

Toxicology of essential oils reviewed

Detailed information on toxicity and other aspects of essential oils is being provided in a series of spreadsheets. The series starts in pages following this article, and will be continued in subsequent issues of *Personal Care Asia Pacific*.

It has always been a challenge to discover the toxicological profile of essential oils and despite some excellent reference works on the topic, there has never been a single reference that supplied all the required data.

Sadly, many of the books published on the topic of aromatherapy have not been written by scientists or toxicologists and this has meant that there is a great deal of poor quality information circulating which has propagated and found its way on to the internet.

The use of the phrase “not tested on animals” is not only illegal but is also totally without truth, since in nearly all cases these essential oils have been tested on animals at one time or another in the past.

The LD₅₀ value (lethal dose 50%) using animals (usually based on rats or mice) gives a value for the death of half the animals tested. An LD₅₀ of 2 g/kg refers to the total weight of material tested/body mass of test animal that caused death in half the number tested. Thus, if a human weighed 70 kg then it might be expected that 140 g could be consumed before it was fatal.

The idea that because a material is natural it therefore must be safe could not be further from reality.

There are essential oils that are so toxic that they should never be consumed or applied to the skin without extreme caution. The risks of sensitisation, irritation, phototoxicity or being an abortifacient are fact. Essential oils contain a rich blend of highly functional molecules some of which are beneficial and others which are not.

General considerations

Finding the results of the oral and dermal studies is very time consuming and I have compiled an overview of the oils and their effects in a spreadsheet format (see pages following this article). This compilation will allow a quick review as to the suitability of an oil in a given product.

Quick summary of unsuitable essential oils

It is useful to check to see if there is a risk associated with an essential oil before looking at the spreadsheet pages.

Essential oils that may be dangerous in aromatherapy

Almond oil bitter (*Prunus amygdalus*) contains hydrocyanic acid; Armoise oil (*Artemisia herba-alba*) contains thujones; Boldo leaf (*Peumus boldus*) contains ascaridole; Calamus oil (*Acorus calamus*) contains β-asarone type compound; Chenopodium (Wormseed) oil (*Chenopodium ambrosioides*) contains ascaridole; Croton oils (*Croton tiglium*, *C. oblongifolius*); Horseradish oil (*Amoracia rusticana*) contains allyl isocyanate, phenylethyl isocyanate; Lanyana oil (*Artemisia afra*) contains thujones; Mustard oil (*Brassica nigra*, *B. juncea*) contains allyl isocyanate; Parsley herb oil (*Petroselinum crispum*) contains dill apiole; Pennyroyal oil

(*Mentha pulegium*) contains pulegone; Perilla oil (*Perilla frutescens*) contains perilla ketone; Savin oil (*Juniperus sabina*) contains sabiny acetate; Sassafras oil (*Sassafras albidum*) contains saffrole; Summer Savoury oil (*Satureja hortensis*); Tansy oil (*Tanacetum vulgare*) contains thujones; Wintergreen oil (*Gaultheria procumbens*) contains methyl salicylate; Wormwood oil (*Artemisia absinthium*) contains thujones.

Oils that may cause irritation

Bay oil West Indian (*Pimenta racemosa*), Clove oils (stem, leaf, bud) *Syzygium aromaticum*, Coriander oil (*Coriandrum sativum*) high linalool content; Ho oil (*Cinnamomum camphora* var. *linaloolifera* and *Cinnamomum camphora* var. *glavescens*) high linalool content; Kuromoji oil (*Linda umbellata*) high linalool content; May Chang oil (*Litsea cubeba*), Melissa oil (*Melissa officinalis*), Origanum oil (*Origanum vulgare*), Pimento berry and leaf oils (*Pimenta officinalis*); Rosewood oil (*Aniba rosaedora*) high linalool content; Summer Savoury oil (*Satureja hortensis*), Winter Savoury oil (*Satureja montana*), Tagetes oil (*Tagetes minuta*), Tea Tree oil (*Melaleuca alternifolia*), Thyme oil (*Thymus vulgaris*), Turpentine oil (*Pinus sylvestris*).

Oils that are known to cause sensitisation in massage

Cassia oil (*Cinnamomum cassia*) contains cinnamic aldehyde, coumarin; Cinnamon bark oil (*Cinnamomum zeylanicum*) contains cinnamic aldehyde; Costus oil, abs, concrete (*Saussurea lappa*) contains sesquiterpene lactones; Elecampene oil (*Inula helenium*) contains sesquiterpene lactones; Fig leaf absolute (*Ficus carica*); Massoia bark oil (*Cryptocarya massoia*) contains massoia lactone; Melissa oil (*Melissa officinalis*) contains citral; Oakmoss (*Evernia prunastri*); Treemoss (*Evernia furfuracea*); Opoponax

Table 1: Composition of Ylang-ylang oil.

Potential allergen	Cananga odorata
Benzyl alcohol	0.000
Benzyl salicylate	3.000
Cinnamyl alcohol	*
Cinnamal	*
Citral	*
Coumarin	*
Eugenol	0.700
Geraniol	1.500
Isoeugenol	*
Anise alcohol	*
Benzyl benzoate	5.000
Benzyl cinnamate	*
Citronellol	*
Farnesol	2.000
Limonene	*
Linalool	3.000

(*Commiphora erythraea*); Peru balsam and oil (*Myroxylon pereirae*); Styra (Liquidamber spp); Verbena absolute and oil (*Lippia citriodora*); Tea absolute (*Camellia sinensis*); Turpentine oil (*Pinus* spp); Lemon Myrtle oil (*Backhousia citriodora*) contains high citral/citronellal content; Inula (*Inula graveolens*) contains sesquiterpene lactones.

Oils that are phototoxic

Amni visnaga oil (*Amni visnaga*); Angelica root oil (*Angelica archangelica*); Bergamot oil expressed (*Citrus aurantium bergamia*); Cumin oil (*Cuminum cyminum*); Fig leaf absolute (*Ficus carica*); Grapefruit oil expressed (*Citrus paradisi*); Lemon oil cold pressed (*Citrus medica limonum*); Lime oil expressed (*Citrus aurantifolia*); Mandarin oil cold-pressed (*Citrus reticulata*); Opoponax oil, absolute, resinoid (*Commiphora erythraea*); Orange oil bitter (*Citrus aurantium amara*); Parsley leaf oil (*Petroselinum crispum*); Petitgrain Mandarin oil (*Citrus reticulata* var. *mandarin*); Rue oil (*Ruta graveolens*); Tagetes oil and absolute (*Tagetes minuta*); Tangerine oil cold-pressed (*Citrus reticulata*); Verbena oil (*Lippia citriodora*).

Pregnancy and effects on the reproductive system (abortifacient)

Chaste Tree oil (*Vitex agnus-castus*); Plectranthus oil (*Plectranthus fruticosus*); Parsley leaf oil (*Petroselinum crispum*); Spanish sage oil (*Salvia lavandulaefolia*); Savin oil (*Juniperus sabina*).

Pregnancy and effects on the reproductive system (avoid during pregnancy)

Balsamite contains camphor; Camphor, White (*Cinnamomum camphora*) contains camphor; Ho leaf oil (*Cinnamomum camphora* var. *linaloolifera* and *Cinnamomum camphora* var. *glavescens*) contains safrole and camphor; Hyssop oil (*Hyssopus officinalis*) contains pinocampnone; Dill seed oil (*Anethum graveolens*) contains apiol; Juniper oil (*Juniperus pfitzeriana*); Parsley leaf and seed oils (*Petroselinum crispum*) contain apiol; Plectranthus Oil (*Plectranthus fruticosus*) contains sabinyl acetate; Spanish sage oil (*Salvia lavandulaefolia*) contains sabinyl acetate; Savin oil (*Juniperus sabina*) contains sabinyl acetate.

Pregnancy and effects on the reproductive system (use with caution during pregnancy)

Wormwood oil (*Artemisia absinthium*) contains thujones; Brazilian Cangerana oil (*Cabralea cangerana* Sald.) [Syn. *C. glaberrima*] contains safrole; French Lavender (*Lavandula stoechas*) contains camphor; Perilla oil (*Perilla frutescens*) contains perilla ketone; Rue (*Ruta graveolens*) contains chalepensis [3-(α -, α -dimethylallyl) psoralen, 13%]; Tree Moss (*Evernia furfuracea*) contains atranorin, physodic acid, furfuracinic acid, and chloro-atranorin.

Pregnancy and effects on the reproductive system (not to be used orally, rectally or vaginally during pregnancy)

Anise (*Pimpinella anisum*) contains anethole; Fennel (*Foeniculum vulgare*) contains anethole; Lavandin (*Lavandula hybrida*) contains camphor, French Lavender (*Lavandula stoechas*) contains camphor; Mace (*Myristica fragrans*) contains safrol and myristicin (which are both contraindicated in pregnancy); Nutmeg (*Myristica fragrans*) contains safrole and myristicin; Rosemary (*Rosmarinus officinalis*) contains camphor; Spike Lavender (*Lavandula latifolia*) contains higher camphor levels than other lavender spp; Star Anise (*Illicium verum*) contains anethole; Yarrow (*Achillea millefolium*) contains camphor.

Oils that are carcinogenic

Birch tar oil crude (*Betula panda*) contains polynuclear hydrocarbons; Cade oil crude (*Juniperus oxycedrus*) contains polynuclear hydrocarbons; Calamus oil (*Acorus calamus*) contains β -asarone type; Cinnamomum porrectum oil; Croton oils (*Croton tiglium*, *C. oblongifolius*); Ocotea cymarum oil; Sassafras oils (*Sassafras albidum*) contains safrole.

Oils that are carcinogenic to rodents (Methyl eugenol)

Bay oil, West Indian (*Pimenta racemosa*) to 12.6% (*Methyl eugenol*); Basil oils (*Ocimum* spp) some chemotypes to 65%

Table 2: SAF and product type consumer exposure levels that drive the IFRA QRA categories.

IFRA QRA category	SAF	Category consumer exposure 1 mg/cm ² /day	Product type that drives the category consumer exposure level	Maximum pragmatic level
Category 1	300	11.70000	Lip products	Not necessary, acceptable exposure level derived from QRA
Category 2	300	9.10000	Deodorants/antiperspirants	Not necessary, acceptable exposure level derived from QRA
Category 3	300	2.20000	Hydroalcoholics for shaved skin	Not necessary, acceptable exposure level derived from QRA
Category 4	100	2.20000	Hydroalcoholics for unshaved skin	Not necessary, acceptable exposure level derived from QRA
Category 5	100	4.20000	Hand cream	Not necessary, acceptable exposure level derived from QRA
Category 6	100	1.40000	Mouthwash	Not necessary, acceptable exposure level derived from QRA
Category 7	300	4.40000	Intimate wipes	Not necessary, acceptable exposure level derived from QRA
Category 8	100	1.00000	Hair styling aids	2% The maximum concentration will not exceed 2% and may be lower if determined by the QRA
Category 9	100	0.20000	Rinse-off hair conditioners	5% The maximum concentration will not exceed 5% and may be lower if determined by the QRA
Category 10	100	0.10000	Hard surface cleaners	2.5% The maximum concentration will not exceed 2.5% and may be lower if determined by the QRA
Category 11	10	0.00033	Candles	These products result in negligible skin contact. The approach for a pragmatic concentration of fragrance ingredient in this category is explained in associated notes

The category consumer exposure level (mg/cm²/day) is driven by the product type in that category with the combined highest consumer exposure level and highest Sensitisation Assessment Factor (SAF).

Table 3: IFRA categories for dermal sensitisation, QRA approach, arranged by category.

Product type	Maximum pragmatic level	Comments
Category 1	Not necessary, acceptable exposure level derived from QRA	
Lip products of all types: solid and liquid lipsticks, balms, clear or coloured, etc.		Products that contain sunscreen or sun block are not listed separately and are included in the major product type (e.g. lip creams containing sunscreen are included in the lip product category). Due to the possibility of ingestion of small amounts of fragrance ingredients, materials present in the fragrance compound for use in this category must be approved for use in food, meaning that all ingredients should be listed as having “no safety concern”, for example by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) and/or as Generally Recognized As Safe (GRAS) in accordance with the US Federal Food, Drug and Cosmetic Act
Toys		This product type has been placed in Category 1 based on the absence of exposure data. Should exposure data become available, this product type may be re-categorised. Due to the possibility of ingestion of small amounts of fragrance ingredients (if oral exposure is foreseeable), materials present in the fragrance compound for use in this toy category must be approved for use in food, meaning that all ingredients should be listed as having “no safety concern”, for example by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) and/or as Generally Recognized As Safe (GRAS) in accordance with the US Federal Food, Drug and Cosmetic Act
Category 2	Not necessary, acceptable exposure level derived from QRA	
Deodorant and antiperspirant products of all types: spray, stick, roll-on, under-arm and body, etc.		
Category 3	Not necessary, acceptable exposure level derived from QRA	
Hydroalcoholic products applied to recently shaved skin		
Eye products of all types: eye shadow, mascara, eyeliner, eye make-up, etc.		
Men’s facial creams, balms		
Tampons		
Category 4	Not necessary, acceptable exposure level derived from QRA	
Hydroalcoholic products applied to unshaved skin		
Hair styling aids, hair sprays of all types: pumps, aerosol sprays, etc.		
Body creams, oils, lotions, fragrancing creams of all types, baby creams, etc.		Products that contain sunscreen or sun block are not listed separately and are included in the major product type – e.g. lip creams containing sunscreen are included in the lip product category
Ingredients of perfume kits		
Fragrance compounds for cosmetic kits		
Scent strips for hydroalcoholic products, “scratch and sniff” samples, other paper products not mentioned elsewhere for which skin exposure is only incidental (e.g. spectacle cleaning tissues)		These product types have been placed in Category 4 based on the absence of exposure data, but it is recognised that these products have similarities to hydroalcoholic products applied to unshaved skin. Should exposure data become available, these product types may be re-categorised
Foot care products		This product type has been placed in Category 4 based on the absence of exposure data, but it is recognised that this product is similar to body creams and lotions. Should exposure data become available, this product type may be re-categorised
Hair deodorant		This product type has been placed in Category 4 based on the absence of exposure data, but it is recognised that this product is similar to hair styling aids and hair sprays. Should exposure data become available, this product type may be re-categorised



Table 3: (continued).



Product type	Maximum pragmatic level	Comments
Category 5	Not necessary, acceptable exposure level derived from QRA	
Women's facial creams/ facial make-up		
Hand cream		
Facial masks		
Wipes or refreshing tissues for face, neck, hands, body		These product types have been placed in Category 5 based on the absence of exposure data, but it is recognised that these products are generic to males and females and have similarities with the product types in this category. Should exposure data become available, these product types may be re-categorised
Category 6	Not necessary, acceptable exposure level derived from QRA	
Mouthwash		 <p>Toothpaste and mouthwash products: with the implementation of the QRA approach, the IFRA Standards will include oral care products. Mouthwash and toothpaste are the principal oral care products currently identified in IFRA Category 6. Exposure limits for these products are established to reduce the risk of peri-oral skin sensitisation and as such, are not related to considerations of safe levels for ingestion. The safety of flavour/fragrance ingredients present in products intended to be orally ingested is outside the scope of IFRA's risk assessment process. In the latter cases, salivary dilution and short/variable contact time in the oral cavity would suggest a different risk assessment approach for ingested flavour/fragrance substances. The aspect of safety through ingestion is managed by the International Organization of the Flavor Industry. Due to the possibility of ingestion of small amounts of fragrance ingredients, materials present in the fragrance compound for use in this category must be approved for use in food, meaning that all ingredients should be listed as having "no safety concern", for example by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) and/or as Generally Recognized As Safe (GRAS) in accordance with the US Federal Food, Drug and Cosmetic Act. Existing IFRA Standards will not be applied to these oral care product types in IFRA Category 6. As the QRA approach for fragrance ingredient dermal sensitisers is implemented, then maximum use levels of these ingredients in toothpaste and mouthwash products will be introduced through definition of new or revised IFRA Standards</p>
Toothpaste		
Category 7	Not necessary, acceptable exposure level derived from QRA	
Intimate wipes		
Baby wipes		
Insect repellent (intended to be applied to the skin)		
Category 8	2%	
Make-up removers of all types (not including face cleansers)	The maximum concentration will not exceed 2% and may be lower if determined by the QRA	
Hair styling aids, non-spray of all types: mousse, gels, leave-in conditioners, etc.	As above	
Nail care	As above	
All powders and talcs (including baby powders and talcs)	As above	 <p>These product types have been placed in Category 8 based on the absence of exposure data, but it is recognised that the exposure would be similar to body creams and lotions. Although the exposure is expected to be similar to body creams and lotions, the overall SAF for powders and talcs is, however, lower and so these products are placed into a different category compared to body creams and lotions. Should exposure data become available, these product types may be re-categorised</p>

Table 3: (continued).

Product type	Maximum pragmatic level	Comments
Category 9	5%	
Conditioner (rinse-off)	5% The maximum concentration will not exceed 5% and may be lower if determined by the QRA	
Liquid Soap	As above	
Shampoos of all types (including baby shampoos)	As above	
Face cleansers of all types: washes, gels, scrubs, etc.	As above	
Shaving creams of all types: stick, gels, foams, etc.	As above	
Depilatories	As above	
Body washes of all types, baby washes, shower gels, etc.	As above	
Bar soap (toilet soap)	As above	
Feminine hygiene – pads	As above	
Feminine hygiene – liners	As above	
Bath gels, foams, mousses, salts, oils and other products	As above	
Additions to bath water	As above	
Other aerosols: air freshener sprays (not antiperspirants, deodorants, or hair styling aid sprays)	As above	
Category 10	2.5%	
Handwash laundry detergents of all types		
Fabric softeners of all types including fabric softener sheets		
Other household cleaning products: fabric cleaners, soft surface cleaners, carpet cleaners, etc.		
Machine wash laundry detergents: liquids, powders, tablets, etc., including laundry bleaches		
Hand dishwashing detergent		
Hard surface cleaners of all types: bathroom and kitchen cleansers, furniture polish, etc.	The maximum concentration will not exceed 2.5% and may be lower if determined by the QRA	
Diapers		
Shampoos for pets	It was assumed that the exposure to humans from shampoos for pets could be expected to be similar to hand dishwashing liquids	
Dry cleaning kits	This product type has been placed in Category 10 based on the absence of exposure data, but it is recognised that this product is similar to fabric softener sheets. Should exposure data become available, this product type may be re-categorised	
Toilet seat wipes	This product type has been placed in Category 10 based on the absence of exposure data, but it is recognised that this product is similar to hard surface cleaner. Should exposure data become available, this product type may be re-categorised	
Category 11 (SEE INSET BOX)	These products result in negligible skin contact. The approach for a pragmatic concentration of fragrance ingredient in this category is explained in associated notes	



Product type (Category 11)

All non-skin contact or incidental skin contact products. Including: candles, air fresheners and fragrancing of all types (plug-ins, solid substrate, membrane delivery, electrical, pot pourri, powders, fragrancing sachets, incense, liquid refills), shoe polishes, deodorisers/maskers not intended for skin contact (e.g. fabric drying machine deodorisers, carpet powders), insecticides (e.g. mosquito coil, paper, electrical, for clothing), toilet blocks, joss sticks or incense sticks, machine dishwash detergent and deodorisers, machine only laundry detergent, plastic articles (excluding toys), fuels, paints, cat litter, animal sprays, treated textiles (e.g. starch sprays, fabric treated with fragrances after wash, deodorisers for textiles or fabrics, tights with moisturisers), distilled water with added odour (that can be used in steam irons), floor wax

(*Methyl eugenol*); Melaleuca oils (e.g. *Melaleuca bracteata*) to 50% (*Methyl eugenol*); Nutmeg oil (*Myristica fragrans*) to 1.2% (*Methyl eugenol*); Pimento oils (*Pimenta officinalis*) to 15% (*Methyl eugenol*); Rose oils (*Rosa* spp.) to 3.0% (*Methyl eugenol*).

Legal requirements

There are 24 potential allergens which have to be calculated not only for the single oil, but which have to be accumulatively accounted for in a blend of essential oils. These must be declared at 0.01% in rinse-off products such as shower gels and bath foams and at 0.001% in the case of leave-on products like lotions and creams.

The list is as follows: amylcinnamyl alcohol, amyl cinnamal, anise alcohol, benzyl alcohol, benzyl benzoate, benzyl cinnamate, benzyl salicylate, cinnamyl alcohol, cinnamal, citral, citronellol, coumarin, eugenol, farnesol, geraniol, hexyl cinnamal, hydroxycitronellal, isoeugenol, butylphenyl methylpropional, limonene, linalool, hydroxyisohexyl-3-cyclohexene carboxaldehyde, methyl 2-octynoate, alpha-isomethyl ionone, *Evernia prunastri* (Oakmoss) extract, *Evernia furfuracea* (Treemoss) extract.

Other requirements

Essential oils are not single components but complex blends. If we took the typical composition of Ylang-ylang oil (from the ECHA list of potential allergens in essential oils) then we would find it contained the materials shown in Table 1.

Each of the materials shown have the potential to cause a skin reaction and determined must be the safety of these in a particular product. In order to assess the safety one has to look at the current technique.

The International Fragrance Association (IFRA) has introduced the Quantitative Risk Assessment (QRA) approach for fragrance ingredients. It is highly recommended that readers acquaint themselves with its website (www.ifraorg.org).

Useful is the table relating to the Sensitisation Assessment Factor (SAF). The safety assessor may determine the Category Consumer Exposure Level (mg/cm²/day) which is driven by the product type in that category with the combined highest consumer exposure level and highest Sensitisation Assessment Factor (SAF).

The category is determined from the IFRA Categories for Dermal Sensitisation, QRA Approach, arranged by category.

The safety is then determined by the category and the method of delivery for

each of the potential allergens. This is a laborious process, but the Research Institute for Fragrance Materials (RIFM) and IFRA have published a number of useful papers that have made those calculations already.

Let us suppose we used 1% of

Cananga odorata essential oil in a lipstick, this would equate to 0.007% eugenol in our example. We now consult the available information (see Table 4).

Clearly this is well within the safety limits for eugenol for Ylang-ylang oil when used at 1%. The process is now repeated

Table 4: Acceptable levels of eugenol in various product types based on QRA.

Using 1% <i>Cananga odorata</i> contains 0.007% eugenol in the example				
Product type	SAF	Exp.	Eugenol	Maximum pragmatic level
Deo/antiperspirant non-spray	300	Colipa	0.3%	
Solid antiperspirant	300	CTFA	0.2%	
Lip products	300	Colipa	0.2%	0.007% eugenol is well within the safety limit
Eye shadow	300	CTFA	0.9%	
Men's facial cream	300	SCCP	0.9%	
Hydroalcoholics, shaved skin	300	C&R	0.9%	
Tampons	200	RIFM	1.0%	
Hydroalcoholics, unshaved skin	100	C&R	2.7%	
Hair spray	100	CTFA	2.7%	
Body cream/lotion	300	Colipa	3.3%	
Women's facial cream	100	Colipa	2.2%	
Women's facial liquid make-up	100	CTFA	1.9%	
Hand cream	100	Colipa	1.4%	
Mouthwash	100	SCCP	4.3%	
Toothpaste	100	Colipa	4.7%	
Baby wipes	300	RIFM	0.5%	
Intimate wipes	300	RIFM	0.4%	
Hair styling aids	100	SCCP	5.9%	2% The maximum concentration will not exceed 2% and may be lower if determined by the QRA
Make-up remover	100	SCCP	6.6%	As above
Nail care	100	SCCP	6.1%	As above
Feminine hygiene pads	100	RIFM	42.1%	As above
Feminine hygiene liners	100	RIFM	42.1%	As above
Shampoo	100	CTFA	34.7%	5% The maximum concentration will not exceed 5% and may be lower if determined by the QRA
Liquid soap	100	Colipa	30%	As above
Conditioners, rinse-off	100	CTFA	29.5%	As above
Face wash	100	CTFA	39.3%	As above
Shaving cream	300	SCCP	28.1%	As above
Aerosol air freshener	100	RIFM	100%	As above
Bar soaps	100	SCCP	100%	As above
Body wash/shower gel	100	CTFA	100%	As above
Bath foams, gels, mousses	100	SCCP	100%	As above
Handwash laundry	100	HERA	59.0%	2.5% The maximum concentration will not exceed 2.5% and may be lower if determined by the QRA
Hand dishwashing	100	HERA	100%	As above
Hard surface cleaner	100	HERA	49.2%	As above
Baby diapers	100	RIFM	100%	As above
Candles	10	FMA	100%	Due to negligible skin contact, the concentration of fragrance ingredient should not exceed the usual concentration of the fragrance compound in the finished product

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for all of the other allergens and any other potential active that may cause problems.

Conclusions

The use of essential oils can be safe provided that the percentage use, product application, target consumer and all of the toxicology data have been carefully evaluated and considered. It is never wise to use an essential oil without first diluting it in a carrier oil.

Every care has been taken to compile this data. If there are any errors or if there is any data that you would like to be added, then please contact the author at dweckdata@aol.com

The responsibility for product safety should not rely on the information provided in this article. **PC**

References

Many works were used to prepare this article and it is impossible to cite the source for each data point, but I am pleased to thank the following reference works and organisations.

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ESSENTIAL OILS

Common name	Latin name	Part extracted	LD ₅₀ , g/kg.		Additional toxicology
			(oral)	(dermal)	
Fir, Silver	<i>Abies alba</i>	Leaf	>5.00	>5.00	Oral – rat >5000 mg/kg Skin – rabbit >5000 mg/kg IFRA recommendation: <10 mmoles/L of peroxides 5% in fragrances SCCP: Essential oils and isolates derived from the <i>Pinaceae</i> family, including <i>Pinus</i> and <i>Abies genera</i> , should only be used when the level of peroxides is kept to the lowest practicable level, for instance by adding antioxidants at the time of production. Such products should have a peroxide value of less than 10 millimoles peroxide per litre Based on the published literature mentioning sensitising properties when containing peroxides [Food and Chemical Toxicology 11,1053 (1973); 16,843 (1978); 16,853 (1978)]
Fir, Canada	<i>Abies balsamea</i>	Needle	>10.00	>5.00	Oral – rat 10200 mg/kg Dermal – rabbit >5g/kg IFRA recommendation: <10 mmoles/L of peroxides 5% in fragrances IFRA recommends for example that oils from the <i>Pinaceae</i> family e.g. Fir needle oil <i>Canada Abies balsamea</i> should have a peroxide value of less than 10 millimoles of peroxide per litre. SCCP: Essential oils and isolates derived from the <i>Pinaceae</i> family, including <i>Pinus</i> and <i>Abies genera</i> , should only be used when the level of peroxides is kept to the lowest practicable level, for instance by adding antioxidants at the time of production Such products should have a peroxide value of less than 10 millimoles peroxide per litre Based on the published literature mentioning sensitising properties when containing peroxides [Food and Chemical Toxicology 11 1053 (1973); 16 843 (1978); 16 853 (1978)] The oleoresin (Canada balsam) is reported to produce dermatitis when applied as perfume The foliage has also induced contact dermatitis
Fir, Grand	<i>Abies grandis</i>	Needle	No data	No data	
Calamus (Sweet Flag)	<i>Acorus calamus</i>	Rhizome	0.777	>5.00	Oral – rat 777 mg/kg Oral – rat LD ₅₀ value 1298.5 mg/kg Intraperitoneal – rat 221 mg/kg Intravenous – mouse 1138 mg/kg Intraperitoneal – mouse 177 mg/kg Intraperitoneal – guinea pig 297 mg/kg Skin – guinea pig >5000 mg/kg Methyl eugenol <0.60% as it has potential carcinogenic activity, max 4% in fragrances
Lemon Verbena	<i>Aloysia triphylla</i>	Fresh herb	5.00	5.00	IFRA critical effect: sensitisation IFRA restricted components: Citral <19.00% sensitiser Geraniol <0.10% sensitiser (E)-2-hexen-1-al <0.10% sensitiser 2% in fragrances Oral – rat LD ₅₀ : 5000 mg/kg Dermal – rabbit LD ₅₀ : 5000 mg/kg The essential oil from the plant might sensitise the skin to sunlight (phototoxicity) <i>Aloysia triphylla</i> (CAS No. 8024-12-2) is synonymous with <i>Lippia citriodora</i> (CAS No. 8024-12-2) so is banned
Cardamom, large	<i>Amomum subulatum</i>	Seed	22.00	No data	Acute oral – mice 22,070 mg/kg
Dill Weed	<i>Anethum graveolens</i>	Seed	4.00	>5.00	Oral – rat 4040 mg/kg Skin – rabbit >5000 mg/kg 2% in fragrances 25 ppm in flavours As a food flavouring additive, the material has been assessed under the provisions of the Federal Food, Drug and Cosmetic Act, section 201 (s), by the Expert Committee of the USA Flavor and Extract Manufacturers Association (FEMA), to be Generally Recognized As Safe (GRAS) under current conditions of use Acute toxicity LDLO/LCLO – lowest lethal dose/conc Mouse – oral LDLO 3 gm/kg Oral – rat LD ₅₀ 4040 mg/kg Subcutaneous – mouse LD ₅₀ 1350 mg/kg Skin – rabbit LD ₅₀ >5 gm/kg Irritation – skin standard Draize test skin – rabbit 500 mg/24H; reaction: moderate
Dill Weed	<i>Anethum graveolens</i>	Herb	4.00	>5.00	Oral – rat 4040 mg/kg Skin – rabbit >5000 mg/kg IFRA restriction eugenol <0.30% sensitiser 4% in fragrances Dill is said to contain the alleged 'psychotroph' myristicine There are also reports that dill can cause photosensitivity and/or dermatitis in some people
Angelica	<i>Angelica archangelica</i>	Root	>2.2	>5.00	Oral toxicity (LD ₅₀): Oral – rat 11160 mg/kg Oral – mouse 2200 mg/kg Dermal toxicity (LD ₅₀): Skin – rabbit >5000 mg/kg Restriction in leave-on formulations to 0.78% and wash-off formulations to 3.9%. This is due to phototoxic effects (genotoxicity) associated with the potential presence in the oil of UV-reactive furocoumarins. Large oral doses should not be taken during pregnancy
Angelica	<i>Angelica archangelica</i>	Seed			May be used in cosmetic products, provided that the total concentration of furocoumarin-like substances in the finished cosmetic product do not exceed 1 ppm 3% in fragrance concentrate 35 ppm in flavour 15 ppm CO ₂ extract in flavour
Chamomile, Roman	<i>Anthemis nobilis</i>	Flower	>5.00	>5.00	Toxicity class D acute oral, mucous membrane C-D (non-irritant), dermal irritation class C, dermal sensitisation class D (4%), Not in the warning list for pregnancy
Wormwood	<i>Artemisia absinthium</i>	Leaf/flowering top	0.96		Not advised for topical use
Artemisia	<i>Artemisia vulgaris</i>	Leaf/flower	0.37		Recommended max 0.5% in fragrance concentrate. Wormwood is classified as an unsafe herb by the Food and Drug Administration (FDA) because of the neurotoxic potential of thujone and its derivatives. The safety of wormwood is poorly documented despite its long history as a food additive. Convulsions, dermatitis, and renal failure have been documented

	Country
<p>Traditional use and ethnobotany</p> <p>Fir has traditionally been used to help reduce symptoms of arthritis, rheumatism, bronchitis, coughs, sinusitis, colds, flu and fevers. It has been found to be a useful antiseptic, antitumor, antiarthritic and stimulating. The buds are antibiotic, antiseptic and balsamic. The bark is antiseptic and astringent. The leaves are an expectorant and a bronchial sedative. The resin is antiseptic, balsamic, diuretic, eupeptic, expectorant, vasoconstrictor and vulnerary. Both the leaves and the resin are common ingredients in remedies for colds and coughs, either taken internally or used as an inhalant. The leaves and/or the resin are used in folk medicine to treat bronchitis, cystitis, leucorrhoea, ulcers and flatulent colic. The resin is also used externally in bath extracts, rubbing oils etc for treating rheumatic pains and neuralgia. Oil of Turpentine, which is obtained from the trunk of the tree, is occasionally used instead of the leaves or the resin. The oil is also rubefacient and can be applied externally in the treatment of neuralgia</p>	France
<p>The resin is a very effective antiseptic and healing agent. It is used as a healing and analgesic protective covering for burns, bruises, wounds and sores. It is also used to treat sore nipples and is excellent for a sore throat. The buds, resin, and/or sap are used in folk remedies for treating corns, and warts. The resin is also antiscorbutic, diaphoretic, diuretic, stimulant and tonic. It is used internally in propriety mixtures to treat coughs and diarrhoea, though taken in excess it is purgative. A warm liquid of the gummy sap was drunk as a treatment for gonorrhoea. A tea made from the leaves is antiscorbutic. It is used in the treatment of coughs, colds and fevers. Widely used medicinally by various North American Indian tribes as an antiseptic healing agent applied externally to wounds, sores, bites etc., it was used as an inhalant to treat headaches and was also taken internally to treat colds, sore throats and various other complaints</p>	America
<p>See below</p>	France
<p>In Arabia and Iran it is used as an aphrodisiac. In Japan the leaves were used as a bathing agent to make "Sweet Flag bath water" It is an aquatic perennial, which emits a smell rather like that of mandarin oranges. Used for treating rheumatism, fever and lumbago</p>	Nepal
<p>The essential oil is used in aromatherapy in the treatment of nervous and digestive problems and also for acne, boils and cysts. The essential oil obtained from the leaves (yield 0.5%) is extensively used in perfumery. There is evidence that the use of this oil can sensitise the skin to sunlight and has been largely replaced by the lemongrass, <i>Cymbopogon</i> spp. The dried leaves retain their fragrance well and are used in pot-pourri. The plant is an insect repellent and repels midges, flies and other insects. The essential oil is an effective insecticide at 1% - 2%</p>	Corsica, Turkey
<p>Larger or Greater Cardamom or Nepal Cardamom. Medicinally, the seeds are credited with stimulant and astringent properties. It is used in gastrointestinal and genito-urinary complaints. It is correctly described by the Arabian physicians under the name Hil-Bawa</p>	Nepal
<p>Dill is a sedative herb and a good remedy for sleeplessness, acting as a mild tranquilliser. A treatment for flatulent pain in infants. Chewing dill seeds will help to sweeten the breath. Carminative and local anodyne. The essential oil in the seed relieves intestinal spasms and griping, helping to settle colic</p>	France, America
<p>See above</p>	Reunion
<p>In the form of an ointment it has a soothing effect on skin complaints, arthritis and rheumatism. A decoction of the root can also be used for scabies or itching and also for wounds. As a compress in gout. The tea is a good eye tonic</p>	Europe
<p>In the form of an ointment it has a soothing effect on skin complaints, arthritis and rheumatism. A decoction of the root can also be used for scabies or itching and also for wounds. As a compress in gout. The tea is a good eye tonic</p>	Europe
<p>Roman Chamomile flower [Syn. <i>Chamaemelum nobile</i>] has certain uses similar to those of Matricaria flower (German Chamomile), although some of its constituents are markedly different and it is much less investigated pharmacologically and clinically. Anti-inflammatory and sedative effects of volatile oil have been demonstrated in rats</p>	
<p>Used in fomentations for skin diseases and ulcerative sores. The entire plant is often made into a decoction and used as a wash for all sorts of wounds and skin ulcers. The boiled leaves are used as a poultice to allay headaches and nervous twitching of the skin and muscles. The dried leaves cut into small fragments are used to help induce more rapid scarring of unhealed wounds. Practitioners also use the leaves in cases of eczema, herpes and purulent scabies. Wormwood extract is the main ingredient in absinthe, a toxic liquor that induces absinthism, a syndrome characterised by addiction, GI problems, auditory and visual hallucinations, epilepsy, brain damage, and increased risk of psychiatric illness and suicide. Thujone-free wormwood extract is currently used as a flavouring, primarily in alcoholic beverages such as vermouth</p>	Nepal

ESSENTIAL OILS

Common name	Latin name	Part extracted	LD ₅₀ , g/kg.		Additional toxicology
			(oral)	(dermal)	
Neem	<i>Azadirachta indica</i>	Leaf	14.00	>2.00	<p>Oral – rat LD₅₀: 14 ml/kg Oral – rabbit LD₅₀: 24 ml/kg Neem oil is non-mutagenic in the Ames mutagenicity test Acute oral toxicity in rats fed technical grade azadirachtin ranged from greater than 3540 mg/kg to greater than 5000 mg/kg, the highest dose tested when administered undiluted to albino rats A primary eye irritation study in rabbits exposed to technical azadirachtin was rated mild to moderately irritating after instillation of 0.1 gm of the undiluted material. At one hour post-instillation, the maximum eye irritation score was 15.3/110; by 24, 48, and 72 hours the scores were 6.2/110, 0.3/110, and 0/110, respectively It was given a toxicity category of III The LD₅₀ (12% azadirachtin a major active constituent from neem) >5000 mg/kg in rats Acute oral – rat >5 g/kg Acute dermal – rat >2g/kg Acute inhalation – rat LC₅₀ >0.72 mg/L Skin irritation – rabbit > no irritation Skin sensitisation – guinea pig – sensitisation Eye irritation – rabbit – positive</p>
Lemon Myrtle	<i>Backhousia citriodora</i>	Leaf	2.43	2.25	<p>Dermal – rabbit (citra) 2.25 g/kg Oral – rat 2425 mg/kg</p>
Myrtle, Lemon	<i>Backhousia citriodora</i>	Flowering twig	2.43	2.25	<p>Dermal – rabbit (citra) 2.25 g/kg Oral – rat 2425 mg/kg</p>
Frankincense	<i>Boswellia carterii</i>	Resin	>5.00	>5.00	<p>8% in fragrances 10 ppm in flavours</p>
Frankincense	<i>Boswellia sacra</i>	Resin	>2.00	>2.00	<p>Toxicity class not given for acute oral, dermal irritation class not given but assumed C/D, dermal sensitisation class D (8% as absolute). Mucous membrane C-D (non-irritant). Rated safe during pregnancy</p>
Frankincense, Indian	<i>Boswellia serrata</i>	Resin	>2.00	>2.00	<p>Applying <i>B. serrata</i> to the skin may cause contact dermatitis, allergic contact dermatitis, or phyto dermatitis. <i>Boswellia</i> spp used in adhesive plasters and perfumes has caused dermatitis in sensitive people. <i>Boswellia</i> gum applied to intact or abraded rabbit skin for 24 hours under occlusion was found to be moderately irritating. Closed patch tests with 8% <i>Boswellia</i> found it was non-irritant to human skin. The fragrance raw material <i>Boswellia</i> absolute, which was prepared by ethanol extraction of <i>Boswellia</i> gum, then followed by evaporation of the ethanol, was found to be non-irritant, non-sensitising, and non-phototoxic in various tests on mice, pigs, and human subjects</p>
Ylang-ylang	<i>Cananga odorata</i>	Flower	>5.00	>5.00	<p>Oral – rat >5000 mg/kg Skin – rabbit >5000 mg/kg IFRA critical effect: sensitisation IFRA other specification: <20 mmoles/L of peroxides IFRA restricted components: Benzyl alcohol <3.50% sensitiser Benzyl benzoate <9.00% sensitiser Benzyl salicylate <3.00% sensitiser (E)-cinnamyl alcohol <0.40% sensitiser Eugenol <0.50% sensitiser Isoeugenol <0.50% sensitiser Famesol <3.00% sensitiser 10% in fragrances, 25 ppm in flavours Toxicity class D acute oral, dermal irritation class C, dermal sensitisation class D (10%). Rated safe during pregnancy, mucous membrane C-D (non-irritant). Not in the warning list for pregnancy</p>
Cedarwood (Atlas Cedar)	<i>Cedrus atlantica</i>	Wood	>5.00	>5.00	<p>Oral – rat >5000 mg/kg Skin - rabbit >5000 mg/kg 8% in fragrances</p>
Chamomile, Roman	<i>Chamaemelum nobile</i>	Flower	>5.00	>5.00	<p>see <i>Anthemis nobilis</i></p>
Camphor, White	<i>Cinnamomum camphora</i>	Leaf	>5.00	>5.00	<p>Oral – rat 3270 mg/kg Skin – rabbit 5000 mg/kg IPR – mouse 3000 mg/kg IFRA specification: <20 mmoles/L of peroxides Restricted components: Citronellol <0.90% sensitiser Methyl eugenol <0.30% has potential carcinogenic activity White camphor oil is said to be less toxic than the yellow and brown varieties which contain large amounts of safrole Japanese camphor contains ketones In Great Britain the recommended exposure limits of synthetic camphor are 2 ppm (long-term) and 3 ppm (short-term)</p>
Camphor, Yellow	<i>Cinnamomum camphora</i>	Bark	3.73	>5.00	<p>Oral – rat 3730 mg/kg Skin – rabbit >5000 mg/kg Toxicity class C acute oral, mucous membrane class B, dermal irritation class B more likely C-D, dermal sensitisation class D (10% for leaf). Not in the warning list for pregnancy Poisoning has occurred from administration of camphorated oil (camphor liniment) to children in mistake for castor oil Symptoms included nausea, vomiting, colic, headache, dizziness, a feeling of warmth, delirium, muscle twitching, epileptiform convulsions, depression of the central nervous system, and coma. Breathing was difficult and the breath had a characteristic odour; anuria may occur</p>
Ho oil	<i>Cinnamomum camphora</i>	Leaf	3.80	>5.00	<p>Camphor in large doses is toxic. Toxicity symptoms include headache, nausea, excitement, confusion and delirium. Camphor also affects the central nervous system and is toxic to humans. Toxicity symptoms in adults have been noted after use of as little as 2g</p>
Cassia	<i>Cinnamomum cassia</i>	Bark	2.80	0.32	<p>Oral – rat 2800 mg/kg Skin – rabbit 320 mg/kg IFRA sensitisation: The prime allergen is Cinnamic aldehyde and concentration of Cinnamic aldehyde in the finished cosmetic product should not exceed 0.1% Benzyl benzoate <2.50% sensitiser Cinnamyl alcohol <1.00% sensitiser Cinnamaldehyde <90.00% sensitiser Eugenol <4.00% sensitiser Methyl eugenol <0.10% has potential carcinogenic activity 1% in fragrances. 25 ppm in flavours</p>

Traditional use and ethnobotany	Country
<p>The medicinal and antimicrobial activity of the plant extract has been known for generations. The earliest use of a plant being used as human medication is found on an Egyptian papyrus dated about 1550 BC. (The Ebers Papyrus). Almost every part of the Neem tree is used in traditional medicine in India, Sri Lanka, Burma, Indochina, Java and Thailand. The stem, root bark, and young fruits are used as a tonic and astringent and the bark has been used to treat malaria and cutaneous diseases. The tender leaves have been used in the treatment of worm infections, ulcers, cardiovascular diseases and for their pesticidal and insect repellent actions. It is used to reduce dental caries and inflammation of the mouth when used as an ingredient in dental preparations. Naturally occurring oil (from seeds of <i>Azadirachta indica</i>) with pronounced antimicrobial properties</p>	India
<p>The essential oil distilled from the leaf has strong anti-bacterial, anti-fungal and anti-viral properties. It has a fine, rounded lemon scent with a somewhat spicy undertone. Its antibacterial qualities are more powerful than tea tree oil. The antimicrobial and toxicological properties of the Australian essential oil, lemon myrtle, (<i>Backhousia citriodora</i>) were investigated. Lemon myrtle oil was shown to possess significant antimicrobial activity against the organisms <i>Staphylococcus aureus</i>, <i>Escherichia coli</i>, <i>Pseudomonas aeruginosa</i>, <i>Candida albicans</i>, Methicillin-resistant <i>S. aureus</i> (MRSA), <i>Aspergillus niger</i>, <i>Klebsiella pneumoniae</i> and <i>Propionibacterium acnes</i> comparable to its major component – citral</p>	Australia
<p>As above</p>	Australia
<p>Fresh, woody, balsamic, slightly spicy and fruity fragrance. Externally, it served in the treatment of stiffness, blood vessels, joints, and various wounds. It is also used in inflammatory conditions, pain in the legs, infections, stomach problems, pressure in the ear, and to stimulate birth. The oil was used as an ingredient in embalming liquids and in mummification. It is also used to treat various diseases of the eyes, toothache, etc. The smoke was considered helpful for women's problems, to eliminate odours in the home, clothing, or body. It was known as a multi-purpose disinfectant. Mixed with pomegranate juice it found use as an astringent</p>	Dhofar, Somalia
<p><i>Boswellia sacra</i> is a tree in the <i>Burseraceae</i> family. It is the primary tree in the genus <i>Boswellia</i> from which frankincense, a resinous dried sap, is derived. Some literature identifies <i>B. sacra</i> as growing in Oman and Yemen, and <i>B. carterii</i> as growing in Somalia. The latest scientific opinion is that these are both the same species and should correctly be called <i>B. sacra</i>. The trees start producing resin when they are about 8 to 10 years old</p>	Oman, Yemen, Southern Saudi Arabia
<p>Indian frankincense is a gum resin from <i>Boswellia serrata</i> of <i>Burseraceae</i> used in Ayurveda and Western medicine for the anti-inflammatory effects of boswellic acids. <i>B. serrata</i> is listed in the USDA Database/Plants Profile as Indian frankincense, which was not considered true frankincense by traditional standards. It produces a soft, odorous resin that hardens in a year. As a result, it is used as incense solely by the natives</p>	Western India (Rajasthan)
<p>Ylang-ylang is extremely effective in calming and bringing about a sense of relaxation. It is antispasmodic, balances equilibrium, said to help with sexual disabilities and frigidity and has been used traditionally to balance heart function. Ylang-ylang in the Malayan language means "flower of flowers." The scent is very sensual, sweet and reminiscent of almonds. It is mentally relaxing and soothing. It is useful in treating insomnia, anger, anxiety and low self-esteem. It is said to relax facial muscles, and a massage with Ylang-ylang helps to ease tension headaches</p>	Indian Ocean
<p>Good for stress related disorders. Said to soothe acne, eczema, arthritis and rheumatism. One of the most ancient oils traditionally used as a fixative in the perfume industry. Soothing woody aroma – helpful for oily skin and itchy scalp. Add to a fragrance jar in a wardrobe to repel moths. A very calming oil for respiratory problems. The oil is widely used for insect repellent activities and Turkish carpet shops are walled with cedarwood boards to deter moths</p>	France
<p>May help with insomnia, muscle tension, cuts, scrapes and bruises. It is useful against infestations and is used extensively in Europe for skin disorders. Soothing and calming, especially on nervously excited children</p>	South Africa, England
<p>Camphor is well-known for its analgesic and infection-fighting abilities when used in combination with eucalyptus oil. The US Over-The-Counter (OTC) Drug Review Ingredient Status Report, (December 1991) listed camphor as a Category I ingredient for fever blisters and as a counter-irritant in the external analgesics monograph. Camphor is also listed as an antitussive ingredient in the cough and cold monograph. A nasal product indicated for the relief of nasal irritations and nasal congestion due to colds consists entirely of a blend of essential oils cajeput, eucalyptus and peppermint. Methyl salicylate, or oil of wintergreen, is listed as a counter-irritant in the external analgesic monograph</p>	
<p>See above</p>	
<p>The essential oil has been used as an anthelmintic, antirheumatic, antispasmodic, cardiogenic, carminative, diaphoretic, sedative and tonic. It has been used externally in liniments for treating joint and muscle pains, balms for chilblains, chapped lips, cold sores and skin diseases. It is often used as an inhalant for bronchial congestion. Some caution is advised, excessive use causes vomiting, palpitations, convulsions and death. It is possible that the oil can be absorbed through the skin, causing systemic poisoning. The essential oil is used in aromatherapy</p>	China
<p>It yields Cassia oil for barbers' shops, was one of the holy anointing oils mentioned in Exodus as being used by Moses on sacred occasions. The dried bark is used. Cassia is chiefly used to scent potpourri and to flavour chocolate; but in China it is given as an antiseptic and as a digestive tonic, and it flavours other medicines</p>	Indonesia