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Review Article

Ylang-Ylang (Cananga odorata) - More than Just a Pretty Aroma

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Abstract

Ylang-ylang essential oil is one of the few essential oils extracted from mature flowers and exploited on a large scale. It is distilled from the flowers of *Cananga odorata*, commonly known as the *Cananga* tree but also as fragrant *Cananga*. Four grades or levels of yang-ylang essential oil are commercially available, namely extra, first, second and third. The distillation time is a determinant of the grade of the extracted oil and the oils vary in the intensity of their scent and have different commercial applications.

Ylang-ylang essential oil, sometimes referred to as *Cananga odorata* essential oil, is comprised of monoterpenes, terpenic and sesquiterpenic alcohols, sesquiterpene hydrocarbons, acetates, benzoates and phenols, with some differences in the percentages of the specific ingredient content of the 4 grades of oil.

Despite numerous anecdotal reports of the health benefits of ylang-ylang essential oil, there is little scientific literature supporting many of these claims. Ylang-ylang essential oil has long been used in aromatherapy for relaxation and for mood adjustment and although many aromatherapy benefits with ylang-ylang may be anecdotal, there is increasing research evidence to support the mental health and mood benefit claims. Studies indicate that ylang-ylang oil does have a relaxing effect, and there is evidence that aromatherapy with the essential oil achieved some relief of depression and stress. In fact, compared to controls, inhalation of ylang-ylang caused a reduction of heart rate and blood pressure and relief of the arousal level in healthy men.

Studies performed on mice found that ylang-ylang essential oil affected serotonin metabolism in the brain and reduced the blood plasma corticosterone level of the m-CPP-treated mice. It was concluded that the anxiolytic effect was associated with the ERK1/2/CREB pathway in the hippocampus and effects on the serotonin system.

The findings from the various human and animal studies suggest that ylang-ylang essential oil inhalation may be beneficial as an anxiolytic and possibly be valuable for sufferers from PTSD.

Research studies indicate that lignan dicarboxylates and terpenoids extracted from the flower buds of ylang-ylang exhibit a potent inhibitory effect on cell melanogenesis and immune-system cytotoxicity when tested on cancerous melanoma skin cells. This suggests that antioxidants in ylang-ylang oil can help protect skin cells from oxidative stress and DNA damage that can lead to cancer cell formation.

Keywords: *Ylang-Ylang; Cananga odorata; Aroma*

Introduction

Ylang-ylang essential oil is one of the few essential oils extracted from mature flowers and exploited on a large scale. It is distilled from the flowers of *Cananga odorata*, commonly known as the *Cananga* tree but also as fragrant *Cananga*, the Macassar-oil plant and the perfume tree. This tree is native to India and throughout parts of Indochina, the Malay peninsula, the Philippines, Indonesia and even as far south as Queensland, Australia.

The primary value of the tree lies in the various types of essential oil extracted from its flowers by steam distillation and four grades or levels of oil are commercially available, namely extra, first, second and third [1]. The distillation time is a determinant of the grade of the extracted oil and the oils vary in the intensity of their scent and have different commercial applications. Ylang-ylang extra has the most powerful scent, but this aroma dissipates quickly whereas essential oils numbered 1, 2 or 3 have progressively less potent scents but their aromas are denser and longer lasting. *Cananga* oil (ylang-ylang #3) has the subtlest scent. It should be noted that "complete" ylang-ylang essential oil contains all four scent levels.

Ylang-ylang extra is the most potent essential oil derived from the flower and is the "top note" in the classic Chanel No. 5 perfume. Apparently at the Paris introduction of Chanel No.5 in 1923, Coco Chanel said, "I wanted a perfume that is composed - not hints of roses or lilies of the valley. A woman's perfume - redolent, evocative of a woman. A perfume unlike any other ever made. The ideal scent for a woman". Apart from *the* alcohol and added power of its oils, the smell of the perfume is nearly identical to that of the ylang-ylang tree. Consequently, the ylang-ylang tree is sometimes referred to as the Chanel No.5 Perfume Tree. *This* perfume reference to *Cananga odorata* is not unique since *Magnolia champaca* (formerly *Michelia champaca*) but also known as champak, champac or the champaca tree is the source of the essential oil used in JOY perfume and is known as the JOY Perfume tree.

The less potent essential oils distilled from *Cananga odorata* are used as "medium-to-base notes" in various perfumes, colognes, lotions and soaps as well as a food flavorant [2].

Composition of ylang-ylang essential oil

Ylang-ylang essential oil, sometimes referred to as *Cananga odorata* essential oil, is comprised of monoterpenes, terpenic and sesquiterpenic alcohols, sesquiterpene hydrocarbons, acetates, benzoates and phenols, with some differences in the percentages of the specific ingredient content of the 4 grades of oil.

The 4 commercial grades of ylang-ylang essential arise from fractionation based on distillation times, and they differ in their chemical compositions. The first fraction (1st grade) is richer in very volatile compounds like esters, aldehydes or alcohols whereas the last fraction (4th grade) is richer in less volatile compounds like sesquiterpenes [3].

The compounds in ylang-ylang essential oil, First or 1st Grade, have been identified by GC-MS and other methodologies following steam distillation and fractionation [1]. The components of the oxygenated fraction of the Ylang-Ylang essential oil, First Grade, are indicated in table 1 whereas the monoterpenes and sesquiterpenes identified from the hydrocarbon fraction of this oil are shown in table 2 [1]. The oxygenated fraction constitutes 67.0% and the hydrocarbon fraction represents 33.0% of the essential oil. It is interesting that determining the sesquiterpene hydrocarbon composition of ylang-ylang was once used to characterize the authenticity of the oil and to detect possible adulteration with basil essential oil [1,4,5]. Modern analytical techniques have greatly facilitated the detection and identification of adulterants.

Compound	Content, %
Linalool	19.0
p-Methylanisole	10.0
Benzyl benzoate	10.0
Geranyl acetate	15.0
Benzyl acetate	10.0
Methyl benzoate	5.0

Table 1: *Principal components identified from the oxygenated fraction of ylang-ylang 1st grade essential oil [1].*

Compound	Content, %
β-Caryophyllene	12.0
Germacrene D	18.0
α-Humulene ε-Cadinene	8.4
γ-Cadinene α-Farnesene	8.1
δ-Cadinene	7.1
α-Muurolene	3.3
α-Muurolened	3.0

Table 2: *Principal monoterpenes and sesquiterpenes identified from the hydrocarbon fraction of ylang-ylang 1st grade essential oil [1].*

A more recent study has identified and confirmed the same principal constituents of ylang-ylang essential oil [6]. What is interesting about this study is that it showed that the percentages of the components of the essential oil will vary with the extraction method[1] which in the study were steam distillation (SD), simultaneous distillation and solvent extraction (SDE) and supercritical CO_2 (SFE) (Table 3). In particular, it was found that oxygenated compounds comprised 85% of the composition of SDE extracts whereas heavy hydrocarbons (C_n >20) and fatty acids were found only in the SFE extracts. The latter also had a higher content of nitrogenated compounds, notably phenylacetonitrile, 4-methylbenzaldoxime, indole, 2-phenyl-nitroethane, and methyl anthranilate. It was found that the sesquiterpenes content was 43% in SFE extracts compared to 19.5% in SD and 8.1% in SDE extracts. On the other hand, the content of monoterpenes and light oxygenated compounds was 1.5 - 2 times lower than for the SD (49.7%) and SDE (64.5%) extracts.

Constituent	Steam distillation	Simultaneous distillation-solvent	Supercritical CO_2
Linalool	20.7	28.0	16.5
Germacrene-D	10.1	3.1	20.3
Benzyl benzoate	14.1	2.9	3.9
Benzyl acetate	9.6	17.0	6.2
Caryophyllene	3.1	2.9	3.9
p-Methylanisole	6.8	6.1	2.7

Table 3: *Principal constituents of ylang-ylang obtained by different extraction methods [5].*

The findings of this study clearly indicate that the extraction method markedly affects the composition of ylang-ylang essential oil and, presumably, its biochemical properties. These variances arise from differences in the polarity of the extraction medium and, in particular, water as used in steam distillation is far more polar than CO_2 and this disparity in turn affects the composition of the extracted matter.

Differences in the relative amounts of the components of ylang-ylang essential oil have been noted not only for the different grades of oil, but also with distillation methods, geography of the source tree as well as the stage of flower development before harvesting [7-11]. Nevertheless, the many analytical studies of ylang-ylang essential oil performed over the years indicate the same principal constituents of the oil.

[1]Note that according to the ISO, an essential oil is the product of steam distillation or a cold-pressed process whereas the products of other extraction processes should be regarded as extracts.

Health benefits of ylang-ylang

Although best known as an ingredient in perfumes and cosmetics, and as a food flavorant to a lesser degree, ylang-ylang essential oil has been used in traditional medicine (CAM) for centuries to treat or alleviate many different conditions (Table 4).

Alleviation of anxiety and depression
Anti-inflammatory
Anti-hypertensive
Aphrodisiacal
Decrease of heart rate and increased blood flow
Gout
Headache
Malaria
Mood boosting
Pneumonia
Rheumatism
Stimulate oil production in the skin and scalp
Stomach distress

Table 4: *Claimed health benefits of ylang-ylang [12].*

There are anecdotal reports that inhalation of a paste made from ylang-ylang flowers can help treat asthma whereas dried ylang-ylang flowers apparently are used to treat the symptoms of malaria in many Asian countries. There are also reports that a popular folk remedy attributes aphrodisiacal properties to ylang-ylang in that it increases sexual desire and reduces sexual anxiety.

However, despite the numerous anecdotal reports of the health benefits of ylang-ylang essential oil, there is little scientific literature supporting many of these claims. Further, many purported benefits, such as anxiety relief, lifting of depressing, mood boosting and, possibly, the claimed aphrodisiacal and sexual stimulating effects may simply be a consequence of the sensory effects of ylang-ylang itself.

Anxiolytic and relaxational effects

Ylang-ylang (*Cananga odorata*) essential oil (YYO) has long been used in aromatherapy where advantage is taken of its aroma for relaxation and for mood adjustment. Although many aromatherapy benefits with ylang-ylang may be anecdotal, there is increasing research evidence to support the mental health and mood benefit claims. A pilot study using 34 volunteers, for example, has shown that ylang-ylang when applied to the skin, inhaled or injected subcutaneously did have an anxiety-reducing effect and boosted self-esteem [13]. However, there were no significant changes in such physiological parameters as mean blood pressure and temperature. In contrast, an earlier study using 24 volunteers showed that ylang-ylang oil inhalation may be characterized by the concept of harmonization rather than relaxation/sedation [14]. It was also noted that compared to the effects of an odorless placebo, ylang-ylang oil caused statistically significant decreases in blood pressure and pulse rate as well as noteworthy increases in subjective attentiveness and alertness. Correlational analyses, however, indicated that the observed effects were mainly due to a subjective odor experience. In other words, it appeared that the Hawthorne effect[2] was thought to be operating.

[2]The Hawthorne effect is the term applied to a situation in which individuals modify an aspect of their behavior in response to an awareness of being observed.

Interestingly, a later study involving 40 healthy volunteers by the same researchers reported on the effect of transdermal application of ylang-ylang oil on certain physiological parameters and mood through self-evaluation [15]. It was found that the ylang-ylang oil caused a significant decrease of blood pressure and an increase of skin temperature whereas on a self-assessment behavioral level, the subjects in the ylang-ylang oil group rated themselves as calmer and more relaxed than controls. It was concluded that ylang-ylang oil did have a relaxing effect, and that there was evidence that aromatherapy with the essential oil achieved some relief of depression and stress.

Another more recent clinical study [16] looked at the effects of ylang-ylang aroma on blood pressure and heart rate in healthy men. The data indicated that compared to controls, inhalation of ylang-ylang caused a reduction of heart rate and blood pressure and relief of the arousal level in healthy men. Thus, this study also indicated the sedative effect of ylang-ylang aroma.

Finally, a larger clinical trial with 144 volunteers looked at the effect of inhaling the aromas of peppermint and ylang-ylang [17]. In particular, peppermint was found to enhance memory whereas ylang-ylang impaired it and lengthened processing speed. Further, with regard to subjective mood perception, peppermint increased alertness whereas ylang-ylang decreased it although there was a significant increase in calmness. It was concluded the data supported the contention that the aromas of essential oils can produce significant and idiosyncratic effects on both subjective and objective assessments of various aspects of human behavior.

It would follow from these studies that aromatherapy, and possibly massage therapy, using ylang-ylang does exert a calming and relaxational effect. However, the reports or conclusions on the effects on such physiological parameters as cardiac health, blood pressure and possibly skin temperature might be more open to question.

In a study of the calming/relaxational and possibly anxiolytic effect of ylang-ylang essential oil (YYO), two recently published scientific papers [18,19] have reported on research performed on ICR mice[3]. In the first study [18], the mice were subjected to three anxiety models after acute and chronic YYO exposure and curiously, this exposure only showed a more significant anxiolytic effect with male mice than females. Further, three of the principal oxygenated constituents of YYO, namely linalool, benzyl benzoate and benzyl alcohol, each showed an anxiolytic effect on the male mice. The YYO exposure effected more significant changes in neurotransmitter levels for the males than the females, decreasing the dopamine concentration in the striatum[4] and increasing the 5-hydroxytryptamine (5-HT) concentration and decreased the ratio of 5-HIAA/5-HT in the hippocampus. The study findings indicated that both acute and chronic YYO exposure exerted an anxiolytic effect on male mice, and it was postulated that the benzyl benzoate in ylang-ylang essential oil might act on the 5-HTnergic and DAnergic pathways. In the former case, it might be through the 5-HT (1A) receptor whereas in the latter, adrenergic receptors, one of a class of G protein-coupled receptors, might be activated.

A second study by the same research team [19] looked at the mechanism involved in ylang-ylang essential oil (YYO) reversing the anxiety induced by a 5-HT2C receptor agonist, 1-(3-chlorophenyl) piperazine (m-CPP), in male ICR mice. Anxiety behavior induced in mice by m-CPP can be reversed by diazepam (2 mg/kg) but it was reported that YYO inhalation had the same effect and was dose-dependent. The study found that YYO affected serotonin metabolism in the brain and reduced the blood plasma corticosterone level of the m-CPP-treated mice. It was concluded that the anxiolytic effect of YYO was associated with the ERK1/2/CREB pathway in the hippocampus and effects on the serotonin system.

[3]The ICR mouse is a strain of albino mice originating in Switzerland that has been sent to various research sites by the U. S. Institute of Cancer Research, and the strain was named ICR after the initial letters of the institute.

[4]The striatum is a cluster of neurons in the subcortical basal ganglia of the forebrain that is a critical component of the motor and reward systems. It receives glutamatergic and dopaminergic inputs from different sources and functions as the primary input to the rest of the basal ganglia.

Although these studies were performed on mice and may not be translatable to humans, the findings are potentially significant in that inhalation of ylang-ylang essential oil was shown to activate adrenergic receptors [18]. The latter are members of the broad class of G protein-coupled receptors which are the target of numerous medications such as catecholamines, beta blockers, β_2 agonists and α_2 agonists. These medications are commonly used to treat high blood pressure and asthma as well as other conditions. The implication is that ylang-ylang may have comparable medicinal effects, and this would account for many of the purported health benefits indicated in table 4. Further, the anxiolytic effect of YYO inhalation was shown [19] to involve the hippocampus and neurotransmitters such as serotonin and, presumably, both glutamate and GABA[5,6]. It follows from this that if YYO inhalation controls serotonin and cortisol, then its effect on many physiological parameters as well as mood, anxiety and, potentially, behavioral issues is logical and almost axiomatic. The beneficial effects of ylang-ylang inhalation (and other essential oils) with regard to victims of intimate partner violence, in fact, has been recently reported [20].

The findings from the various studies cited here suggest that inhalation of ylang-ylang essential oil may be beneficial as an anxiolytic and possibly be valuable for sufferers from PTSD. Although using ylang-ylang oil in aromatherapy does not appear to improve attention, memory or thinking skills, i.e. it has no apparent benefits for cognitive function, there is increasing evidence that it does facilitate calmness and improve feelings of self-esteem. Clinical research studies also indicate that inhalation of ylang-ylang can exert a sedative effect, presumably through its action in reducing systolic and diastolic blood pressure rates as well as heart rates.

Anti-microbial properties of ylang-ylang

Essential oils have been used for millennia to treat various skin diseases [21] and a comprehensive review of the literature [22] has indicated that ylang-ylang has anti-bacterial properties against many common dermatological pathogens. At least one study [23] has shown that a combination of *Lavandula angustifolia* (lavender oil) with ylang-ylang is effective against the pathogenic bacteria *S. aureus* and *P. aeruginosa*. The anti-bacterial effects of ylang-ylang have been ascribed to the components noted in table 5 [22]. Linalool in particular has long been known to possess antibacterial and antifungal activity [24] and, therefore, these properties are to be expected in ylang-ylang essential oil. However, similar antimicrobial effects are known for the numerous terpenes present in essential oils [25-27] and many of these bioactive terpenes are also present in ylang-ylang, as indicated previously.

Benzyl Acetate
Bicyclosesquiphellandrene
β-Farnesene
Linalool
Methyl benzoate

Table 5: *Purported anti-bacterial constituents of ylang-ylang essential oil [22].*

The presence of linalool, germacrene, geranyl acetate, methyl benzoate, and p- methylanisole in ylang-ylang has prompted an *in vitro* study of the antibacterial efficacy of the essential oil against *Staphylococcus aureus* [28]. There have been no reports to date, however, of any findings from this proposed study although based on the constituents of ylang-ylang, antimicrobial activity is to be expected [24].

[5]Gamma-aminobutyric acid

[6]Fear and anxiety affect the thalamus which relays external stimuli to the amygdala. These signals are transferred by neurotransmitters (such as serotonin, glutamate and GABA) to other parts of the brain and the adrenal glands. The latter release stress hormones which include adrenaline, noradrenaline and cortisol, that cause the fight-or-fight response as well as increasing blood pressure, heart rate, respiratory rate and blood sugar.

It has been reported that several essential oils have *in vitro* antiviral activity against many RNA and DNA viruses, including type 1 and type 2 herpes simplex virus (HSV-1 and HSV-2), poliovirus, dengue virus type 2 and many others [26]. Whether such activity also occurs with ylang-ylang is unknown at this time but might be anticipated. It should be noted, however, that the mechanisms involved in the diverse antibacterial, antifungal and antiviral properties of essential oils has not been completely elucidated, because of both the complex microbiology of pathogenic bacterial species and the plethora and wide variety of constituents in the oils. Comments on antimicrobial activity of essential oils are provided in the appendix.

Despite the numerous therapeutic claims made for essential oils, at least one scientific paper [21] has commented that most claims of anti-microbial efficacy have been published in books on aromatherapy (and, latterly, in blogs) rather than in peer-reviewed journals. Accordingly, the increasing number of such claims should be treated with caution until many more rigorous clinical trials have been published in the scientific literature.

Other health benefits of ylang-ylang

There have been studies that indicate that lignan dicarboxylates and terpenoids extracted from the flower buds of ylang-ylang exhibit a potent inhibitory effect on cell melanogenesis and immune-system cytotoxicity when tested on cancerous melanoma skin cells [29]. This suggests that antioxidants in this oil can help protect skin cells from oxidative stress and DNA damage that can lead to cancer cell formation. Further, the biological effect of these compounds was greater than that of arbutin, the agent commonly used to reduce hyperpigmentation. The authors indicated that these isolated terpenoid derivatives might be promising therapeutic agents for the treatment of several skin disorders.

Other workers have reported *in vitro* studies that indicated the constituents of the fruits of *Cananga odorata* exhibit cytotoxicity against two human hepatocarcinoma cell lines [30]. It also has been stated [31] that constituents isolated from the flower buds of *Cananga odorata* (ylang-ylang) have inhibitory effects on aldose reductase[7]. This finding indicates that ylang-ylang extracts may show promise in treating or preventing complications arising from diabetes.

Studies indicate that sprays and shampoos containing ylang- ylang essential oil together with anise and neem oils and various other ingredients are about 92% effective in treating head lice in children [32,33]. Apparently, the repellency effectiveness of ylang-ylang is comparable to that of bug-killers such as permethrin and malathion. However, ylang-ylang essential oil is likely to smell much nicer and is probably less toxic than the customarily used OTC insecticides used to treat head lice.

This application of ylang-ylang may be predicted from its reported insecticidal activity and spatial repellency effectiveness against different pests such as social wasps, stink bugs, mosquitoes and houseflies [34-36].

Other uses of ylang-ylang

There has also been an interesting report that ylang-ylang essential oil can function as a corrosion inhibitor of carbon steel in hydrochloric acid solution [37]. Corrosion inhibition by the "green inhibitor" ylang-ylang was shown to be due to the adsorption of the essential oil onto the steel surface and the inhibitory effect increased with concentration of inhibitor in solution but decreased with temperature.

This type of electrochemical behavior found with ylang-ylang essential oil has been observed with many organic compounds containing nitrogen, sulfur or oxygen atoms. These compounds added to the electrolyte surrounding them are able to protect metals from corrosion by adsorption on the surface of the electrode to form a protective film [38-41]. Although ylang-ylang did function as a corrosion inhibitor, there did not appear to be any comments regarding inhibitory effectiveness compared to other "green" or even standard corrosion inhibitors such as chromates. It has to be mentioned that the application of ylang-ylang essential oil as a corrosion inhibitor would have to be extra-ordinarily effective to be economically viable.

[7]Aldose reductase is an enzyme present in several human tissues that reduces glucose to sorbitol and studies with animal models indicate that the production of sorbitol is associated with the development of diabetic complications.

Adverse effects of ylang-ylang

Daily exposure to fragrances is a common occurrence in modern society because of the ubiquity and wide variety of their sources. These include cosmetics, moisturizing creams, perfumes and household products such as massage oils, detergents and even scented candles as well as a variety of foodstuffs [1,12,21,42]. Unfortunately, the ingredients of perfumes and cosmetics are amongst the most common causes of contact allergic reactions [43,44]. In fact, it has been reported that nickel and perfumes are the major contact allergens causing atopic dermatitis (AD), contact dermatitis and other effects such as asthma, allergic rhinitis and hand eczema in adolescents [45]. It has been found that, overall, the lifetime prevalence of AD was 21.3%, with 25.7% being observed with girls and 17.0% for boys among 1501 eighth grade school children, ages 12 - 16 years. There was also a statistically significant association between AD and inhalant allergy, and between AD and hand eczema [48].

The prevalence of allergic reactions to fragrances has long been recognized, as has the fact that despite the importance of essential oils in traditional medicine [12], they can be major contributors to hypersensitivity in affected patients [21,45-47]. It follows from this that the literature will inevitably contain reports of allergic reactions to ylang-ylang [48-50]. Interestingly, the allergenicity of ylang-ylang has been attributed to its reported albeit relatively low content of the known allergen isoeugenol [12,51-53] although it could also be caused by other allergens such as benzyl salicylate, linalool or benzyl benzoate.

A possible contributing factor to this allergenicity is that it has been demonstrated that ylang-ylang is an effective skin penetration enhancer for topical medications [53]. In particular, a study using excised human skin showed that ylang-ylang oil effected an 8-fold increase in skin penetration of 5-fluorouracil[8] although the observed effect was not as pronounced as that found for *Eucalyptus* and *Chenopodium*[9] [56]. On the other hand, if ylang-ylang possesses skin penetration enhancing properties, this would be a marked advantage for its inclusion in fragrances (perfumes) and cosmetics. Nevertheless, as with any essential oil, applying full-strength ylang-ylang to skin may be ill-advised and it should always be mixed with a carrier oil and patch tested in inconspicuous areas before topical use over a large area of the body, face or scalp.

It should be noted that various blogs have suggested that ylang-ylang is poisonous to dogs and cats. Despite a careful review of the literature, it has not been possible to confirm or refute this claim but avoiding applying ylang-ylang, and indeed most essential oils, to a pet's skin, paws or coat might be a sensible precaution.

What is surprising is that an older systematic review of case reports and case series on the adverse effects of aromatherapy indicated that lavender, peppermint, tea tree oil and ylang-ylang were the most common essential oils responsible for adverse effects [54]. The latter ranged from mild to severe and included one fatality, but the most common adverse effect was dermatitis. Although it was concluded that aromatherapy has the potential to cause adverse effects some of which are serious, their frequency is unknown.

Ylang-ylang oil is a relatively common flavor ingredient in the food industry and there is no evidence that its daily estimated consumption from flavorant use of 0.0001 mg/kg has led to any adverse human health effects [55]. These data indicate that at the current level of intake as a food ingredient, ylang-ylang oil poses no health risk to humans and there is no indication in the literature that food exposure to ylang-ylang oil has caused allergic reactions.

Conclusion

Ylang-ylang is possibly one of the more interesting essential oils. Not only is it atypically extracted from the flowers of its botanical source on an industrial scale, but it has a wide spectrum of applications. The latter include its presence in fragrances, food flavorants and

[8]Fluorouracil (Adrucil, Efudex) is a topical medication used to treat pre-cancerous and cancerous skin growths.

[9]Chenopodium is a genus of many species of perennial or annual herbaceous flowering plants known as the goosefoots, these plants are known to occur almost anywhere in the world.

as an effective aromatherapy relaxant. Despite the venerable therapeutic use of ylang-ylang in traditional medicine, there is scant scientific literature supporting many of the claimed health benefits. On the other hand, there does appear to be strong evidence supporting the relaxational and self-esteem enhancing properties of this essential oil. Certainly, its place within the cosmetics industry appears to firmly be established because of its unique and very pleasant aroma. The other interesting aspect of the topical use of ylang-ylang essential oil is its ability to facilitate penetration of the epidermis, a characteristic that suggests great potential in dermatology and other topical applications of medications and beauty aids.

Appendix

For many years, the antimicrobial action of essential oils was considered to be the result of toxic effects on the bacterial cell membrane structure and its functions [25,56-58] but this view has been modified in recent years. It now appears that the antimicrobial action involves many effects, including degradation of the cell wall, damage to the cytoplasm[10] membrane, coagulation of the cytoplasm as well as damage to the proteins in the protective bacterial outer membrane [25]. The latter effect results in increased permeability of the membrane, leakage of the cell contents and, in turn, interfering with the intracellular functions such as energy (ATP[11]) synthesis and ion exchange. The net effect is destabilization of the cellular architecture, breakdown of the membrane integrity and disruption of many cellular activities such that, overall, microorganism viability is severely impaired.

There are, however, many different factors that affect the antimicrobial properties of essential oils. These include the characteristics of the bacterial cell wall; with Gram-positive and Gram-negative bacteria having distinctly different structures and these differences markedly affect the ability of the components of essential oils to penetrate the cells. It appears that hydrophobic molecules can readily penetrate Gram-positive bacterial cell walls whereas Gram-negative bacteria are more resistant to essential oils [25]. As a result, the antimicrobial properties of essential oils can be quite variable depending in part on the constituents of the oil. Nevertheless, it has become increasingly clear from the many *in vitro* studies reported in the literature that essential oils can inhibit the growth of drug-resistant microbial strains that are difficult treat by the available spectrum of antibiotics or which are becoming increasingly resistant to them [25,27].

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[10]The cytoplasm is the protoplasm or the material within a living cell but not the cell nucleus.

[11]ATP (Adenosine Triphosphate) provides the energy that drives many processes in living cells including chemical synthesis, nerve impulse propagation and muscle contraction.

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