"NATURAL PRESERVATIVES"

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SUMMARY

This paper looks at the theoretical development of a natural preservative system using a data base on medicinal plants as a source of reference. The legal aspects of this concept are considered. The traditional methods of preservation, many taken from the food industry are summarised. The use of alcohol, glycerine, sugar, salt, dessication, anhydrous systems and temperature are amongst examples considered.

KEY WORDS

Natural preservation, traditional preservation, legal status.

INTRODUCTION

The subject of natural preservatives is one that probably has more academic interest than practical or economic virtue. However, it does have a wonderful marketing angle which may justify the higher raw material costs.

The paper reviews the most commonly used methods of preservation that are already available to the formulator. The food and beverage industry may be called upon for many of these examples.

LEGAL POSITION

No preservative may be used which does not appear in Annex VI Part 1 or 2 of the EEC Cosmetic Directive 76/768/EEC - including 7th. amending Commission Directive 94/32/EC.

However, there is no legislation for those natural materials, which, when used for their beneficial effect on the skin, may coincidentally have a positive effect on the total preservative requirement of the formulation. Of course, no material appearing in Annex II may be considered.

The food industry often uses a preservation technique known as the “hurdle approach”, where there are a number of different methods that might eliminate organisms on their own if used at a high level, but which in a food might make the product unpalatable. The idea of using a whole variety of these “hurdles” to slowly weaken each organism, but at individual levels that would be ineffective is an almost alien concept to the cosmetic and toiletry industry.

SUGAR

High levels of sugar can preserve against spoilage organisms, this may be seen in jams, preserves, certain sweet pickles and marmalades. This is also an important factor in the preservation of boiled sweets and chocolates etc. Increasingly, it will be noticed that many products now have to be kept in the refrigerator of freezer once opened, because

sugar has been replaced by artificial sweetener which is cheaper and healthier to eat, but which compromises the self-preservation of the product.

HONEY

Honey in its undiluted form is also a natural preservative and, indeed, there are many learnéd papers citing honey as a viscous barrier to bacteria and infection.

ALCOHOL

Not all organisms are bad! The production of alcohol from sugar by yeast is an industry in its own right. A wine carefully produced using sterilised equipment and fermented to 13% by volume will just about resist further infection from external organisms, once the ferment has completed. It is during the time of the fermentation process that the fermenting must is vulnerable to infection. The naturally produced fermentation grade alcohol can be concentrated by distillation and used as a natural preservative in toners, aftershaves and colognes.

HEAT

Heating, cooking and pasteurisation is another natural form of preservation that will sterilise products, especially where that product is designed as a one-shot use product - for example, a phial or a sachet. Alternatively, once opened, the product can be stored in the fridge of freezer to prevent microbiological degradation.

DESICCATION

Removing water from a product or making it totally dehydrated will greatly reduce the possibility of spoilage, however, it must be recognised that the presence of spore-bearing organisms could become active once that water is reintroduced.

ANHYDROUS

In a similar vein, one could make products with materials that do not contain any traces of water, i.e. to deliberately design and formulate a totally anhydrous product. However, creams that can be finished by the consumer, by introducing water to the blend of oils, fats and waxes are prone to the same restrictions as the dessicated products.

SALT

The use of extreme levels of salt as used by the ancient mariners to preserve their meat is effective and it very likely that the preservation of the Egyptian mummies was, in part, achieved by the 40 day treatment in natron (a concentrated brine solution that osmotically drained the tissues of water).

COLD

Placing a product in the cold merely 'stops the clock' on microbiological growth and this is perfectly fine, provided the product was sterile when it was placed in the cold and/or had sufficient preservative 'mass' to counter any new organisms subsequently introduced.

ACID pH

The preservative activity can be boosted by operating at as low a pH as possible. Natural acidity could be obtained from one of the many of the alpha hydroxy acids (AHAs) which are obtained from citrus species, where the major components are citric and malic acids.

CHELATING AGENTS

In addition to formulating at low pH, chelating agents such as ferulic acid extracted from rice bran, could be added to enhance the activity of the natural preservative.

ANTIOXIDANTS

Antioxidants such as natural tocopherol and ascorbic acid will further aid in preservation, as well as reducing the potential rancidity.

GLYCERINE

High levels of vegetable glycerine, up to 15-20%, will also have a preservative effect, similar to that effect obtained by the use of high levels of sugar.

PLANTS SELF-PRESERVATION

Plants in the wild do not go mouldy, and yet they are in an environment that predisposes them to suffer from the infestation of all manner of spoilage organisms. Yeasts, moulds and bacteria abound in the soil, all working to breakdown dead plant material and provide fresh humus for those plants living in the soil. Living plants resist the natural forces of disintegration.

The chemicals present in all parts of the plant protect it from the environment. However, examples can be seen where tampering with the plant leads to a reduction in the efficacy of this natural mechanism.

It is concluded, that the chemical constituents within each plant clearly differ in composition. Furthermore, that there may be in certain species a chemical or group of chemicals present in the plant that is capable of killing micro-organisms. This chemical composition varies according to whether the plant is alive or dead, and in certain/most plants will vary according to season.

In many cases, when these plants are extracted, it is found that the extracts are capable not only of resisting certain spoilage organisms, but in some cases can actively act to destroy them. The time and speed of extraction of the fresh plant is often critical if the preservative activity is to be retained.

COMMERCIAL PRODUCTS

There are a number of natural preservatives available on the market that is not strictly speaking legal, since they have no entry in Annex VI as a permitted preservative. However, the use of a plant for its marketing claim, or for other functional benefits

smudges the issue. One may use a number of plant derivatives as fragrance components and coincidentally achieve a lower overall preservative requirement for the product in which they are used.

There are many cases where plants may contain paraben-type compounds in addition to other functional actives and the difficulty is to decide whether the botanical is being used as a preservative or for other legitimate and perfectly legal benefits.

Plants used to eliminate *Candida albicans* – a review of the literature

A survey of papers published between 1995 and 1999 showed a tremendous activity in the examination of botamicals for their antimicrobial and antiseptic effects. A cross-section of plants examined is shown below.

***Abies* (fir) species**

The antimicrobial activity of essential oils isolated from nine *Abies* species (*A. koreana*, *A. alba*, *A. pinsapo*, *A. concolor*, *A. firma*; *A. nordmanniana* subsp. *nordmanniana* which are plantation forms; and *A. cilicica* subsp. *cilicica*, *A. cilicica* subsp. *isaurica* and *A. nordmanniana* subsp. *bornmuelleriana* which are natural forms) against bacteria (*Escherichia coli*, *Bacillus megaterium*, *B. cereus*, *B. subtilis*, *B. brevis*, *Pseudomonas aeruginosa*, *Listeria monocytogenes*, *Klebsiella pneumoniae*, *Enterobacter aerogenes*, *Staphylococcus aureus*) and yeasts (*Saccharomyces cerevisiae* and *Candida albicans*) were investigated using a disc diffusion method. The essential oils could be classified into 3 groups according to the strength of their antimicrobial activities. The first group of essential oils of *A. pinsapo* and *A. concolor* had no antimicrobial activity, the second group of essential oils, isolated from *A. alba* and *A. firma*, had a modest activity. The third group, *A. koreana*, *A. cilicica* subsp. *cilicica*, *A. cilicica* subsp. *isaurica*, *A. nordmanniana* subsp. *nordmanniana* and *A. nordmanniana* subsp. *bornmuelleriana*, had the highest antimicrobial activity against the bacteria and yeast species tested. Surprisingly, it was found that most of the essential oils used in this study had little effect on the growth of *E. coli*. The essential oils of the *Abies* species tested were more active against yeast species than against bacteria, and the antimicrobial activity of essential oils was variable, depending on the bacterial strains and the source of the essential oil. [Bagci, *et al*]

Aframomum melegueta

6-Paradol and 6-shogaol were isolated from the seeds of *Aframomum melegueta* following bioactivity-guided fractionation. These compounds were active against *Mycobacterium chelonei* [*M. chelonae*], *M. intracellulare*, *M. smegmatis* and *M. xenopi* (MIC values of 10-15 ug/ml). The antimicrobial properties of derivatives were also investigated. The desmethyl derivative of 6-paradol retained antimycobacterial activity, and was more active against *Candida albicans* than either 6-paradol or 6-shogaol.[Galal]

***Alectoria sarmentosa* - Lichen**

Four antimicrobial compounds, identified as (-)-usnic acid, physodic acid, 8'-O-ethyl-beta-alectoronic acid and a new dibenzofuranoid lactol named alectosarmentin, were isolated from the ethanol extract of *A. sarmentosa*. Alectosarmentin exhibited activity against *Staphylococcus aureus* and *Mycobacterium smegmatis* at 25 ug/ml; the known compounds exhibited activity against these 2 bacteria and against *Candida albicans*. [Gollapudi, *et al*]

Alpinia speciosa
Essentials oils prepared by hydrodistillation of leaves (L), rhizomes (R), and stems (S) of *A. speciosa* [*A. zerumbet*] were analysed by capillary gas chromatography coupled to mass spectrometry (CGC-MS). The study revealed mainly terpinen-4-ol (17.3, 20.2 and 16.0%) and 1,8-cineole [eucalyptol] (14.4, 15.9 and 11.5%, respectively). The hydrocarbons constituted 52.2% (L), 40.9% (R) and 44.3% (S) of the oil, and comprised mainly sabinene 10.1% (L), 9.8% (R) and 7.5% (S), and gamma-terpinene 11.1% (L), 9.3% (R) and 8.2% (S). The essential oils of the three organs exhibited significant antimicrobial activity against certain Gram-positive bacteria (*Bacillus subtilis*, *Staphylococcus aureus*, *Sarcina lutea* and *Mycobacterium phlei*) and Gram-negative bacteria (*Escherichia coli* and *Pseudomonas aeruginosa*), as well as *Candida albicans*. [Pooter, *et al*]

Alpinia galanga
A. galanga, a SE Asian medicinal plant used to treat colic, dysentery, food poisoning and skin diseases, was collected from Indonesia in 1988. An antimicrobial diterpene was isolated from *A. galanga*. Its structure was (E)-8beta,17-epoxylabd-12-ene-15,16-dial. This diterpene synergistically enhanced the antifungal activity of quercetin and chalcone against *Candida albicans*. Antifungal activity was reversed by unsaturated fatty acids. Protoplasts of *C. albicans* were lysed by the diterpene. [Haraguchi, *et al*]

Aniba canelilla
A. canelilla is used in traditional medicine to treat headaches and diarrhoea, and as a febrifuge. The composition of the essential oil and the hexane extract of the stem bark of *A. canelilla* was analysed by GC-MS, MS and NMR spectroscopy. Twelve components were identified; the main constituent in both the essential oil and the extract was 1-nitro-2-phenylethane. Nitro-2-phenylethane exhibited a high toxicity against yeasts, especially *Candida albicans*. The LD50 of a petroleum ether extract of this plant was >800 mg/kg for BALB/c mice. [Oger, *et al*]

Arnebia tinctoria
Two naphthoquinones, alkannin and isovalerylalkannin, were isolated from the light petroleum extract of roots of *A. tinctoria*. The extract exhibited activity against *Bacillus subtilis*, *Staphylococcus aureus*, *Streptomyces pyogenes* and *Candida albicans*. [El-Alfy, *et al*]

***Artemisia* species**
Flavonoids were isolated from *A. molinieri*, *A. selengensis* and *A. stolonifera*. The flavonoid fractions of all 3 plants exhibited activity against *Candida albicans*, *Rhodotortula* [*Rhodotorula*] *rubra*, *Aspergillus fumigatus*, *Fusarium culmorum* and *Alternaria solani*. [Swiader, *et al*]

Artemisia herba-alba* and *Artemisia judaica
The essential oils extracted from flowering, aerial parts of *A. herba-alba* and *A. judaica*. The essential oil of *A. herba-alba* contained alpha-thujone (25.6%), chrysanthenone (16.4%), beta-thujone (15.6%) and camphor (14.2%). The essential oil of *A. judaica* contained piperitone (53.5%), chrysanthenone (9.8%) and chrysanthenyl acetate (7.4%). Both oils exhibited good activity against *Staphylococcus* spp., *Candida* spp. and *Microsporum* spp. [Charchari, *et al*]

Artemisia selengensis* and *Artemisia stolonifera
The essential oils hydrodistilled from 2 species and harvested at flowering were investigated by GC and GC/MS. The main constituents of *A. selengensis* oil were *beta*-pinene (17.9%) and *alpha*-pinene (14.8%), and those of iwere *beta*-caryophyllene (25.2%), 1,8-cineole [eucalyptol] (9.1%), and *alpha*-humulene (4.6%). The antifungal properties of the oils against *Candida albicans*, *Rhodotorula rubra* and *Aspergillus fumigatus* were also investigated. Both oils (at 2%) showed total inhibition of *A. fumigatus*. [Swiader, *et al*; 1997]

Artemisia sieversiana* and *Inula racemosa
The aerial parts of *A. sieversiana* afforded, in addition to *beta*-sitosterol, stigmasterol and daucosterol, 2 novel lignans as well as 1 known and 3 new guaianolides. The roots of *I. racemosa* gave *beta*-sitosterol, daucosterol and isoalantolactone. All isolates were subjected to antifungal tests. Isoalantolactone, a major sesquiterpene lactone of *I. racemosa* was active against the human pathogenic fungi, *Aspergillus flavus*, *A. niger*, *Geotrichum candidum*, *Candida tropicalis* and *C. albicans* at concentrations of 50, 50, 25, 25 and 25 μg/ml, respectively. [Tan (4), *et al*; 1998]

Aspidistra elatior
The methanol extract of *A. elatior* plants (Haran, used in traditional medicine, and as a serving material, in place of a dish, for food) showed antifungal activity against the food-borne fungi *Saccharomyces cerevisiae*, *Hansenula anomala*, *Mucor mucedo* and *Candida albicans*. The powdered methanol extract was dissolved in water and partitioned with hexane, ethyl acetate, n-butanol and then water. Only the n-butanol fraction exhibited antifungal activity. The antifungal compound in the n-butanol fraction was finally isolated by silica gel chromatography and HPLC. Analysis revealed the structure of the antifungal compound as aspidistrin (diosgenin 3-O-beta-lycotetraoside). The MIC of aspidistrin was 2.5 ug/ml against *S. cerevisiae*, 10 ug/ml against *H. anomala*, 10 ug/ml against *M. mucedo* and 50 ug/ml against *C. albicans*. [Koketsu, *et al*]

Asteriscus graveolens
Re-investigation of the alcohol extract of *A. graveolens* plants afforded two new bisabolone hydroperoxides, the structures of which were determined as 6-hydroxy-11-peroxy-bisabol-2,9-diene-1-one and 6-hydroxy-10-peroxy-bisabol-2,11-diene-1-one by spectral analysis. Lipophilic extracts of *A. graveolens* showed antimicrobial activity. The petrol extract was active against most of the test organisms (7 bacteria, *Candida albicans* and *Saccharomyces cerevisiae*), whereas the chloroform extract showed activity against the Gram-negative bacilli and the ethyl acetate extract was only active against the *Staphylococcus* species. [Sarg, *et al*]

Ballota saxatilis* subsp. *saxatilis
Three known diterpenoids, hispanolone, dehydrohispanolone and ballonigrine, were isolated from aerial parts of *B. saxatilis* subsp. *saxatilis*. All 3 compounds exhibited activity against 5 species of bacteria and *Candida albicans*. [Citoglu, *et al*]

Bidens cernua
Cernuol was isolated from aerial parts of the medicinal plant, *Bidens cernua* (collected from Ukraine). It exhibited activity against *Microsporum canis* and 7 *Trichophyton* spp. (MIC values of 10-20 μg/ml), *Epidermophyton floccosum* (10 μg/ml), *Candida albicans*

(50 μ g/ml), C. krusei (100 μg/ml) and 7 Gram positive bacteria (5-10 μg/ml) activity. [Smirnov, *et al*]

Bixa orellana

An ethanol extract of leaves of *B. orellana* was screened for in vitro antifungal and antibacterial activity using the agar diffusion and tube dilution methods. The extract (5 mg/ml) exhibited activity against standard strains of Gram-positive bacteria including *Bacillus subtilis*, *Staphylococcus aureus* and *Streptococcus faecalis*, and exhibited slight activity against *Escherichia coli*, *Serratia marcescens*, *Candida utilis* and *Aspergillus niger*. The MIC values were in the range 4-16 mg/ml, while its bactericidal actions were exerted at higher doses (16-64 mg/ml). [Irobi, *et al*;1996]

Bridelia ferruginea

In Cote d'Ivoire, the decoction of the roots of *B. ferruginea* is used as a folk medicine to treat gonorrhoea infections. In western Nigeria it is used as a mouthwash and remedy for candidal oral thrush, and in northern Nigeria, the bark is used for the treatment of infections caused by poisoned-arrow wounds. The water and ethanol extracts of powdered *B. ferruginea* bark were found to exhibit antifungal activity against *Candida albicans*, and antibacterial activity against *Staphylococcus aureus*, *S. epidermidis*, *Escherichia coli*, *Streptococcus lactis*, *S. pyogenes*, *Proteus vulgaris*, *P. mirabilis* and *Klebsiella* sp., at a concentration of 5 mg/ml. Preliminary phytochemical analysis of the plant extracts revealed the presence of phenols and tannins. [Irobi, *et al;1994*]

Buddleja madagascariensis

Mimengoside A was isolated from the leaves of B. madagascariensis. The $CHCl_3$ extract of the leaves exhibited activity against fungi and protozoa. Mimengoside A exhibited activity against 8 *Candida* strains (LC100 value of 50 ug/ml). The compound exhibited activity against *Trichomonas vaginalis* and *Leishmania infantum* (LC100 values of 12.5 and 25 ug/ml, respectively). Mimengoside A (4 mg/litre for 24 h) was lethal to *Biomphalaria alexandrina*. [Emam, *et al*]

The methanolic extract of B. madagascariensis leaves (from Egypt) showed protozoocidal activity against *Trichomonas vaginalis* and *Leishmania infantum* at 200 ug/ml. Corresponding figures for the methanolic extract of *S. scorodonia* flowers were 100 and 250 ug/ml, respectively. The biological activity of buddlejasaponin, isolated recently for the first time from both plants, was examined. LC100 values against the 2 protozoa were 20 and 40 ug/ml, respectively. It also showed activity against *Biomphalaria alexandrina* snails (LC100 value at 24 h of 10 ug/ml) and 9 yeast strains (7 *Candida* spp., *Cryptococcus neoformans* and *Trichosporon asahii*; LC100 value of 100 ug/ml). [Emam, *et al*; 1997]

Calluna vulgaris

The antimicrobial activity of aqueous, ethanolic and ethereal extracts of dried aerial parts of *C. vulgaris* (obtained from a commercial source) was studied in vitro and compared with that of some of its pure compounds: arbutin, hydroquinone and ursolic acid. Neither the ethereal nor the ethanolic extracts inhibited the growth of any microorganism tested. The aqueous extract inhibited the growth of *Staphylococcus aureus* and *S. epidermidis*, *Candida albicans* and *Cryptococcus neoformans*, *Escherichia coli*; *Pseudomonas aeruginosa* and *Proteus vulgaris* were less susceptible. Arbutin showed no antimicrobial activity. Hydroquinone slightly and ursolic acid markedly inhibited the growth of *S.*

aureus. Neither compound inhibited the growth of Gram-negative bacteria or yeasts. [Braghiroli *et al*]

***Capsicum* species**
A survey of the Mayan pharmacopoeia revealed that tissues of *Capsicum* species are included in a number of herbal remedies for a variety of ailments of probable microbial origin. Using a filter disk assay, plain and heated aqueous extracts from fresh *C. annuum*, *C. baccatum*, *C. chinense*, *C. frutescens*, and *C. pubescens* cultivars (mostly fruits, but in the case of *C. annuum* cv. Jalapeno, fruits and leaves were used) were tested for their antimicrobial effects against 15 bacterial species and 1 yeast (*Candida albicans*); garlic extract was used as the control. Two pungent compounds found in Capsicum species (capsaicin and dihydrocapsaicin) were also tested for their antimicrobial effects. The garlic extract completely inhibited all microorganisms, but the capsaicinoids showed no activity. The plain and heated Capsicum extracts exhibited varying degrees of inhibition against *Bacillus cereus*, *B. subtilis*, *Clostridium sporogenes*, *Clostridium tetani*, and *Streptococcus pyogenes*. In many cases, the extracts had a slight stimulatory effect on *Candida albicans*.

Carica papaya
C. papaya latex sap inhibited the growth of *C. albicans* when added to a culture during the exponential growth phase. Approx. 60% inhibition was achieved. This fungistatic effect is the result of cell wall degradation due to a lack of polysaccharide constituents in the outermost layers of the fungal cell wall and release of cell debris into the culture medium. [Giordani, *et al*]

Cassia tora
The antifungal activity of the dealcoholized extract of leaves of Cassia tora was determined against *Candida albicans*, *Aspergillus niger*, *Saccharomyces cerevisiae* and *Trichophyton mentagophytes* [*T. mentagrophytes*]. The extract inhibited the growth of all 4 fungi in a concentration dependent fashion. [Mukherjee, *et al*]

Cephalaria transsylvanica
The antimicrobial activities of the MeOH extract of the flowers of *Cephalaria transsylvanica* and of 3 triterpenic acid glycosides (transsylvanosides A-C) isolated from the flowers were investigated. The extract and transsylvanosides A-C exhibited activity against *Staphylococcus aureus*, *Escherichia coli*, *Proteus vulgaris*, *Pseudomonas aeruginosa*, *Corynebacterium xerosis*, *Klebsiella pneumoniae*, *Candida utilis*, *Kluyveromyces fragilis*, *Aspergillus oryzae* and *Aspergillus flavus*. [Kirmizigul, *et al*]

***Cetraria islandica* - Lichen**
Ethyl acetate, acetone, chloroform and ethanol extracts of Cetraria islandica were prepared and screened for activity against *Escherichia coli* ATCC 11230, *Enterobacter aerogenes* CCM 2531, *Staphylococcus aureus* 6538P, *S. epidermidis*, *Bacillus subtilis* La2114, *B. cereus* var. *mycoides*, *B. sphaericus*, *B. thuringiensis*, *B. megaterium*, *Mycobacterium smegmatis* RUT, *Salmonella typhimurium*, *Candida utilis* La991, *C. albicans* CCM314, *Aspergillus flavus*, *A. oryzae*, *A. fumigatus*, *Trichophyton rubrum*, *Botrytis cineriae* [*B. cinerea*], *Fusarium oxysporum*, *Streptomyces murinus* ISP 5091 and *Nocardia cornea* IFO 14403. *Cetraria islandica* was active only against some Gram-positive bacteria. [Dulger, *et al*]

Chamaecyparis obtusa
A neutral wood oil was extracted by steam distillation from fresh sawdust collected from 250 to 300 year old *C. obtusa* (Kiso-Hinoki) trees from the Kiso area of Nagano, Japan. Hinokitiol, or thujaplicin ($C_{10}H_{12}O_2$), which has been believed to exist in Cupressaceae, was not found in this neutral wood oil. A new chemical substance (yoshixol, 4,4-dimethyl-6-methylene-2-cyclohexen-1-one) was synthesized based on several criteria which suggested it to be a major constituent of the neutral wood oil from *C. obtusa*. The antibiotic effects of hinokitiol, the neutral wood oil and yoshixol on methicillin-resistant *Staphylococcus aureus* (MRSA) were examined bacteriologically and morphologically. Yoshixol also showed a strong antibiotic effect on *Escherichia coli*, *Mycobacterium chelonei* [*M. chelonae*], *Pseudomonas aeruginosa* and *Candida albicans*. [Koyama, *et al*]

Chara zeylanica
Petroleum ether extract (PEX) and its fractions of the alga *Chara zeylanica* were tested in the laboratory against 29 species of microbes and the cotton pest *Dysdercus koenigii*. The PEX showed antimicrobial activity against 12 out of 29 microbes tested. Only 15 of 19 fractions of PEX exhibited microbicidal activity. Some fractions retained that lethal activity for 6 months. The dermatophyte *Candida albicans* was the most susceptible microbe. [Sarkar, *et al*]

Cinnamomum zeylanicum
The fungitoxic properties of the vapours of cinnamic aldehyde, the active constituent of cinnamon (*Cinnamomum zeylanicum*) bark oil, against *Aspergillus niger*, *A. fumigatus*, *A. nidulans*, *A. flavus*, *Candida albicans*, *C. tropicalis*, *C. pseudotropicalis* [*C. kefyr*] and *Histoplasma capsulatum* were determined *in vitro* as min. inhibitory concn (MIC), min. lethal concn (MLC), inoculum density sustained, and exposure duration for fungicidal action at MIC and higher doses. The MIC varied from 16-40 p.p.m. for the fungi tested; *A. fumigatus* was the most susceptible and *H. capsulatum* and *Candida* spp. were the most resistant. [Singh, *et al*]

Aqueous extracts of powdered bark of *Cinnamomum zeylanicum* exhibited activity against fluconazole-resistant and susceptible *Candida* spp. *in vitro* (MIC values of <0.05-30 mg/ml). *trans*-Cinnamaldehyde and O-methoxycinnamaldehyde (isolated from *Cinnamomum zeylanicum*) also exhibited activity against *Candida* spp. (MIC values of 0.03-0.5 mg/ml). Cinnamon sweets were also tested for activity (MIC values of 25-100 mg/ml). [Quale, *et al*]

Clausena anisata
In traditional medicine, the leaves of *C. anisata* are placed in wounds to drive away maggots. The essential oil, hydrodistilled from leaves of *C. anisata* was analysed by a combination of GC and GC-MS. The main compounds were sabinene (33.0%), germacrene D (17.0%) Z-β-ocimene (6.0%), germacrene B (5.5%), (E)-β-ocimene (4.9%) and terpinen-4-ol (4.7%). Using the hole-plate diffusion method for antibacterial testing, the volatile oil exhibited significant activity against *Flavobacterium suaveolens*, *Enterococcus faecalis* [*Streptococcus faecalis*], *Bacillus subtilis*, *Serratia marcescens*, *Alcaligenes faecalis* and *Leuconostoc cremoris*. The mycelium growth inhibition method was used to test for antifungal activity. The oil exhibited significant activity against *Geotrichum candidum*, *Aspergillus parasiticus*, *Candida albicans*, *Penicillium citrinum* and *Alternaria alternata*. [Gundidza, *et al*]

Two new carbazole alkaloids, named clausenol and clausenine, were isolated from an alcoholic extract of the stem bark of C. anisata. Their structures were established as 1-hydroxy-6-methoxy-3-methylcarbazole and 1,6-dimethoxy-3-methyl carbazole, respectively. Clausenol exhibited activity against *Escherichia coli*, *Pseudomonas aeruginosa*, *Candida albicans* and *Trychophyton rubrum* [*Trichophyton rubrum*] (MIC values of 40, 16, 5 and 2 ug/ml, respectively). [Chakraborty (2), *et al*]

Clausena heptaphylla
A new carbazole alkaloid, named clausenal, was isolated from the leaves of *C. heptaphylla*. The alkaloid was active against *Escherichia coli*, *Staphylococcus aureus*, *Bacillus subtilis*, *Salmonella typhi*, and *Pseudomonas aeruginosa* (MIC values of 6, 3, 18, 25 and 20, respectively), and the fungi, *Candida albicans* and *Trychophyton rubrum* [*Trichophyton rubrum*] (MIC 8 and 3 ug/ml, respectively). [Chakraborty, *et al*]

Coleus aromaticus [*Plectranthus amboinicus*]
The essential oil secretory elements of *C. aromaticus* [Plectranthus amboinicus], from Martinique, were observed under the scanning electron microscope. The oil, hydrodistilled from the leaves, was analysed by GC-MS. The main oil constituent was carvacrol (72%); (Z)-1,3-hexadiene (0.1%), (Z)-3-hexenol (0.6%), (E,Z)-alpha-farnesene (0.2%), (E,E)-alpha-farnesene (0.2%) and alpha-muurolene (0.2%) were identified for the first time. The essential oil inhibited the growth of 6 bacteria and 6 fungi, including *Vibrio cholera* [V. cholerae], *Escherichia coli*, *Mycobacterium smegmatis* and *Staphylococcus aureus* (MIC values between 0.062 and 0.5 mg/ml), and *Botrytis cinerea*, *Aspergillus niger* and *Candida albicans* (MIC values between 0.125 and 0.25 mg/ml). The n-hexane and dichloromethane extracts of the leaves also exhibited activity against these organisms. [Prudent, *et al*].

Cordia linnaei
Three new meroterpenoid naphthoquinones, the known cordiaquinone B and a new naphthoxirene were isolated from roots of *C. linnaei*. Their structures were established from spectral data. The naphthoquinones showed activity against *Cladosporium cucumerinum*, *Candida albicans* and larvae of *Aedes aegypti*. The naphthoxirene derivative was inactive. [Ioset, *et al*]

Cosmos caudatus
One hydroxyeugenol derivative and 5 coniferyl alcohol derivatives (2 of which were novel) were isolated from the roots of *C. caudatus* (collected from Indonesia). The novel compounds were identified as Z-coniferyl alcohol-3'-acetyl-4-isobutyrate and 1',2'-dihydroxy-coniferyl alcohol-3'-isobutyryl-4-isobutyrate from spectral data. Five of these compounds exhibited activity against *Cladosporium cucumerinum*, and 3 of these compounds exhibited activity against *Candida albicans*. [Fuzzati, *et al*]

Cryptolepis sanguinolenta
From the 80% ethanol extract of *C. sanguinolenta* root bark a cryptolepine isomer named neocryptolepine, and 2 dimeric alkaloids named biscryptolepine and cryptoquindoline were isolated. These compounds were tested for their putative antibacterial and antifungal activities. Neocryptolepine showed antibacterial activity against Gram-positive bacteria (MIC < 100 μg/ml), but was less active against Gram-negative bacteria. It also inhibited the growth of the yeast *C. albicans*. Biscryptolepine exhibited activity only against some

Gram-positive bacteria (MIC = 62.5 or 31 μg /ml), while cryptoquindoline did not show activity against the selected microorganisms. The antibacterial activity of neocryptolepine and biscryptolepine was bacteriostatic rather than bactericidal. No antifungal activity was observed for the alkaloids against *Epidermophyton floccosum*, *Trichophyton rubrum* and *Aspergillus fumigatus* at the highest test concentration of 100 μg /ml. [Cimanga, *et al*]

Cuminum cyminum

The antimicrobial activities of the volatile oil of cumin (*Cuminum cyminum*) and the active constituent, cuminaldehyde, were investigated. *Aspergillus niger*, *A. flavus*, *A. parasiticus*, *Penicillium chrysogenum*, *Saccharomyces cerevisiae* and *Candida utilis* were more sensitive to cumin volatile oil and cuminaldehyde than bacteria. Among Gram-negative bacteria, *Escherichia coli* was most sensitive to the volatile oil while *Pseudomonas aeruginosa* was the most resistant. *Staphylococcus aureus* had a min. inhibitory concn (MIC) almost double that of all other Gram-positive species tested, while the fungi had MIC values 10- to 20-fold lower than those of the bacteria. [Shetty, *et al*]

***Cupressus* spp**

The essential oils of Algerian *Cupressus sempervirens*, *C. arizonica*, *C. glabra* [*C. arizonica*], *Eucalyptus globulus* and *E. punctata* were screened for antimicrobial properties. All essential oils exhibited activity against *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Candida albicans*. [Chanegriha. *et al*]

Curcuma longa

Bioassay-directed fractionation of the ethyl acetate extract of *C. longa* rhizomes yielded 3 curcuminoids which inhibited the activities of topoisomerases I and II. Curcumin III was the most active curcuminoid, inhibiting topoisomerase at 25 μg /ml. Curcumins I and II inhibited the topoisomerases at 50 μg/ml. Fractionation of the volatile oil from rhizomes afforded ar-turmerone, which displayed activity against *Aedes aegyptii* [*A. aegypti*] larvae (LD_{100} value of 50 μg /ml). Bioassay-directed fractionation of the hexane extract of leaves yielded *labda*-8(17),12-diene-15,16 dial. This compound exhibited activity against *Candida albicans* at 1 μg /ml, inhibited the growth of *C. krusei* and *C. parapsilosis* at 25 μg /ml, and killed 100% of *A. aegyptii* larvae at 10 μg /ml. [Roth, *et al*]

Cyclamen mirabile

Six saponins, cyclaminorin, deglucocyclamin, cyclacoumin, cyclamin, isocyclamin and mirabilin, were isolated from tubers of *C. mirabile*. Mirabilin was a new natural compound. Its structure was established using both spectral and chemical methods. All compounds, and mirabilin lactone isolated from *C. coum*, exhibited weak antibacterial properties (MIC values >400 ug/ml) and significant antifungal properties. The most potent compounds against 5 *Candida* species and *Cryptococcus neoformans* were cyclaminorin, deglucocyclamin and cyclamin (MIC values of 80-160 ug/ml). [Calis *et al*]

Cynodon dactylon

C. dactylon is used in traditional medicine as an antiinflammatory, diuretic, antiemetic and purifying agent, and to treat dysentery. The essential oil of *C. dactylon*, obtained from aerial parts contained glucose, fructose, mannitol, xylose, triticin, agropyrene and palmitic, oleic and stearic acids. The essential oil did not exhibit antimicrobial properties; agropyrene exhibited weak activity against *Candida albicans*, *Saccharomyces cerevisiae*, *Staphylococcus aureus* and *Bacillus subtilis*. [Artizzu, *et al*]

Daphne gnidium

The antimicrobial activities of the methanol extract and coumarins obtained from leaves of *D. gnidium* were investigated against 22 Gram-positive and Gram-negative strains (both fresh clinical isolates and ATCC standard strains) and 2 strains of *Candida albicans*. The methanolic extract showed the best activity against Gram-positive rods (MIC values in the range 390-781 mg/litre). *Moraxella catarrhalis* was the most susceptible Gram-negative bacteria (MIC value of 780 mg/litre). *D. gnidium* extracts exhibited complete and rapid bactericidal activity lasting 24 h; no regrowth was observed. [Iauk *et al*]

Desmodium canum

Three antimicrobial isoflavanones, named desmodianones A, B and C, were isolated from the CH_2Cl_2-soluble fraction of the ethanol extract of the roots of *D. canum* following bioactivity-directed fractionation. Their structures were determined from spectral data. Desmodianones A and B exhibited activity against *Bacillus subtilis*, *Staphylococcus aureus*, *Mycobacterium smegmatis*, *Streptococcus faecalis*, *Escherichia coli*, *Candida albicans* and *Neurospora crassa*. [Delle Monache, *et al*].

Elaeis guineensis

Traditionally extracted *Elaeis guineensis* kernel oil (local name: mmanyanga), a viscous black liquid, is used by the people of Akwa Ibom and Cross River States, Nigeria, in the treatment of various diseases. The antimicrobial properties of the oil, and its calcium, zinc, aluminum and mercuric soaps, were investigated. A comparative study was also made with palm (*E. guineensis*) oil and coconut [*Cocos nucifera*] oil. The results showed that only traditionally extracted *E. guineensis* oil showed any significant inhibitory activity against some of the tested bacteria, with activity being highest against *Escherichia coli*. This oil was also active against *Aspergillus fumigatus*. The metallic soaps inhibited the growth of most of the tested bacteria and *Candida albicans*. The antimicrobial effects of constituent fatty acids were responsible for antimicrobial activity. [Ekpa, *et al*]

Eriosema tuberosum

E. tuberosum is used in traditional Chinese medicine to treat diarrhoea, orchitis and hydrophobia, and as a detoxifying agent. A dichloromethane extract of the roots of *E. tuberosum* exhibited antifungal activity against *Cladosporium cucumerinum* and *Candida albicans*. Bioassay-directed fractionation led to the isolation of 4 new compounds, named eriosemaones A-D, and a known compound (flemicin D), as the active constituents. [Ma, *et al*]

Four new prenylated chromones were isolated from a dichloromethane extract of the roots of *E. tuberosum*. Eriosematin A exhibited antifungal activity against *Cladosporium cucumerinum* and *Candida albicans*. [Ma WeiGuang *et al*]

Two new prenylated chromones, eriosematins D and E, were isolated from a dichloromethane extract of roots of *E. tuberosum*. In solution, both compounds were in equilibrium at room temperature; stable derivatives were obtained after acetylation. Both chromones exhibited antifungal activity against *Cladosporium cucumerinum* and *Candida albicans* in TLC bioautographic assays. [Ma (3), *et al*]

***Eupatorium* species**
Extracts of eight *Eupatorium* spp. were screened for antimicrobial activity using a solid media diffusion test. Of the 32 extracts, 10 demonstrated activity against at least one of the tested microorganisms: *Bacillus subtilis*, *Micrococcus luteus*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Candida albicans*, *Mucor* sp. and *Aspergillus niger*. [Penna, *et al*]

Euphorbia tuckeyana
Simiarenone, 24-methylenecycloartanol and *beta*-sitosterol were isolated from aerial parts of *E. tuckeyana*. Extracts of the plant exhibited activity against Gram positive bacteria and *Candida albicans*. [Ferreira, *et al*]

Garcinia kola
In traditional medicine, *G. kola* is used to treat a variety of ailments. The seeds of *G. kola* were successively extracted with petroleum ether, 70% ethanol and water. The ethyl acetate fraction of the ethanol extract, which showed the maximum antimicrobial activity, was recovered in a 2.4% w/w yield. The petroleum ether, ethanol, milky layer and ethyl acetate fractions also exhibited antimicrobial properties. The observed activity was due to the presence of a polyisoprenyl benzophenone (kolanone) in the petroleum ether extract, and due to the presence of hydroxybiflavanonols in the ethyl acetate fraction. GB1 (a hydroxybiflavanonol) was the main component exhibiting activity against Gram-positive and Gram-negative bacteria and against *Candida albicans* and *Aspergillus flavus*. The MIC values of GB1 against *Staphylococcus aureus* and *Escherichia coli* were 3.1 x 10-7 and 3.0 x 10-3 ug/ml, respectively. [Madubunyi (2), *et al*]

Gentiana algida
G. algida is used in traditional medicine to treat pneumonia, bronchitis, tuberculosis and inflammations of the gall-bladder and liver. A new secoiridoid, 2'-(o,m-dihydroxybenzyl) sweroside, 5 known secoiridoids, and anofinic, oleanolic and fomannoxin acids, sitosterol, daucosterol, stigmasterol, orientin and gentianose, were isolated from the aqueous acetone extract of whole plants of *G. algida*. Anofinic and fomannoxin acids were active against *Cladosporium cucumerinum*. Preliminary structure-activity studies indicated that the presence of carboxylic moieties in these acids was presumably a precondition for activity, whereas their methyl esters, inactive against *Cladosporium cucumerinum*, were active against *Candida albicans*. [Tan, *et al*]

Gentiana macrophylla
G. macrophylla is used in traditional Chinese medicine to treat jaundice, hepatitis, constipation, pain and rheumatism. Three new chromene derivatives (2-methoxyanofinic acid and macrophyllosides C and D), 2 novel secoiridoids (macrophyllosides A and B), 6 known secoiridoids, and the known compounds kurarinone, kushenol I, beta-sitosterol, stigmasterol, daucosterol, beta-sitosterol-3-O-gentiobioside, alpha-amyrin, oleanolic acid, isovitexin, gentiobiose and methyl 2-hydroxy-3-(1-beta-D-glucopyranosyl)oxybenzoate were isolated from an aqueous acetone extract of the roots of G. macrophylla The 6 known secoiridoids were gentiopicroside, sweroside, 6'-O-beta-D-glucosylgentiopicroside, 6'-O-beta-D-glucosylsweroside, trifloroside and rindoside. 2-Methoxyanofinic acid, its methyl ester, kurarinone and kushenol I exhibited activity against *Cladosporium cucumerinum*. The methyl ester and kurarinone also inhibited the growth of *Candida albicans*. [Tan (2), *et al*]

Gentiana tibetica
Repetitive chromatography of the methanol extract of roots of G. tibetica (collected from Gansu Province, China) afforded 2 new secoiridoid glycosides and a novel antifungal anthranilic acid derivative, together with *beta*-sitosterol, daucosterol, oleanolic acid, loganic acid, gentiopicroside, sweroside, 2'-(2,3-dihydroxybenzoyl)sweroside, trifloroside, rindoside and macrophylloside A. The structures of the new products were determined from spectral data as 8-hydroxy-10-hydrosweroside, isomacrophylloside and ethyl N-docosanoylanthranilate. Ethyl N-docosanoylanthranilate inhibited the growth of the human pathogenic fungi *Candida albicans* and *Aspergillus flavus*. [Tan, *et al*; 1998]

Geranium sanguineum
The antiinfective activity of a polyphenol extract (PC) obtained from the aerial roots of a Bulgarian medicinal plant, *G. sanguineum*, was studied. The extract inhibited the reproduction of a range of viruses (influenza, herpes simplex, vaccinia, HIV-I) in cell cultures. The polyphenol extract inhibited the in vitro growth of *Staphylococcus aureus* and *Candida albicans*. [Serkedjieva]

Glehnia littoralis* ssp. *leiocarpa
G. littoralis subsp. *leiocarpa*, a species of ethnopharmacological interest in British Columbia, has antibacterial and antifungal properties. Antibacterial and antifungal compounds include 2 hitherto unreported polyine compounds (extracted from roots), (9Z)1,9-heptadecadiene-4,6-diyne-3,8,11-triol and (10E)1,10-heptadecadiene-4,6-diyne-3,8,9-triol. These compounds exhibited activity against *Pseudomonas aeruginosa*, *Escherichia coli*, *Staphylococcus aureus*, *Bacillus subtilis* and *Candida albicans*. [Matsuura, *et al*]

***Haplopappus* spp.**
In Chile, the resin of *Haplopappus* spp., known as bailahuen, is used as an antiseptic, emmenagogue, and aphrodisiac, and to treat colds, and liver, kidney and stomach ailments, and to promote wound healing in horses. The antimicrobial properties and preliminary chemical information of the extracts of resinous exudates from twigs and leaves of 9 *Haplopappus* species from Chile (*H. diplopappus*, *H. anthylloides*, *H. schumannii*, *H. cuneifolius*, *H. velutinus*, *H. uncinatus*, *H. multifolius*, *H. illinitus* and *H. foliosus*), are presented. The exudates contained terpenoids, flavonoids, and coumarins, and although they differed in chemical composition, the exudates exhibited similar antibacterial activities against 8 bacteria (including 3 species of *Bacillus*, *Micrococcus luteus*, *Staphylococcus aureus*, *S. epidermidis*, *Micrococcus flavus*, and *Proteus vulgaris*), slight activity against 3 bacteria, and no activity against *Candida albicans* and *Saccharomyces cerevisiae*. [Urzua, *et al*]

Harungana madagascariensis
In Nigeria, *H. madagascariensis* is used in traditional medicine to treat jaundice, stomach problems, skin diseases and leprosy. Leaves of *H. madagascariensis* were successively extracted with petroleum ether and 70% ethanol. The ethanol fraction exhibited activity against *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Aspergillus flavus* and *Candida albicans*. [Madubunyi, *et al*]

Holarrhena floribunda
Stem bark of *H. floribunda*, used in traditional medicine to treat malaria, dysentery, fever, female sterility, skin infections venereal diseases and snake bites. The ethanol extract and saponins, polar steroidal glycosides, steroidal glycosides and alkaloids from the stem bark were tested for antimicrobial activity. Fractions containing saponins, polar steroidal glycosides, steroidal glycosides and alkaloids exhibited some antibacterial activity against *Escherichia coli* and *Bacillus subtilis* and antifungal activity against *Candida albicans* and the saponin fraction markedly inhibited growth of *Aspergillus niger*. [Chukwurah]

Hypericum roeperanum
H. roeperanum is used in traditional medicine to treat female sterility. Four new xanthones, named 5-O-methyl-2-deprenylrheediaxanthone, 5-O-methylisojacareubin, 5-O-demethylpaxanthonin and roeperanone, were isolated from roots of *H. roeperanum*. In addition, 2-hydroxyxanthone, 5-hydroxy-2-methoxyxanthone, 1,5-dihydroxy-2-methoxyxanthone, 2-deprenyl rheediaxanthone B, isojacareubin and calycinoxanthone D were isolated and characterized. Some of the isolated xanthones exhibited antifungal activity against *Candida albicans*. [Rath (2) *et al*; 1996]

Hyssopus officinalis* L. var *decumbens
The antimicrobial activity of essential oils, of (above-ground parts of) *H. officinalis* var. *decumbens* from Banon in France and of *H. officinalis* from Piedmont in Italy, was studied taking account of their chemical composition. Pinocamphone and isopinocamphone were present in *H. officinalis* (4.4% and 43.3%, respectively), but they were lacking (1.0 and 1.4%) in var. *decumbens*, where linalol (51.7%), 1,8-cineole (12.3%) and limonene (5.1%) predominated instead. Disc diffusion tests carried out on Gram-positive (*Staphylococcus aureus* and *Enterococcus* spp.) and Gram-negative bacteria (*Klebsiella oxytoca*, *Escherichia coli*, *Proteus mirabilis*, *Pseudomonas* spp. and 2 strains of *Salmonella* spp.) showed that antimicrobial activity was generally negligible for *H. officinalis*, but broader, and in a few cases more evident (*Enterococcus* spp. and *E. coli*), for var. *decumbens*. All the yeasts tested (7 strains of *Candida albicans*, *C. krusei* and *C. tropicalis*) were strongly inhibited by both species. In liquid medium the MIC of H. officinalis was always >1.2% v/v for bacteria and between 0.6 and 1.2% v/v for yeasts, while MIC values of var. *decumbens* were 0.15-0.6% v/v for Gram-positive bacteria, 0.3-1.2% v/v for Gram-negative bacteria, and 0.15-0.3% v/v for yeasts. The effect of var. *decumbens* was generally bactericidal. Linalol, and to a lesser extent 1,8-cineole [eucalyptol], may contribute to the greater antimicrobial activity of var. *decumbens* in comparison with *H. officinalis*, while limonene may be responsible for the antimycotic action observed in both oils, as suggested by results of disc diffusion tests carried out with pure reference substances. [Mazzanti, *et al*]

Isopyrum thalictroides
The antimicrobial and immunological properties of ethanol extracts, non-alkaloid, tertiary alkaloid and quaternary alkaloid fractions, obtained from roots and aerial parts of *I. thalictroides* were examined. The non-alkaloid fraction from the aerial parts inhibited the growth of 7 test microorganisms (6 bacteria and *Candida albicans*) and was the most effective suppresser of classical pathway complement activity in normal human serum and guineapig serum. [Ivanovska, *et al*]

***Juniperus* species**

The antimicrobial activity of the essential oils from the leaves and berries of 4 *Juniperus* species (*J. oxycedrus* subsp. *oxycedrus*, *J. oxycedrus* subsp. *macrocarpa*, *J. drupacea* and *J. phoenicea*) was tested against 5 Gram-positive bacteria, 2 Gram-negative bacteria and *Candida albicans*. Essential oils from the berries were generally more active than those from the leaves. The essential oil of *J. oxycedrus* subsp. *oxycedrus* berries, which was the most active oil, was fractionated by CC and the antimicrobial activity of each fraction was tested. The fraction with the highest activity (that eluted with diethyl ether) was analysed by GC-MS and was found to contain mainly alpha-terpineol (88.4%). [Stassi, *et al*]

Kielmeyera coriacea

Analysis of the dichloromethane extracts of leaves and stems of *K. coriacea* revealed the presence of several xanthones. Phytochemical investigation of these extracts resulted in the isolation and identification of 10 xanthones, 1 biphenyl and 2 triterpenes. One xanthone and 2 triterpenes are new compounds. Four xanthones and the biphenyl exhibited antifungal activity against the plant pathogenic fungus *Cladosporium cucumerinum*. Two prenylated xanthones inhibited the growth of *Candida albicans*. [Garcia Cortez, *et al*]

Kigelia africana

A disc diffusion susceptibility test was used to screen concentrated extracts from the bark of 3 medicinal plants (*Alstonia boonei*, *Kigelia africana* and *Morinda lucida*) for antimicrobial activity. Solvents with different polarity were used for the extraction (methylene chloride, ethyl acetate, 95% ethanol and acetonitrile), and the extracts were tested against 5 human pathogens (*Candida albicans*, *Staphylococcus aureus*, *Enterococcus faecalis* [*Streptococcus faecalis*], *Escherichia coli* and *Pseudomonas aeruginosa*). The patterns of inhibition varied with the plant extract, the solvent used for extraction, and the organism tested. The largest zones of inhibition were observed for ethanol extracts of *K. africana* against *S. aureus* and *P. aeruginosa*. *S. aureus* was the most inhibited microorganism. No inhibitory effects were observed against *C. albicans*. The extent of the inhibition of the bacteria was related to the concentration of the plant extract. [Kwo, *et al*]

Kigelia pinnata

K. pinnata is a tropical tree from which the leaves, bark and fruits are used in prescriptions for syphilitic conditions, gonorrhoea, dysentery and ringworm. A biologically monitored fractionation of the methanolic extracts of the root and fruits of *K. pinnata* was carried out. Seven compounds isolated were tested for their activity against *Staphylococcus aureus*, *Bacillus subtilis*, *Corynebacterium diphtheria*[e], *Aspergillus niger*, *A. flavus*, *Candida albicans* and *Pullularia pullularis* [*Aureobasidium* sp.]. The naphthoquinones kigelinone, isopinnatal, dehydro-alpha-lapachone and lapachol and the phenylpropanoids p-coumaric acid and ferulic acid were isolated as the compounds responsible for the observed antibacterial and antifungal activity of the root and kigelinone and caffeic acid from the fruits of this plant. [Binutu, *et al*]

Landolphia owrrience

L. owrrience [*L. owariensis*] is used in traditional medicine in Nigeria to treat venereal diseases and colic. The ether, ethylacetate and n-butanol extracts of leaves (collected from Nigeria) and 6 TLC components (A-F) from the n-butanol extract were screened for

antimicrobial properties against *Escherichia coli*, *Bacillus subtilis*, *Candida albicans* and *Aspergillus niger*. The n-butanol extract was active against all the organisms except *B. subtilis*. TLC fractions A, D and E showed similar antimicrobial properties and were active against *E. coli*, *B. subtilis* and *C. albicans*. Fractions B and F were active against *B. subtilis* and *C. albicans*. Fractions B and F exhibited the greatest fungicidal activity. Fraction A was the most potent against bacteria. These activities were attributed to the presence of steroids, saponins, tannins and saponins probably as glycosides. [Ebi, *et al*]

Lepechinia hastata
The minimum inhibitory concentrations (MIC) of carnosol and of the ethanolic extract from the aerial part of *Lepechinia hastata* (which contains carnosol) were determined against a range of bacteria and *Candida albicans*. Carnosol and the ethanol extract showed activity against Gram +ve bacteria, but no activity against the yeast and the Gram -ve bacteria. The results could explain the use of this plant in Mexican traditional medicine against uterine infections. [Encarnacion-Dimayuga, *et al*]

Limonium axillare
L. axillare is used to treat wounds and inflammation in the United Arab Emirates. Sitosterol, stigmasterol, sitosterol glucoside, and 6 flavonoids (ka[e]mpferol, luteolin, myricetin, apigenin, luteolin-7-O-glucoside and apiin) were isolated from a methanol extract of aerial parts of *L. axillare*. This is the first report of apiin in the Plumbaginaceae. The antibacterial and antifungal activities of 2 plant extracts (methanol and chloroform), and the isolated flavonoids, were investigated against *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Candida albicans*, *Aspergillus terreus* and *A. flavus*. The methanol extract was more active than the chloroform extract, and all 6 flavonoids inhibited the growth of the test organisms; apigenin and apiin exhibited the greatest activity. [Bashir (1), *et al*]

Lippia citriodora (*Aloysia triphylla*).
L. citriodora [*A. triphylla*], a small tree known as lemon-scented grass, is used medicinally for its stomachic, diuretic and antispasmodic properties. The essential oil of fresh leaves was extracted by steam distillation, and investigated for its antifungal activity against *Microsporum canis*, *M. gypseum*, *Trichophyton mentagrophytes*, *Candida albicans* and *Aspergillus niger*. The essential oil was active against the first 3 fungi (at òabove 600 p.p.m.), slightly active against *C. albicans* but completely inactive against *A. niger*. The highest activity was observed at 2000 p.p.m. against both *M. gypseum* and *T. mentagrophytes* (inhibition halos of 20.3 and 25.2 mm, respectively). [Guerrera, *et al*]

***Lippia* species**
Of eight essential oils from *Lippia* species screened against six bacteria (*Pseudomonas aeruginosa*, *Staphylococcus aureus*, *S. albus*, *Bacillus cereus*, *Klebsiella* spp. and *Escherichia coli*) and 7 fungi (*Candida albicans*, *Colletotrichum coffeanum* [*Glomerella cingulata*], *Fusarium solani*, *Cercospora* spp., *Aspergillus* spp., *Microsporum canis* and *M. audouinii*). *L. grandifolia* and *L. javanica* oils exhibited strong antimicrobial activity especially on *G. cingulata*. It is suggested these oils have potential for exploitation as natural fungicides. [Mwangi *et al*]

Lychnophora salicifolia
L. salicifolia is a native Brazilian medicinal plant used in folk medicine to treat inflammatory diseases. Two known caryophyllene derivatives, lychnopholic acid and

acetyl lychnopholic acid, were isolated from the ethanol extract of aerial parts of *L. salicifolia*. Acetyl lychnopholic acid exhibited antifungal activity against *Candida albicans*, *C. tropicalis* and *Trichophyton rubrum*. Both compounds exhibited antibacterial activity against *Escherichia coli* and *Staphylococcus aureus*; acetyl lychnopholic acid was more potent than lychnopholic acid, suggesting that the acetyl group is responsible for activity. [Miguel, *et al*]

Lysimachia vulgaris

L. vulgaris has been used in the folk medicine of Europe and Asia in the treatment of fever, ulcers, diarrhoea and as an analgesic and antiinflammatory agent. From the underground parts a benzoquinone pigment and triterpene saponosides were isolated. Cytotoxic and antifungal properties of these compounds were tested in vitro against human and mouse melanoma cells and *Candida albicans*. Saponoside B exhibited cytotoxicity especially towards human melanoma cells. The pigment was more active as an antifungal agent. [Podolak, *et al*]

Mariscus psilostachys

Phytochemical investigation of 2 batches of *M. psilostachys* led to the isolation and characterization of 5 flavans and 3 flavanones. Two flavans are new natural products. Their structures were established as (2S)-4'-hydroxy-5,7,3'-trimethoxyflavan and (ñ)-5,4'-dihydroxy-7-3'-dimethoxyflavan. Absolute configuration of the optically active compound isolated was determined on the basis of its CD spectrum. All compounds exhibited antifungal activity against *Candida albicans* and *Cladosporium cucumerinum*. The less polar flavans were more active in both TLC assays and dilution assays. [Garo. *Et al*]

Melaleuca alternifolia

The antimicrobial activity of 8 components of tea tree oil was evaluated to determine the susceptiblity of a range of microorganisms to 1,8-cineole [eucalyptol], 1-terpinen-4-ol, p-cymene, linalool, alpha-terpinene, gamma-terpinene, alpha-terpineol and terpinolene. Terpinen-4-ol was active against all the test organisms while *p*-cymene demonstrated no antimicrobial activity. Linalool and alpha-terpineol were active against all organisms with the exception of *Pseudomonas aeruginosa*. Minimum inhibitory and minimum cidal concentrations of each component against *Candida albicans*, *Escherichia coli* and *Staphylococcus aureus* were determined. These results may have implications for the future development of tea tree oil as an antimicrobial agent. [Carson, *et al*]

Methods to increase the activity of *Melaleuca alternifolia* essential oil against *C. albicans* were investigated. Little improvement was observed following the blending of *M. alternifolia* essential oil with those of *Leptospermum citratum*, *Cymbopogon citratus* or *Lavandula angustifolia*. The antifungal activities of different fractions of the essential oil of *M. alternifolia* were also compared. It was found that high concentrations of terpinen-4-ol were important for activity. [Williams, *et al*]

Melissa officinalis

The essential oil of *Melissa officinalis* was analysed, and the main constituents were citronellal (25.2%), geraniol (16.4%) and citronellol (11.0%). The essential oil inhibited the growth of *Staphylococcus aureus*, *Streptococcus faecalis* and *Candida albicans* (MIC values of 100, 250 and 300 ug/ml, respectively), and inhibited the growth of *Escherichia coli*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* to a lesser extent (MIC values

of 500 ug/ml). Citronellol, beta-caryophyllene, thymol, carvacrol and citronellal were the most active oil components against the microorganisms. [Kedzia, *et al*]

Micromeria nervosa

Organic and aqueous solvent extracts and fractions of *M. nervosa* were investigated for antimicrobial activities on several microorganisms including bacteria and yeast. The extracts differed significantly in their antimicrobial activities, with the ethanolic extract being most active, followed by ethyl acetate and petroleum ether extracts. The least active extract was the aqueous. There was no significant difference between the different test microorganisms in their susceptibility to different extracts. For *Candida albicans* the ethanolic extract was the most active, giving 1.5 times the effect of nystatin. One of the main active ingredients of *M. nervosa* was isolated and identified as carvacrol. No significant difference in antimicrobial activity was found between carvacrol and its isomer thymol. The most susceptible test microorganism was *Proteus vulgaris* to carvacrol, and *P. vulgaris* and *C. albicans* to thymol. The least susceptible bacterium to both fractions was *Pseudomonas aeruginosa*. [Ali-Shtayeh, *et al*]

Mitracarpus villosus

M. villosus leaves, used to treat skin diseases including eczema, were collected from Nnokwa, Nigeria. Flavonoids, saponins, tannins and carbohydrates were found in the aqueous extract and flavonoids in the chloroform extract. The chloroform extract exhibited a broad spectrum of antimicrobial activity especially against *Candida albicans* and *Escherichia coli*. The 6 isolated flavonoidic fractions of the chloroform extract had varying degrees of activity against *E. coli* and *Staphylococcus aureus*, whereas only 1 fraction showed activity against *C. albicans*. [Ohiri, *et al*]

Morinda lucida

In Zaire, *M. lucida* is used to treat yellow fever and jaundice. Ten anthraquinones were isolated from a dichloromethane extract of the roots of *M. lucida*. Four of these were active against *Cladosporium cucumerinum* and *Candida albicans*. The most potent antifungal anthraquinone was identified as alizarin-1-methyl ether, which exhibited activity against *Aspergillus fumigatus* and *Trichophyton mentagrophytes* (MIC values of 100 and 50 ug/ml, respectively). [Rath, *et al*]

Murraya exotica

The essential oils of fresh flowers, leaves and fruits of *M. exotica* (syn. *M. paniculata*), cultivated in Egypt, were analysed by GC-MS. Forty-four components were identified in the oils. The monoterpene hydrocarbon *alpha*-pinene was the major constituent in all cases. The oils exhibited strong antifungal activity against *Candida albicans*, and showed a modest antibacterial activity against *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Sarcina lutea*. This species is used in traditional medicine. [El-Sakhawy, *et al*]

Nelumbo nucifera

Quercetin, myricetin, kaempferol 3-O-glucoside, quercetin 3-O-glucoside and luteolin 7-O-glucoside were isolated for the first time from aerial parts of *N. nucifera*. They were identified by physicochemical methods and direct comparisons. Kaempferol 3-O-glucoside and luteolin 7-O-glucoside showed significant activity against 6 bacteria and *Candida albicans*, exhibited antiinflammatory and analgesic activities. [Wassel, *et al*]

Newbouldia laevis
Four new naphthoquinones (6-hydroxydehydroiso-alpha-lapachone, 7-hydroxydehydroiso-alpha-lapachone, 5,7-dihydroxydehydroiso-alpha-lapachone and 3-hydroxy-5-methoxydehydroiso-alpha-lapachone) and 6 known naphthoquinones were isolated from a dichloromethane extract of roots of *N. laevis*. All naphthoquinones showed activity against *Cladosporium cucumerinum*, *Candida albicans* and *Bacillus subtilis* and *Escherichia coli*. [Gafner, *et al*]

Ocimum gratissimum
The leaves of *O. gratissimum*, used as a febrifuge and against cough and angina, and O. basilicum were collected from south of Brazzaville, Massissia, Congo. The essential oils, obtained by hydrodistillation, were tested for antibacterial and antifungal activity. O. gratissimum was particularly active against *Staphylococcus aureus*, *Streptococcus faecalis*, *Escherichia coli*, *Salmonella* spp., *Klebsiella pneumoniae*, *Proteus vulgaris*, *Candida albicans*, *Aspergillus fumigatus* and *Trichophyton mentagrophytes*. Oil of *O. basilicum* showed moderate antibacterial and antifungal effects. Thymol was the major constituent of the essential oil of *O. gratissimum* leaves. [Ndounga, *et al*].

Otostegia fruticosa
The essential oil, hydrodistilled from fresh aerial parts of *O. fruticosa* was analysed by GC-MS. The main components of the essential oil were thymol (43.7%), gamma-terpinene (16.4%) and p-cymene (12.4%). The oil exhibited significant activity against *Klebsiella aerogenes* (MIC value of 6 ug/ml), *Staphylococcus faecalis* and *S. epidermidis* (MIC values of 2 ug/ml), and *Bacillus subtilis*, *S. aureus*, *Escherichia coli*, and *Candida albicans* (MIC values of 6 ug/ml). [Aboutabl, *et al*]

Parthenium argentatum
P. argentatum is used to treat allergic contact dermatitis. Guayulins A and B, and argentatines A-D, have been isolated from dried aerial parts of *P. argentatum* (collected from Mexico). The material deswcribed as argentatine A exhibited activity against *Candida albicans*, *Torulopsis glabrata*, *Hansenulla* [*Hansenula*] sp., *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa*. [Martinez-Vazquez, *et al*]

Perilla frutescens
Seeds of *P. frutescens* (cultivars Aka-Shiso and Ao-Shiso, imported from Japan) were propagated and cultivated in Egypt. The growth, herbal yield and volatile oil yield were recorded. The yield of volatile oil, extracted by hydrodistillation, reached 0.17%, 0.01% and 0.16% of FW of leaves, stem and flowers, respectively. The volatile oil of the aerial parts of each cultivar was analysed by capillary GC-MS. The hydrodistillates of both cultivars mainly consisted of perillaldehyde, caryophyllene oxide, limonene and caryophyllene, with perillaldehyde being the main constituent (32.9% and 34.2% for Aka-Shiso and Ao-Shiso, respectively). Some significant differences in the oil constituents were observed; caryophyllene oxide reached 23.3% in Ao-Shiso but accounted for only 6.0% in Aka-Shiso. The antimicrobial activity of both oils was studied. Both showed good activity against *Aspergillus niger*, *Candida albicans*, *Bacillus subtilis* and *Escherichia coli*, but Ao-Shiso oil was more active than Aka-Shiso oil. [Omer, *et al*]

Pimenta racemosa* var. *racemosa
The essential oils, hydrodistilled from leaves of 3 types (neral/geranial, methylchavicol/ methyl eugenol and chavicol/eugenol) of *P. racemosa* var. *racemosa* were screened for

activity against 5 bacteria (*Staphylococcus aureus*, *Enterococcus faecium* [*Streptococcus faecium*], *Escherichia coli*, *Pseudomonas aeruginosa* and *Mycobacterium smegmatis*) and 5 fungi (*Candida albicans*, *Aspergillus niger*, *Absidia corymbifera*, *Penicillium verrucosum* and *Cladosporium cladosporioides*). Bacteria were less sensitive to the essential oils than fungi. The oils were bacteriostatic and fungistatic, but did not exhibit biocidal properties. [Aurore, *et al*]

Piper aduncum

An ethanol extract of the leaves of P. aduncum (collected from Mississippi, USA) demonstrated good antimicrobial activity. Bioassay-directed fractionation of this extract led to the isolation of 4-methoxy-3,5-bis(3'-methylbenzoic acid), 2,6-dihydroxy-4-methoxy-chalcone, nervogenic acid and 2,2-dimethoxy-8-(3-methyl-2-butenyl)-2H-chromene-6-carboxylic acid. These compounds showed considerable antifungal and antibacterial activities in vitro (against *Candida albicans*, *Cryptococcus neoformans*, *Mycobacterium intracellulare*, *Staphylococcus aureus*, *Bacillus subtilis* and *Pseudomonas aeruginosa*). [Okunade, *et al*]

Piper angustifolium

Aerial parts of *P. angustifolium*, a plant used in folk medicine as a decoction for external disinfection of wounds and sores. The essential oil of *P. angustifolium* was analysed by GC-MS. Camphor and camphene were the main constituents. The essential oil exhibited bacteriostatic and fungistatic activities against *Trichophyton mentagrophytes*, *Pseudomonas aeruginosa*, *Candida albicans*, *Cryptococcus neoformans*, *Aspergillus flavus*, *A. fumigatus* and *Escherichia coli*. Camphor and camphene did not exhibit bacteriostatic activity but exhibited moderate fungistatic activity against *Candida albicans*. [Tirillini, *et al*].

Polygala gazensis

The chromonocoumarins, frutinones A and B, and lignans, eudesmin, magnolin, yangambin and kobusin, were isolated from the lipophilic extract of P. gazensis. This medicinal species and 2 other related *Polygala* species (*P. teretifolia* and *P. fruticosa*) were analysed. Frutinone A was also found in the roots and aerial parts of *P. teretifolia* and *P. fruticosa*, while the presence of frutinone B was limited principally to the roots. Lignans were present in the aerial parts of *P. teretifolia* and *P. gazensis*. Frutinone A showed antifungal activity against *Cladosporium cucumerinum* and *Candida albicans* (MIC 20 ug/ml for both) while eudesmin and kobusin were antifungal only against *Cladosporium cucumerinum*. [Bergeron, *et al*]

Prangos platychlaena

Prangos platychlaena has been used in traditional medicine in eastern Turkey; it stops bleeding and heals the scars when applied externally. When the coumarins were tested against bacterial strains and *Candida albicans*, only a slight antibacterial activity was obtained against *Escherichia coli* (MIC 48.25 ug/ml) and a slight antifungal activity (MIC 54 ug/ml) against *C. albicans*. [Ulubelen, *et al*]

Pseudolarix kaempferi

The bark of *P. kaempferi* [*P. amabilis*] is used to treat dermatological fungal infections. Pseudolaric acid B was isolated and identified as the main antifungal constituent of the bark of *P. kaempferi*. Pseudolaric acid B was active against *Trichophyton mentagrophytes*, *Torulopsis petrophilum*, *Microsporum gypseum*, and *Candida* spp. The

minimum inhibitory concentrations and minimum fungicidal concentrations of pseudolaric acid B against *Candida* and *Torulopsis* species were comparable with those of amphotericin B. The *in vivo* activity of pseudolaric acid B was evaluated in a murine model of disseminated candidiasis [candidosis]. Pseudolaric acid B reduced significantly the number of recovered colony-forming units at different dosages. [Li, *et al*]

Rhazya stricta

Rhazya stricta is used in traditional medicine for the treatment of diabetes mellitus, skin infection and stomach disorders. The chloroform and methanol extracts (and/or various fractions) of the roots, collected from plants growing wild in United Arab Emirates showed antimicrobial activity against *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Aspergillus terreus*, *Aspergillus flavus* and *Candida albicans*. Strictanol, tetrahydrosecamine, akuammidine and rhazimanine were isolated. Tetrahydrosecamine showed broad spectrum antimicrobial activity (active against all except E. coli; MIC values 0.1-5.0 mg/ml). Strictanol was most active against E. coli and P. aeruginosa (MIC 0.5 mg/ml for both organisms). [Bashir (2), *et al*].

Rhus coriaria

The antibacterial activity of *R. coriaria* leaf methanol extract was assayed against Gram-positive and Gram-negative bacteria and antimycotic activity was assayed against *Candida albicans*. Good activity was observed against both Gram-positive and Gram-negative bacteria; *Bacillus subtilis*, *Staphylococcus aureus*, *Enterococcus faecalis* [*Streptococcus faecalis*] and *Escherichia coli* was the most sensitive to the extract. Some activity was observed against *C. albicans*. [Iauk, *et al*; 1998]

Salvadora persica

The antimycotic effect of the aqueous extract of the roots of *Salvadora persica* (miswak) was investigated. Several concn of aqueous extract of miswak prepared with Sabouraud medium were inoculated with *C. albicans*. These were incubated at 37°C and the turbidity was determined by OD at 600 nm wavelength measured at specific intervals over a period of 48 h. At a concentration of 15% the extract had a fungistatic effect for up to 48 h. It is suggested that this antimycotic effect was probably due to one or more of the root contents which included chlorine, trimethylamine, an alkaloid resin and sulfur compounds. [Al-Bagieh, *et al*]

Sansevieria zeylanica

The *in vitro* antifungal activity of an aqueous extract of *S. zeylanica* against clinical isolates of *Trichophyton rubrum*, *T. mentagrophytes*, *Microsporum audouinii*, *Epidermophyton floccosum*, *Candida albicans*, *Aspergillus flavus*, *A. niger* and *A. fumigatus* was investigated. All isolates were inhibited by *S. zeylanica* extract; *T. rubrum* showed the greatest sensitivity, followed by *E. floccosum*, *A. niger* and *C. albicans*. *M. audouinii* and *T. mentagrophytes* showed the greatest resistance. [Onah, *et al*]

Santolina chamaecyparissus

Santolina oil, a volatile oil distillate of *S. chamaecyparissus*, was effective against *Candida albicans* (MIC 62.5-125 ug/ml, compared with 3.125-6.25 ug/ml for clotrimazole) and had a synergistic effect on clotrimazole in vitro (MIC of 31.25 ug santolina oil + 3.125 ug clotrimazole/ml). [Suresh, *et al*]

Serjania salzmanniana
Two novel saponins, named salzmannianosides A and B, and 2 known saponins (pulsatilla saponin D and 3-O-[[beta-D-glucopyranosyl-(1->4)]-[alpha-L-rhamnopyranosyl-(1->2)]-alpha-L-arabinopyranosyl] oleanolic acid) were isolated from the methanol extract of the stems of *S. salzmanniana* [*S. salzmaniana*]. The saponins showed antifungal activity against *Cryptococcus neoformans* and *Candida albicans* (MIC values of 8 and 16 ug/ml, respectively). [Ekabo, *et al*]

***Sideritis* species**
The essential oils, hydrodistilled from aerial parts of *Sideritis congesta*, *S. argyrea* and *S. lycia*, were screened for antimicrobial activity. All essential oils exhibited activity; more potent activity was observed against fungi (*Candida albicans* and *C. parapsilosis*) than against bacteria (*Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Streptococcus faecalis*). The essential oils of *S. argyrea* and *S. lycia* showed similar potencies against all tested microorganisms. [Ezer *et al*]

Sium nodiflorum
S. nodiflorum is widely used in Moroccan medicine against abscesses, stomatitis, gumboils and mouth ulcers. Different extracts (ethyl ether, ethyl acetate and n-butanol) of the aerial parts of *S. nodiflorum* were examined for their antifungal activity against 2 groups of fungi. The growth of both yeasts (*Candida* spp. and *Torulopsis glabrata*) and molds (*Aspergillus* spp. and *Scopurialopsis* [*Scopulariopsis*] *brevicaulis*) was significantly inhibited, the effects depending on the extract and fungal species tested. In general, extracts were more effective against *Candida* than against *Aspergillus*. In tests on mice for analgesic activity, the extracts (100 mg/kg, p.o.) showed no significant effect on the writhing induced by acetic acid. In acute toxicity tests in mice, the extracts were well tolerated at an oral dose up to 5 g/kg, except for the ethyl ether extract which caused 16% mortality at this dose. [Larhsini, *et al*]

Solanum nigrescens
S. nigrescens is used as a folk medicine in Guatemala for the treatment of certain fungal infections, particularly vaginitis. The aqueous ethanol extract of the dried leaves of this plant was tested *in vitro* for its antifungal activity against *Candida albicans*, *Cryptococcus neoformans* and *Aspergillus fumigatus*. The minimum inhibitory dilution of the extract was 1:256 for *C. albicans* and 1:152 for *C. neoformans*; no antifungal activity was observed against *A. fumigatus*. Using chemical and spectral analyses, the structure was identified as cantalasaponin-3, a spirostanol glycoside. [He *et al*]

***Sporochnus pedunculatus* – a seaweed**
Bioassay-guided fractionation of the ethanol extract of *S. pedunculatus* led to the isolation of 2-(3'-methylbut-2'-enyl)-4-(1",1"-dimethylprop-2"-enyl)phenol. This structure of this compound was elucidated from spectral data. The compound inhibited the growth of *Candida albicans*, *Cryptococcus neoformans* and *Bacillus subtilis* (MIC values of 3.1, 3.1 and 6.2 ug/ml, respectively). [Gunasekera, *et al*]

Striga lutea
Striga lutea is used in Ayurvedic medicine. The petrol, chloroform, ethanol and water successive extracts of whole plants were investigated for anthelmintic and antimicrobial properties. All extracts exhibited activity against *Escherichia coli*, *Staphylococcus citreus*, *Pseudomonas aeruginosa*, *Proteus vulgaris*, *Aspergillus niger* and *Candida*

albicans, with the exception of the water extract, which only inhibited the growth of the first 3 microorganisms. [Hiremath, *et al*]

Swertia calycina
In a study on the chemical and biological properties of 25 species of the Gentianaceae family, the methanolic and dichloromethane extracts of *S. calycina* exhibited strong antifungal activities against *Cladosporium cucumerinum* and *Candida albicans*. 2-Methoxy-1,4-naphthoquinone was identified as the active compound. This is the first report of a naphthoquinone isolated from a member of the Gentianaceae. Six known xanthones and secoiridoids were isolated from the crude extracts of *S. calycina.* [Rodriguez, *et al*]

Tanacetum parthenium
Leaves of *T. parthenium*, used to prevent migraine and asthma, were collected from Zagorje, Croatia. Two extracts were prepared by percolation with 45% (extract 1) or 90% (extract 2) ethanol. These extracts were tested for their activity against 14 bacterial and 5 fungal species. Both extracts showed activity against *Bacillus subtilis*, *B. pumilus*, *Staphylococcus aureus*, *Streptococcus haemolyticus*, *Sarcina flava*, *Candida albicans* and *Trychophyton mentagrophytes* [*Trichophyton mentagrophytes*]. Extract 2 showed activity against a further 5 bacteria and 2 fungi. Extract 2 was more potent than extract 1. [Kalodera, *et al*]

Tephrosia nubica
The flavonoid glabratephrin was isolated from seeds of T. nubica. Glabratephrin showed significant activity against *Candida albicans*, *Klebsiella pneumoniae* and *Escherichia coli*. It also exhibited potent analgesic properties in rats. [Saeed, *et al*]

Terminalia citrina
T. citrina is used in traditional medicine in Thailand to treat diarrhoea and skin infections. Five known tannins were isolated from the methanol extract of the fruits and identified as corilagin, punicalagin, 1,3,6-tri-O-galloyl-beta-D-glucopyranose, chebulagic acid and 1,2,3,4,6-penta-O-galloyl-beta-D-glucopyranose. All compounds exhibited antibacterial activity against *Staphylococcus aureus* (MIC values of 128-1024 ug/ml). Only corilagin was active against *Escherichia coli* and *Klebsiella pneumoniae* (MIC values of 1024 ug/ml for both bacteria), whereas both corilagin and punicalagin were active against *Pseudomonas aeruginosa* (MIC value of 1024 ug/ml). Except for 1,3,6-tri-O-galloyl-beta-D-glucopyranose, all compounds exhibited antifungal activity against *Candida albicans* (MIC values of 512-1024 ug/ml). [Burapadaja, *et al*]

Terminalia bellerica
A bioactivity-guided fractionation of an extract of fruit rind of *T. bellerica* [*T. bellirica*] led to the isolation of 2 new lignans named termilignan and thannilignan, together with 7-hydroxy-3',4'-(methylenedioxy)flavan and anolignan B. All 4 compounds exhibited anti-HIV [human immunodeficiency virus]-1, antimalarial (against *Plasmodium falciparum* strain 3D7) and antifungal (against *Penicillium expansum* and *Candida albicans*) activities in vitro. [Raghavan Valsaraj, *et al*]

Terminalia spinosa
Extracts of the stem bark of *T. spinosa* were investigated for antibacterial and antifungal activity. The extracts were active against *H. pylori in vitro*, with the following min.

inhibitory concn (MIC): MIC50 of 125 mg/litre, MIC90 of 250 mg/litre and MIC-range of 62.5-500 mg/litre. *Candida* spp. (*C. albicans*, *C. krusei*, *C. guilliermondii*, *C. tropicalis*, *C. glabrata* [*Torulopsis glabrata*] and *C. parapsilosis*) showed a similar susceptibility. It is concluded that the plant is a source of antimicrobial compounds with therapeutic potential. [Fabry *et al*]

Thymus vulgaris

The preservative properties of thyme essential oil with a known composition were evaluated in 2 types of final formulations, suitable for use as pharmaceutical or cosmetic vehicles, by means of a standard challenge test (against *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Aspergillus niger* and *Candida albicans*) proposed by the latest European Pharmacopoeia (1996). The formulations tested were a simple oil in water cream (O/W), and a simple water in oil cream (W/O) [compositions given] each with 3% thyme essential oil. The required preservation efficacy criteria were satisfied against the bacterial strains, against the yeast in 1 of the formulations (W/O), but not against the mould strain. Interactions between the essential oil compounds and other factors present in the final formulation might have influenced the activity of this essential oil, leading to an incomplete satisfaction of the criteria. [Manou, *et al*]

***Trichocolea* spp.**

The main cytotoxic component in New Zealand collections of *Trichocolea mollissima* was identified as methyl 4-[(5-oxogeranyl)oxy]-3-methoxybenzoate. Reinvestigation of the benzoates from Japanese collections of *Trichocolea tomentella* led to the identification of 4 geranyl ethers, which had previously been assigned incorrect geranyl ester structures. One compound, previously reported as a 3,3-dimethylallyl ester, could not be re-isolated from *Trichocolea tomentella*, but was found in a New Zealand collection of *Trichocolea lanata*. It was shown to be a 3,3-dimethylallyl ether by synthesis from methyl vanillate. Several of these compounds exhibited activity against monkey kidney cells, *Candida albicans* and *Trichophyton mentagrophytes*. [Perry, *et al*].

Vernonia amygdalina

Vernolepin and vernodalin were isolated from leaves of *Vernonia amygdalina* (collected from Sudan). Both compounds exhibited activity against a panel of bacteria (*Bacillus subtilis*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Escherichia coli*) and fungi (*Aspergillus niger* and *Candida albicans*). [Al-Magboul, *et al*]

Conclusions

The studies in this period show that there is great scope for a natural preservative to be developed for the cosmetic and toiletry industry. The period from 1999 to 2003 is in the process of being reviewed and will be the subject of an update in the not too distant future.

It can be seen that many of the plants that we were recognised as being antiseptics or are used for various infections have proven efficacy when examined microbiologically.

References

Aboutabl, EA; Sokkar, NM; Megid, RMA; Pooter, HL de; Masoud, H. Composition and antimicrobial activity of Otostegia fruticosa Forssk. oil. Journal of Essential Oil Research (1995) 7(3): 299-303.

Al-Bagieh, NH; Idowu, A; Salako, NO. Effect of aqueous extract of miswak on the *in vitro* growth of *Candida albicans*. Microbios (1994) 80(323): 107-113.

Al-Magboul, AZI; Bashir, AK; Khalid, SA; Farouk, A. Antimicrobial activity of vernolepin and vernodalin. Fitoterapia (1997) 68(1): 83-84.

Ali-Shtayeh, M. S., Al-Nuri, M. A., Yaghmour, R. M. R., Faidi, Y. R. Antimicrobial activity of *Micromeria nervosa* from the Palestinian area. Journal of Ethnopharmacology 1997, 58, 3, 143-147

Artizzu, N; Bonsignore, L; Cottiglia, F; Loy, G. Studies on the diuretic and antimicrobial activity of *Cynodon dactylon* essential oil. Fitoterapia (1996) 67(2): 174-176

Aurore, G. S., Abaul, J., Bourgeois, P., Luc, J Antibacterial and antifungal activities of the essential oils of *Pimenta racemosa* var. *racemosa* P.Miller (J.W.Moore) (Myrtaceae) Journal of Essential Oil Research. 1998, 10, 2, 161-164.

Bagci, E; Digrak, M. Antimicrobial activity of essential oils of some *Abies* (fir) species from Turkey. Flavour and Fragrance Journal (1996) 11(4): 251-256.

Bashir, AK; Abdalla, AA; Wasfi, IA; Hassan, ES; Amiri, MH; Crabb, TA. Flavonoids of Limonium axillare. International Journal of Pharmacognosy (1994) 32(4): 366-372.

Bashir, AK; Abdalla, AA; Hassan, ES; Wasfi, IA; Amiri, MA; Crabb, TA. Alkaloids with antimicrobial activity from the root of Rhazya stricta Decn. growing in United Arab Emirates. Arab Gulf Journal of Scientific Research (1994) 12(1): 119-131.

Bergeron, C; Marston, A; Wolfender, JL; Mavi, S; Rogers, C; Hostettmann, K. Isolation of polyphenols from *Polygala gazensis* and liquid chromatography-mass spectrometry of related African Polygala species. Phytochemical Analysis (1997) 8(1): 32-36.

Binutu, OA; Adesogan, KE; Okogun, JI. Antibacterial and antifungal compounds from *Kigelia pinnata*. Planta Medica (1996) 62(4): 352-353.

Braghiroli, L; Mazzanti, G; Manganaro, M; Mascellino, MT; Vespertilli, T.: Antimicrobial activity of *Calluna vulgaris*. Proceedings of the VIII Congresso nazionale della Societa Italiana di Farmacognosia and 1st joint meeting of Belgian, Dutch, Spanish and Italian research groups on pharmacognosy, Naples, Italy, 9-14 June 1996 [edited by Capasso, F.; Evans, F. J.; Mascolo, N.]. Phytotherapy Research (1996) 10(Supplement 1): S86-S88.

Burapadaja, S; Bunchoo, A. Antimicrobial activity of tannins from *Terminalia citrina*. Planta Medica (1995) 61(4): 365-366.

Calis, I; Satana, ME; Yuruker, A; Kelican, P; Demirdamar, R; Alacam, R; Tanker, N; Ruegger, H; Sticher, O. Triterpene saponins from *Cyclamen mirabile* and their biological activities. Journal of Natural Products (1997) 60(3): 315-318.

Carson, CF; Riley, TV. Antimicrobial activity of the major components of the essential oil of Melaleuca alternifolia. Journal of Applied Bacteriology (1995) 78(3): 264-269.

Chakraborty, A; Saha, C; Podder, G; Chowdhury, BK; Bhattacharyya, P. Carbazole alkaloid with antimicrobial activity from *Clausena heptaphylla*. Phytochemistry (1995) 38(3): 787-789.

Chakraborty, A; Chowdhury, BK; Bhattacharyya, P. Clausenol and clausenine - two carbazole alkaloids from *Clausena anisata*. Phytochemistry (1995) 40(1): 295-298.

Chanegriha, N., Foudil-Cherif, Y., Baailouamer, A., Meklati, B. Y.: Antimicrobial activity of Algerian cyprus and eucalyptus essential oils. Rivista Italiana EPPOS 1998 No. 2511-16

Charchari, S; Dahoun, A; Bachi, F; Benslimani, A. In vitro antimicrobial activity of essential oils of *Artemisia herba-alba* and *Artemisia judaica* from Algeria. Rivista Italiana EPPOS (1996) (No. 18): 3-6.

Chukwurah, BKC. Antimicrobial activity of *Holarrhena floribunda* stem bark ethanol extract. Fitoterapia (1997) 68(2): 180-181.

Cichewicz, RH; Thorpe, PA. The antimicrobial properties of chile peppers (Capsicum species) and their uses in Mayan medicine. Journal of Ethnopharmacology (1996) 52(2): 61-70.

Cimanga, K., Bruyne, T. de. Pieters, L., Totte, J., Tona, L., Kambu, K., Berghe, D. vanden, Vlietinck, A. J.: Antibacterial and antifungal activities of neocryptolepine, biscryptolepine and cryptoquindoline, alkaloids isolated from *Cryptolepis sanguinolenta*. Phytomedicine 1998, 5, 3, 209-214.

Citoglu, G., Tanker, M., Sever, B., Englert, J., Anton, R., Altanlar, N.: Antibacterial activities of diterpenoids isolated from *Ballota saxatilis* subsp. *saxatilis*. Planta Medica 1998, 6, 45, 484-485

Delle Monache, G; Botta, B; Vinciguerra, V; Mello, JF de; Andrade Chiappeta, A de. Antimicrobial isoflavanones from *Desmodium canum*. Phytochemistry (1996) 41(2): 537-544.

Dulger, B., Gucin, F., Aslan, A. Antimicrobial activity of the lichen Cetraria islandica (L.) Ach. Cetraria islandica (L.) Ach. likeninin antimikrobiyal aktivitesi.Turkish Journal of Biology 1998, 221, 111-118.

Ebi, GC; Ofoefule, SI. Investigations into the folkloric antimicrobial activities of *Landolphia owrrience*. Phytotherapy Research (1997) 11(2): 149-151.

Ekabo, OA; Farnsworth, NR; Henderson, TO; Mao GuoHua; Mukherjee, R. Antifungal and molluscicidal saponins from *Serjania salzmanniana*. Journal of Natural Products (1996) 59(4): 431-435.

Ekpa, OD; Ebana, RUB. Comparative studies of mmanyanga, palm and coconut oils: antimicrobial effects of the oils and their metallic soaps on some bacteria and fungi. Global Journal of Pure and Applied Sciences (1996) 2(2): 155-163.

El-Alfy, TS; El-Tanbouly, ND; Sokkar, NM. Naphthoquinones of *Arnebia tinctoria* (Forssk). Egyptian Journal of Pharmaceutical Sciences (1996) 37(1/6): 65-70.

El-Sakhawy, F. S., El-Tantawy, M. E., Ross, S. A., El-Sohly, M. A Composition and antimicrobial activity of the essential oil of *Murraya exotica* L. Flavour and Fragrance Journal. 1998, 13, 1, 59-62.

Emam, AM; Moussa, AM; Faure, R; Favel, A; Delmas, F; Elias, R; Balansard, G. Isolation and biological study of a triterpenoid saponin, mimengoside A, from the leaves of *Buddleja madagascariensis*. Planta Medica (1996) 62(1): 92-93.

Emam, AM; Diaz-Lanza, AM; Matellano-Fernandez, L; Faure, R; Moussa, AM; Balansard, G. Biological activities of buddlejasaponin isolated from *Buddleja madagascariensis* and *Scrophularia scorodonia*. Pharmazie (1997) 52(1): 76-77.

Encarnacion-Dimayuga, R., Almada, G., Virgen, M.: Minimum antimicrobial inhibitory concentration of carnosol and of the ethanol extract from *Lepechinia hastata* (Lamiaceae). Phytomedicine, 1998, 5, 4, 301-305.

Ezer, N; Abbasoglu, U. Antimicrobial activity of essential oils of some *Sideritis* species growing in Turkey. Fitoterapia (1996) 67(5): 474-475.

Fabry, W; Okemo, P; Mwatha, WE; Chhabra, SC; Ansorg, R. Susceptibility of *Helicobacter pylori* and *Candida* spp. to the East African plant *Terminalia spinosa*. Arzneimittel Forschung (1996) 46(5): 539-540.

Ferreira, MJU; Duarte, A; Ascenso, JR. Antimicrobial activity and phytochemical study of *Euphorbia tuckeyana*. Fitoterapia (1996) 67(1): 85-86.

Fuzzati, N; Sutarjadi; Dyatmiko, W; Rahman, A; Hostettmann, K. Phenylpropane derivatives from roots of *Cosmos caudatus*. Phytochemistry (1995) 39(2): 409-412.

Gafner, S; Wolfender, JL; Nianga, M; Stoeckli-Evans, H; Hostettmann, K. Antifungal and antibacterial naphthoquinones from *Newbouldia laevis* roots. Phytochemistry (1996) 42(5): 1315-1320.

Galal, AM. Antimicrobial activity of 6-paradol and related compounds. International Journal of Pharmacognosy (1996) 34(1): 64-69.

Garcia Cortez, D. A., Young, M. C. M., Marston, A., Wolfender, J. L., Hostettmann, K.: Xanthones, triterpenes and a biphenyl from *Kielmeyera coriacea*. Phytochemistry 1998 47 7 1367-1374

Garo, E; Maillard, M; Antus, S; Mavi, S; Hostettmann, K. Five flavans from *Mariscus psilostachys*. Phytochemistry (1996) 43(6): 1265-1269.

Giordani, R; Cardenas, ML; Moulin-Traffort, J; Regli, P. Fungicidal activity of latex sap from *Carica papaya* and antifungal effect of D(+)-glucosamine on *Candida albicans* growth. Mycoses (1996) 39(3-4): 103-110.

Gollapudi, SR; Telikepalli, H; Jampani, HB; Mirhom, YW; Drake, SD; Bhattiprolu, KR; Velde, DV; Mitscher, LA. Alectosarmentin, a new antimicrobial dibenzofuranoid lactol from the lichen, *Alectoria sarmentosa*. Journal of Natural Products (1994) 57(7): 934-938.

Guerrera, PM; Leporatti, ML; Foddai, S; Moretto, D; Mercantini, R. Antimycotic activity of [the] essential oil of *Lippia citriodora* Kunt (*Aloysia triphylla* Britton). Rivista Italiana EPPOS (1995) (No. 15): 23-25.

Gunasekera, LS; Wright, AE; Gunasekera, SP; McCarthy, P; Reed, J. Antimicrobial constituent of the brown alga Sporochnus pedunculatus. International Journal of Pharmacognosy (1995) 33(3): 253-255.

Gundidza, M; Chinyanganya, F; Chagonda, L; Pooter, HL de; Mavi, S. Phytoconstituents and antimicrobial activity of the leaf essential oil of *Clausena anisata* (Willd.) J.D. Hook ex. Benth. Flavour and Fragrance Journal (1994) 9(6): 299-303.

Haraguchi, H; Kuwata, Y; Inada, K; Shingu, K; Miyahara, K; Nagao, M; Yagi, A. Antifungal activity from *Alpinia galanga* and the competition for incorporation of unsaturated fatty acids in cell growth. Planta Medica (1996) 62(4): 308-313.

He, X; Mocek, U; Floss, HG; Caceres, A; Giron, L; Buckley, H; Cooney, G; Manns, J; Wilson, BW. An antifungal compound from Solanum nigrescens. Journal of Ethnopharmacology (1994) 43(3): 173-177.

Hiremath, SP; Swamy, HKS; Shrishailappa Badami; Purohit, MG. Antibacterial, antifungal and anthelmintic activity of various extracts of Striga lutea. Fitoterapia (1994) 65(4): 372-374.

Iauk, L; Aleo, G; Caccamo, F; Rapisarda, A; Ragusa, S; Speciale, AM. Antibacterial and antimycotic activities of *Daphne gnidium* L. leaf extracts. Proceedings of the VIII Congresso nazionala della Societa Italiana di Farmacognosia and 1st joint meeting of Belgian, Dutch, Spanish and Italian research groups on pharmacognosy, Naples, Italy, 9-14 June 1996 [edited by Capasso, F.; Evans, F. J.; Mascolo, N.]. Phytotherapy Research (1996) 10(Supplement): S166-S168.

Iauk, L., Caccamo, F., Speciale, A. M., Tempera, G., Ragusa, S., Pante, G.: Antimicrobial activity of *Rhus coriaria* L. leaf extract. Proceedings of the second international symposium on natural drugs, Maretea, Italy, 28 September-1 October, 1997 [edited by Capasso, F.; Basso, F.; Pasquale, R. de; Evans, F. J.; Mascolo, N.]. Phytotherapy Research,1998, 12, Supplement 1, S152-S153.

Ioset, J. R., Marston, A., Gupta, M. P., Hostettmann, K Antifungal and larvicidal meroterpenoid naphthoquinones and a naphthoxirene from the roots of *Cordia linnaei* Phytochemistry. 1998, 47, 5, 729-734.

Irobi, ON; Moo-Young, M; Anderson, WA; Daramola, SO. Antimicrobial activity of bark extracts of Bridelia ferruginea (Euphorbiaceae). Journal of Ethnopharmacology (1994) 43(3): 185-190.

Irobi, ON; Moo-Young, M; Anderson, WA. Antimicrobial activity of Annatto (*Bixa orellana*) extract. International Journal of Pharmacognosy (1996) 34(2): 87-90.

Ivanovska, N; Philipov, S; Istatkova, R; Georgieva, P. Antimicrobial and immunological activity of ethanol extracts and fractions from *Isopyrum thalictroides*. Journal of Ethnopharmacology (1996) 54(2/3): 143-151.

Kalodera, Z; Pepeljnjak, S; Petrak, T. The antimicrobial activity of *Tanacetum parthenium* extract. Pharmazie (1996) 51(12): 995-996.

Kedzia, B; Krzyzaniak, M; Holderna-Kedzia, E; Segiet-Kujawa, E. Composition and antimicrobial characteristics of Ol. Melissae and its components. Herba Polonica (1994) 40(1-2): 5-11.

Kirmizigul, S; Anil, H; Ucar, F; Akdemir, K. Antimicrobial and antifungal activities of three new triterpenoid glycosides. Phytotherapy Research (1996) 10(3): 274-276.

Koketsu, M; Kim, M; Yamamoto, T. Antifungal activity against food-borne fungi of *Aspidistra elatior* Blume. Journal of Agricultural and Food Chemistry (1996) 44(1): 301-303.

Koyama, S., Yamaguchi, Y., Tanaka, S., Motoyoshiya, J. A new substance (yoshixol) with an interesting antibiotic mechanism from wood oil of Japanese traditional tree (Kiso-Hinoki), *Chamaecyparis obtusa*. General Pharmacology 1997, 28, 5, 797-804

Kwo, VT; Craker, LE. Screening Cameroon medicinal plant extracts for antimicrobial activity. International symposium on medicinal and aromatic plants, Amherst, Massachusetts, USA, 27-30 Aug. 1995 [edited by Craker, L. E.; Nolan, L.; Shetty, K.]. Acta Horticulturae (1996) (No. 426): 147-155. ISBN 90-6605-808-0

Larhsini, M; Lazrek, HB; Amarouch, H; Jana, M. Investigation of antifungal and analgesic activities of extracts from *Sium nodiflorum*. Journal of Ethnopharmacology (1996) 53(2): 105-110.

Li, EG; Clark, AM; Hufford, CD. Antifungal evaluation of pseudolaric acid B, a major constituent of Pseudolarix kaempferi. Journal of Natural Products (1995) 58(1): 57-67.

Ma, WG; Fuzzati, N; Li, QS; Yang, CR; Stoeckli-Evans, H; Hostettmann, K. Polyphenols from *Eriosema tuberosum*. Phytochemistry (1995) 39(5): 1049-1061.

Ma WeiGuang; Fuzzati, N; Xue Yun; Yang ChongRen; Hostettmann, K. Four chromones from *Eriosema tuberosum*. Phytochemistry (1996) 41(5): 1287-1291.

Ma WeiGuang; Fuzzati, N; Lu ShaoLong; Gu DeShun; Hostettmann, K. Further chromones from *Eriosema tuberosum*. Phytochemistry (1996) 43(6): 1339-1343.

Madubunyi, II; Obi, SKC; Nwebube, NI; Chime, AB. Antihepatotoxic and antimicrobial activities of Harungana madagascariensis leaf extracts. International Journal of Pharmacognosy (1995) 33(2): 129-134.

Madubunyi, II. Antimicrobial activities of the constituents of Garcinia kola seeds. International Journal of Pharmacognosy (1995) 33(3): 232-237. [En, 13 ref.] [Department of Veterinary Physiology and Pharmacology, Faculty of Veterinary Medicine, University of Nigeria, Nsukka, Nigeria.]

Manou, I., Bouillard, L., Devleeschouwer, M. J., Barel, A. O.: Evaluation of the preservative properties of *Thymus vulgaris* essential oil in topically applied formulations under a challenge test. Journal of Applied Microbiology 1998, 84, 3, 368-376

Martinez-Vazquez, M; Martinez, R; Espinosa Perez, G; Diaz, M; Herrera Sanchez, M. Antimicrobial properties of argentatine A, isolated from Parthenium argentatum. Fitoterapia (1994) 65(4): 371-372.

Matsuura, H; Saxena, G; Farmer, SW; Hancock, REW; Towers, GHN. Antibacterial and antifungal polyine compounds from *Glehnia littoralis* ssp. *leiocarpa*. Planta Medica (1996) 62(3): 256-259.

Mazzanti, G., Battinelli, L., Salvatore, G.: Antimicrobial properties of the linalol-rich essential oil of *Hyssopus officinalis* L. var *decumbens* (Lamiaceae). Flavour and Fragrance Journal,1998, 13, 5, 289-294.

Miguel, OG; Lima, EO; Morais, VMF; Gomes, STA; Delle Monache, F; Cruz, AB; Cruz, RCB; Cechinel Filho, V. Antimicrobial activity of constituents isolated from *Lychnophora salicifolia* (Asteraceae). Phytotherapy Research (1996) 10(8): 694-696.

Mukherjee, PK; Kahahi Saha; Saha, BP; Pal, M; Das, J. Antifungal activities of the leaf extract of *Cassia tora* Linn. (Fam. Leguminosae). Phytotherapy Research (1996) 10(6): 521-522.

Mwangi, JW; Njonge, EW; Addea-Mensah, I; Munavu, RW; Lwande, W. Antimicrobial activity of essential oil of *Lippia* species in Kenya. Discovery and Innovation (1994) 6(1): 58-60.

Ndounga, M; Ouamba, JM. Antibacterial and antifungal activities of essential oils of *Ocimum gratissimum* and *O. basilicum* from Congo. Fitoterapia (1997) 68(2): 190-191.

Oger, JM; Richomme, P; Guinaudeau, H; Bouchara, JP; Fournet, A. Aniba canelilla (H.B.K.) Mez essential oil: analysis of chemical constituents, fungistatic properties. Journal of Essential Oil Research (1994) 6(5): 493-497.

Ohiri, FC; Okelu, VC. Antimicrobial properties of *Mitracarpus villosus* leaf. Fitoterapia (1997) 68(3): 287-288.

Okunade, AL; Hufford, CD; Clark, AM; Lentz, D. Antimicrobial properties of the constituents of *Piper aduncum*. Phytotherapy Research (1997) 11(2): 142-144.

Omer, E. A., Khattab, M. E., Ibrahim, M. E.: First cultivation trial of *Perilla frutescens* L. in Egypt., Flavour and Fragrance Journal,1998,13,4,221-225.

Onah, JO; Ntiejumokun, S; Ayanbimpe, G. Antifungal properties of an aqueous extract of *Sansevieria zeylanica*. Medical Science Research (1994) 22(2): 147-148.

Penna, C. A., Marino, S., Gutkind, G. O., Clavin, M., Ferraro, G., Martino, V. Antimicrobial activity of *Eupatorium* species growing in Argentina. Journal of Herbs, Spices & Medicinal Plants 1997, 5, 2, 21-28.

Perry, NB; Foster, LM; Lorimer, SD; May, BCH; Weavers, RT; Toyota, M; Nakaishi, E; Asakawa, Y. Isoprenyl phenyl ethers from liverworts of the genus *Trichocolea*: cytotoxic activity, structural corrections, and synthesis. Journal of Natural Products (1996) 59(8): 729-733.

Podolak, I., Elas, M., Cieszka, K.: In vitro antifungal and cytotoxic activity of triterpene saponosides and quinoid pigments from *Lysimachia vulgaris* L. Proceedings of the second international symposium on natural drugs, Maretea, Italy, 28 September-1 October, 1997 [edited by Capasso, F.; Basso, F.; Pasquale, R. de; Evans, F. J.; Mascolo, N.]. Phytotherapy Research, 1998, 12, Supplement 1, S70-S73.

Pooter, HL de; Aboutabl, EA; El-Shabrawy, AO. Chemical composition and antimicrobial activity of essential oil of leaf, stem and rhizome of Alpinia speciosa (J.C. Wendl) K. Schum. Grown in Egypt. Flavour and Fragrance Journal (1995) 10(2): 63-67.

Prudent, D; Perineau, F; Bessiere, JM; Michel, GM; Baccou, JC. Analysis of the essential oil of wild oregano from Martinique (Coleus aromaticus Benth.) - evaluation of its bacteriostatic and fungistatic properties. Journal of Essential Oil Research (1995) 7(2): 165-173.

Quale, JM; Landman, D; Zaman, MM; Burney, S; Sathe, SS. In vitro activity of *Cinnamomum zeylanicum* against azole resistant and sensitive *Candida* species and a pilot study of cinnamon for oral candidiasis. American Journal of Chinese Medicine (1996) 24(2): 103-109.

Raghavan Valsaraj; Palpu Pushpangadan; Smitt, UW; Adsersen, A; Christensen, SB; Sittie, A; Nyman, U; Nielsen, C; Olsen, CE. New anti-HIV-1, antimalarial, and antifungal compounds from *Terminalia bellerica*. Journal of Natural Products (1997) 60(7): 739-742.

Rath, G; Ndonzao, M; Hostettmann, K. Antifungal anthraquinones from Morinda lucida. International Journal of Pharmacognosy (1995) 33(2): 107-114.

Rath, G; Potterat, O; Mavi, S; Hostettmann, K. Xanthones from *Hypericum roeperanum*. Phytochemistry (1996) 43(2): 513-520. [English, 26 ref.] [Institut de Pharmacognosie et Phytochimie, Universite de Lausanne, BEP, CH-1015, Lausanne, Switzerland.]

Rodriguez, S; Wolfender, JL; Hakizamungu, E; Hostettmann, K. An antifungal naphthoquinone, xanthones and secoiridoids from *Swertia calycina*. Planta Medica (1995) 61(4): 362-364.

Roth, G. N., Amitabh Chandra, Nair, M. G.: Novel bioactivities of *Curcuma longa* constituents. Journal of Natural Products 1998, 61, 4, 542-545

Saeed, A; El-Eraqy, W. Glabratephrin from *Tephrosia nubica* seeds and biological evaluation. Egyptian Journal of Pharmaceutical Sciences (1996) 37(1/6): 621-628.

Sarg, TM; El-Dahmy, SI; Ateya, AM; Abdel-Fattah, HA. Two new bisabolone hydroperoxides and biological activity of Asteriscus graveolens. Fitoterapia (1994) 65(3): 241-244.

Sarkar, GM; Banerjee, RD; Chatterjee, ML; Dutta, S; Ghosh, A. Antimicrobial and insecticidal activity of an aquatic alga *Chara zeylanica* Klein ex Willd. International Journal of Environmental Studies (1995) 48(1): 29-39.

Serkedjieva, J. Antiinfective activity of a plant preparation from *Geranium sanguineum* L. Pharmazie 1997, 52, 10, 799-802.

Shetty, RS; Singhal, RS; Kulkarni, PR. Antimicrobial properties of cumin. World Journal of Microbiology & Biotechnology (1994) 10(2): 232-233.

Singh, HB; Srivastava, M; Singh, AB; Srivastava, AK. Cinnamon bark oil, a potent fungitoxicant against fungi causing respiratory tract mycoses. Allergy (Copenhagen) (1995) 50(12): 995-999.

Smirnov, V. V., Bondarenko, A. S., Prikhodko, V. A Antimicrobial activity of sesquiterpene phenol from *Bidens cernua.* Fitoterapia. 1998, 69, 1, 84-85.

Stassi, V; Verykokidou, E; Loukis, A; Harvala, C; Philianos, S. The antimicrobial activity of the essential oils of four *Juniperus* species growing wild in Greece. Flavour and Fragrance Journal (1996) 11(1): 71-74.

Suresh, B; Sriram, S; Dhanaraj, SA; Elango, K; Chinnaswamy, K. Anticandidal activity of *Santolina chamaecyparissus* volatile oil. Journal of Ethnopharmacology (1997) 55(2): 151-159.

Swiader, K; Lamer-Zarawska, E. Flavonoids of rare *Artemisia* species and their antifungal properties. Fitoterapia (1996) 67(1): 77-78.

Swiader, K., Krzyzanowska, J Chemical composition of essential oil of *Artemisia selengensis* Turcz. and *Artemisia stolonifera* Maxim and their antifungal properties. VIth Conference on the application of chromatographic methods in phytochemical and biomedical research, Lublin, Poland, 19-21 June, 1997. Herba Polonica. 1997, 43, 4, 434-436.

Tan, RX; Wolfender, JL; Ma, WG; Zhang, LX; Hostettmann, K. Secoiridoids and antifungal aromatic acids from *Gentiana algida*. Phytochemistry (1996) 41(1): 111-116.

Tan, RX; Wolfender, JL; Zhang, LX; Ma, WG; Fuzzati, N; Marston, A; Hostettmann, K. Acyl secoiridoids and antifungal constituents from *Gentiana macrophylla*. Phytochemistry (1996) 42(5): 1305-1313.

Tan, R. X., Kong, L. D., Wei, H. X.: Secoiridoid glycosides and an antifungal anthranilate derivative from *Gentiana tibetica*. Phytochemistry 1998, 47, 7, 1223-1226.

Tan, R. X., Tang, H. Q., Hu, J., Shuai, B.: Lignans and sesquiterpene lactones from *Artemisia sieversiana* and *Inula racemosa*. Phytochemistry, 1998, 49, 1, 157-161.

Tirillini, B; Velasquez, ER; Pellegrino, R. Chemical composition and antimicrobial activity of essential oil of *Piper angustifolium*. Planta Medica (1996) 62(4): 372-373.

Ulubelen, A; Topcu, G; Tan, N; Olcal, S; Johansson, C; Ucer, M; Birman, H; Tamer, S. Biological activities of a Turkish medicinal plant, *Prangos platychlaena*. Journal of Ethnopharmacology (1995) 45(3): 193-197.

Urzua, A; Torres, R; Munoz, M; Palacios, Y. Comparative antimicrobial study of the resinous exudates of some Chilean Haplopappus (Asteraceae). Journal of Ethnopharmacology (1995) 45(1): 71-74.

Wassel, G; Saeed, A; Ibrahim, N; El-Eraqy, W. Flavonoids of *Nelumbo nucifera* Gaertn and biological evaluation. Egyptian Journal of Pharmaceutical Sciences (1996) 37(1/6): 585-595.

Williams, L; Home, V. A comparative study of some essentials oils for potential use in topical applications for the treatment of the yeast *Candida albicans*. Australian Journal of Medical Herbalism (1995) 7(3): 57-62.