S.: Planta Med. **37**, 367 (1979)
78 Tripathi, Y. B.; Malhotra, O. P.; Tripathi, S. N.: Planta Med. **50**, 78 (1984)
79 Hasan, M. Z.: "Selected Herbo Mineral Remedies", 158 (1989)
80 Lata, S.; Saxena, K. K.; Bhasin, V.; Saxena, R. S.; Kumar, A.; Srivastava, V. K.: J. Postgrad. Med. **37**, 132 (1991)
81 Sarbhoy, A. K.; Varshney, J. L.; Maheshwari, M. L.; Saxena, D. B.: Zentralbl. Bakteriol. (Naturwiss.) **133**, 723 (1978)
82 Claeson, P.; Raadstroem, P.; Skoeld, O.; Nilsson, A.; Hoeglund, S.: Phytother. Res. **6**, 94 (1992); C. A. **117**, 44399 (1992)
83 Zygmunt, P.; Claeson, P.: Phytother. Res. **5**, 142 (1991)
84 Thufin, M.; Claeson, P.: Economic Botany **45**, 487 (1991)
85 Claeson, P.; Andersson, R.; Samuelsson, G.: Planta Med. **56**, 685 (1990)
86 Claeson, P.; Andersson, R.; Samuelsson, G.: Planta Medica **57**, 352 (1991)
87 Watt, J. M.; Breyer Brandwijk, M. G. Ed.: "Medicinal and Poisonous Plants of Southern and Eastern Africa", 2nd ed., 151 (1962)
88 Abou karam, M.; El Fiky, F. K.; Atif, O. A.; Shier, W. T.: Alex. J. Pharm. Sci. **8**, 93 (1994)
89 Ghazanfar, S. A. Ed.: "Handbook of Arabian Medicinal Plants", 64 (1994)
90 Sharma, P. K.; Sharma, J. D.: Curr. Sci. **71**, 68 (1996).