RESEARCH

The potential effectiveness of essential oils as a treatment for headlouse, *Pediculus humanus capitis*

Lowana Veal

Essential oils of aniseed, cinnamon leaf, red thyme, tea tree, peppermint, nutmeg, rosemary, and pine were tested in vitro against lice, *Pediculus humanus*. All the oils except for rosemary and pine were found to be effective in the laboratory when applied in an alcoholic solution and followed by a rinse the following morning in an essential oil/vinegar/water mixture. Peppermint and nutmeg were only used as a blend rather than as individual oils. Problems of solubility and toxicity are discussed, as are possible mechanisms of action. Phenols, phenolic ethers, ketones, and oxides (1,8-cineole) appear to be the major toxic components of these essential oils when used on lice. Aldehydes and sesquiterpenes may also play a role.

INTRODUCTION

The occurrence of headlouse is an ongoing problem, as many parents of young children will know. Although various commercial preparations are available for the treatment of headlouse, some parents are wary of using patent insecticidal products and prefer to use natural products such as essential oils.

According to Tisserand (1988), in the first century AD, Dioscorides noted the use of *Juniperus phoenicea* as a treatment for headlouse, and, in 1694, John Pechey described the use of lavender essential oil in the control of headlouse. Juniper no longer appears to be used for lice treatment, although *Juniperus communis* is mentioned by Valnet (1982) as a parasiticide. Lavender oil, on the other hand, is frequently mentioned as an anti-louse agent. Other oils that are recommended for lice treatment include rosemary, geranium, tea tree, eucalyptus, red thyme, thyme (unspecified type), lemon, origanum, and cinnamon (Price 1994, Worwood 1991, Dye 1992, Kusmirek 1993). Valnet (1982) also ascribes louse control properties to lemongrass, pine, and terebinth (oil of turpentine), while Lawless (1992) mentions lavandin, spike lavender, and galbanum as oils that control headlouse. Gauthier et al (1989) have shown that myrtle oil is effective on head lice in both laboratory and clinical trials.

Although recipes for the control of lice abound, it is difficult to find any scientific papers that demonstrate the effectiveness of essential oils in lice treatment.

MATERIALS AND METHODS

Shirley Price Aromatherapy oils were used for the tests. These are guaranteed to be pure oils, free of adulterative substances. The three blended oils were in the following proportions:

- **Mix A**: Red thyme (*Thymus vulgaris*) 4 ml, Rosemary 6 ml, *Rosmarinus officinalis*.
- **Mix B**: Peppermint (*Mentha piperita*) 3 ml, Nutmeg (*Myristica fragrans*) 7 ml.
Mix C  Tea tree (Melaleuca alternifolia) 5 ml
Cinnamon leaf (Cinnamomum zeylanicum) 5 ml

As mentioned earlier, the other oils tested were origanum (Origanum vulgare), pine (Pinus sylvestris), and aniseed (Pimpinella anisum).

For each oil, three replicates were used in each test, and the oils were tested on both adult lice and young eggs. Most of the tests used 40% ethanol as a solvent for the oils, although sometimes water was used. Two drops, i.e. 0.1 ml, of the relevant oil/oil blend were added to 10 ml of solvent and the mixture was shaken to facilitate dispersion. For each essential oil tested, a rinse mixture of 2 drops oil:47.5 ml malt vinegar:47.5 ml water was also prepared at the same time. Thus, the oils were used at a concentration of 1% for the initial exposure and approximately 0.1% for the rinse.

The Cambridge reference strain of lice was used for the tests. For the adult lice, batches of 20 lice were counted out and placed in small plastic petri dishes on squares of gauze measuring approximately 3×3 cm. The lice were kept in an incubator at 30°C ± 1°C and approximately 75% relative humidity until the test started.

The test was carried out as described below. 3 ml of the appropriate oil mixture was placed in a 30 mm diameter plastic petri dish, and the lice were tipped into the mixture for a 10-second dip. They were then removed from the oil solution, blotted gently dry on a tissue, returned to their original petri dish and placed in the incubator until next morning. Thus, the lice were exposed to the oil for a period of approximately 17 hours. A solution of 40% ethanol or water was used as a control, depending on the solvent used for the oils. Next morning, each dish of lice was washed for 3 minutes in a 1:15 solution of Boots' Frequent Wash Shampoo, and then rinsed three times with warm water through a glass crucible under light vacuum pressure. The base of each crucible was blotted dry. After each of the replicates has been washed, they were then rinsed with about 30 ml of the oil/vinegar/water mixture (unless stated otherwise) and again blotted dry. The crucibles were labelled and the lice were returned to the incubator. About 4 hours later, the number of living, dead, or morbid lice was recorded for each oil. Morbid lice are those which cannot walk properly or which are motionless apart from twitching limbs or gut peristalsis.

The lice eggs were treated by a similar protocol. Small squares of gauze, each containing about 100-200 eggs, were cut up and placed in petri dishes. Again, they were exposed to the oil in solvent, returned to the incubator overnight, washed in shampoo, rinsed with the oil/vinegar/water mixture, and returned to the incubator for about a week. After all the lice from the control gauzes had emerged and died, the numbers of hatched, half-hatched, dead, and undeveloped eggs were noted for each of the replicates.

In order to test whether or not the rinse was effective by itself, or if vinegar alone kills lice, adult lice were also exposed to a rinse mixture of mix C/vinegar/water or 50% vinegar water without prior exposure of the lice to essential oil in alcohol.

Mix C was chosen on the basis of preliminary experiments, where it appeared to be the most effective of the 3 blended oils in terms of its lonsidal activity. Mix C was also tested on the lice using a 10-minute exposure period to essential oil and ethanol.

**RESULTS**

Initially, the tests were carried out on the three blended mixtures of oils, namely mix A, B, and C. These were done on both lice and eggs, with and without an oil/vinegar/water rinse. The results are shown in Boxes 1 and 2. In all the boxes, the percentage mortality figures have been corrected for control mortalities using Abbott's correction, i.e. test mortality-control mortality/100-control mortality (Abbott 1925).

Adult lice are easier to kill than eggs, which explains the similarity in the two sets of figures shown in Box 1. It is probable that mix C has a faster action than the other oils, as none of the adult lice exposed to the tea tree/cinnamon leaf blend had laid eggs before they died, although eggs had been laid by both the control lice and those exposed to mix A and mix B oils. The enhanced effect of using a rinse on lice eggs is clearly seen in Box 2.

When mix C was tested on lice eggs, using a 10-minute exposure time, the mortality rate was only 11.9% compared to 91.9% with an overnight exposure performed simultaneously, which shows that a longer exposure time is more effective.

The role of the rinse solution is described in the next section. It does not work without prior exposure of the lice to the oils, as the mortality of lice exposed...
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to 50% vinegar/water or to a mix C/vinegar/water rinse is only 1.7% and 1.6% respectively.

Seven oils were tested by themselves on lice and lice eggs. Peppermint and nutmeg were not tested, as they are not reputed to be effective against lice, although they are the constituents of mix B which proved very effective when dissolved in alcohol. The percentage mortalities of lice and lice eggs exposed to various oils in alcohol are shown in Boxes 3 and 4, and Box 5 shows the percentage mortalities when water is used as a solvent instead of alcohol. Rosemary and pine were not tested in water as they proved to be completely ineffective on lice eggs when alcohol is used as a solvent (see Box 3).

The egg results in Box 4 should be viewed as an indicator of performance rather than reliable data as two of the control replicates had unacceptably high mortalities, probably due to aromatic contamination of the controls by the lighter volatile components such as terpenes, which Gauthier et al (1989) found was an effective cause of mortality with myrtle oil when lice were exposed to the vapourized oil. Nevertheless, as one would expect a higher mortality rate when alcohol is used as a solvent rather than water, the egg results in Box 4 appear to substantiate the results in Box 5.

In Box 5, both the red thyme and tea tree oils showed widely different results within the three replicates when tested on lice eggs, which probably indicates uneven dispersion of the oils in the oil/vinegar rinse mixture. A dispersal problem also occurred with red thyme on adult lice when alcohol was used as a solvent, and again with cinnamon leaf oil in water on adult lice.

**DISCUSSION**

Out of the seven individual oils and three blended oils that were tested in this set of experiments, the most effective oils for killing lice and lice eggs appeared to be aniseed, oregano, and the tea tree/cinnamon leaf blend. Cinnamon leaf, red thyme, tea tree, and the peppermint/nutmeg blend all performed well when alcohol was used as a solvent.

The mechanism by which essential oils kill lice is unknown. Commercial insecticides for lice, mostly containing either malathion, carbaryl or a pyrethroid, are neuroactive agents that may work in one of three ways. Most organophosphates and carbamates affect the action of the nerve transmitter acetylcholine by inhibiting the action of the enzyme acetylcholinesterase, which then leads to overstimulation of the nervous system, followed by convulsions, paralysis, and death. Pyrethroid products affect ion permeability; and nicotine and lindane (which is currently an ingredient of Quellada lotion) both affect nerve receptors. These types of insecticides also lead to convulsions, paralysis, and death (Matsumara 1985, Patrick 1995).

It is probable that the essential oils that were effective in these experiments also cause death by acting on the nervous system. Aniseed, cinnamon leaf, origanum, red thyme, peppermint, and nutmeg all contain large amounts of phenols or the closely related phenolic ethers (see Box 6) while aniseed and peppermint also contain ketones (Valnet 1982, Sellar 1992, Price 1993, 1994). Both phenols and ketones are neurotoxic and many phenols, especially thymol, carvacrol, and eugenol, are also skin irritants in humans. Safrol, a phenolic compound, has been found to be very effective as a lousicide (Burgess, personal communication). In addition, ketones are lipolytic, which may contribute to their effectiveness as lousicides (Gattefossé 1993, Manahan 1992, Price 1993). Skin irritancy could be seen as analogous to abrasion, and abrasion of the outer cement and wax layers of the insect cuticle accelerates the rate of entry of insecticides (Matsumara 1985). However, substances that are irritant to humans may not be irritant to insects. Aldehydes, which occur in aniseed and cinnamon leaf, are also known to have irritant properties to humans (Price 1993, 1994) and are known to be toxic to insects, as are some sesquiterpenes (Harbourne 1993). The phenolic ether myristicin, which is found in nutmeg, may act as a feeding deterrent (Rhodes 1985).

Tea tree is the only essential oil that is effective against lice that does not contain either a phenol or a ketone. However, it does contain 1, 8-cineole, an oxide that Gauthier et al (1989) also found to be an active lousicidal component of myrtle oil and which
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<table>
<thead>
<tr>
<th>Box 6</th>
<th>Main constituents of essential oils</th>
</tr>
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<tbody>
<tr>
<td>Cinnamon leaf</td>
<td>eugenol (t), safrol (t) (phenols), cinnamaldehyde (t)</td>
</tr>
<tr>
<td>Origanum</td>
<td>carvacrol (t), thymol (s) (phenols), terpenes (t)</td>
</tr>
<tr>
<td>Red thyme*</td>
<td>thymol (m), carvacrol (t), sesquiterpenes (t), alcohol (s), 1,8-cineole (s) (oxide), terpenes (m)</td>
</tr>
<tr>
<td>Aniseed</td>
<td>trans-anethole (t), methyl chavicol (t) (phenolic ethers), cineole (t) (ketone), anise aldehyde (t), sesquiterpenes (t)</td>
</tr>
<tr>
<td>Tea tree</td>
<td>1,8-cineole (t), terpinen-4-ol (m), terpenes (m)</td>
</tr>
<tr>
<td>Peppermint</td>
<td>menthone (t) (ketone), 1,8-cineole (s), menthol (m), terpenes (t)</td>
</tr>
<tr>
<td>Nutmeg</td>
<td>safrol (t), myristicin (t) (phenolic ether), alcohol (s), 1,8-cineole (t), terpenes (t)</td>
</tr>
</tbody>
</table>

*The thymol chemotype of Thymus vulgaris was used in these experiments. Large (t) > 60%, medium (m) 30–50%, small (s) 5–29%, trace (t) < 5%

It is also present in large amounts in the essential oil from Eucalyptus globulus (Valnet 1982), which is also said to control lice. 1,8-cineole is, like phenol, a skin irritant (Williams & Home 1989, Price 1993, 1994).

It is unclear why rosemary oil is ineffective on lice as its cineole content is 30–50% and it also contains a moderate amount of alpha-pinene, which Gauthier et al (1989) found was an effective lousicidal component.

It is possible that, as regards penetration, some of the essential oil components become lodged in the insect cuticle, as happens with malathion. In lipophilic compounds, such as essential oils, subsequent penetration through the insect haemolymph may be slow and limited, and instead entry may occur via the tracheal system (Matsumara 1985). This is especially likely to happen with tea tree oil, as it is less soluble than the other oils. However, mode of entry is a complex subject and so these observations should only be regarded as hypothetical.

The oil/vinegar rinse appears to greatly increase the effectiveness of the oils. It may be that it is the second application of the oils that makes the rinse effective, rather than the vinegar, as Gatufossé (1993) stated that if the sebum is removed by way of a solvent, the skin will then absorb the oils at a faster rate. He suggested that the skin should be cleansed first with either a solvent, such as alcohol, or with another solution of the same essential oils. An initial treatment using eucalyptus, tea tree, and thyme in jojoba oil, followed by a rinse using oils in an alcoholic solution, is mentioned by Watson as a method of killing lice.

Alcohol penetrates the insect cuticle faster than water, yet is also more toxic than water. However, it has been demonstrated that the toxicity of alcohol, at least to humans, is markedly decreased when essential oils are added to it (Gatufossé 1993). Thus, oils in an alcoholic solution should be safe to use on children.

The solubility of oils is a problem, as they are not generally hydrophilic and hence do not disperse evenly (Deans & Svoboda 1993). Phenols, aldehydes, ketones, and alcohols are more soluble than terpenes, sesquiterpenes, oxides, and phenolic ethers, so tea tree oil (which is chiefly composed of an oxide, terpenes, and alcohols) should be less soluble than the other oils tested. The oils appear to be more soluble in alcohol, but the solution should still be shaken thoroughly before use. The solubility problem could potentially be remedied by putting a small amount of emulsifier with the oil solution, if oils are sold as a blend for killing lice. However, it is currently illegal to sell essential oils, or products containing essential oils, as a lousicidal preparation.

Some of the oils that are effective against lice have potential toxicity problems for the same reasons that make them effective against lice, ie. neurotoxicity and skin irritancy, although Tisserand and Balacs (1995) consider that none of the oils mentioned in this paper are toxic unless ingested orally. However, many aromatherapists believe that aniseed, nutmeg, origanum, peppermint, and possibly thyme should not be used on/baby pregnant women. The toxicity of thyme depends largely on its chemotype. The red thyme chemotypes, which contain phenols, are the most toxic (Price 1993, 1994), but are also the ones that are likely to be the most effective lousicides. Cinnamon oil can also be a skin irritant, either because of the eugenol in the leaf oil or, if bark oil is used unintentionally instead of the leaf oil, because of the large amount of cinnamic aldehyde present (Sellari 1992, Price 1993, 1994). Safrol, which is found in small quantities in origanum and nutmeg, may be carcinogenic (Tisserand & Balacs 1995, Lis-Balchin 1995). Anethol, which is the main component of aniseed, has allergenic properties. The potential toxicity of these oils is a problem, especially as a proportion of mothers of small children would undoubtedly be pregnant themselves. There is some dispute as to whether aniseed and origanum should be used at all (Sellari 1992). Perhaps the solution would be to let qualified aromatherapists dispense the oils, with clear instructions for use. Tea tree is safe enough for the general public to use without fear of toxicity. The tea tree/cinnamon leaf blend may also be potentially sold in shops, under guidance from the sales staff. On the basis of the preliminary findings described in this paper, a clinical trial should be carried out using the oils that appear to be the most effective at killing lice in the laboratory and which are regarded by most aromatherapists as safe, namely tea tree/cinnamon leaf in 50:50 ratio, peppermint/nutmeg as a 30:70 blend, cinnamon leaf, tea tree, and red thyme. Aniseed and origanum should also be included in the trial, if they can be considered safe enough to use on children.

If one knows the constituents of essential oils, it may be possible to predict other oils that may
also be effective as a louse control agent. Oils containing phenols, ketones, oxides, or aldehydes may be effective. Oils which have a high phenol content include savoury (carvacrol), winter savoury (carvacol or thymol), and clove bud (eugenol), while fennel contains the phenolic ether trans-anethol. Ketones are found in sage, caraway, and hyssop, and the oxide 1,8-cineole is found in Spanish marjoram (Thymus mastichina), eucalyptus, niaouli, and cajuput, as well as myrtle. Lemongrass may also be effective as it contains the aldehyde citral.

CONCLUSIONS

Aniseed, origanum, cinnamon leaf, red thyme, and tea tree all appeared to be effective lousicides in the laboratory when tested in an alcoholic solution, using an overnight exposure. A clinical trial should be carried out using cinnamon leaf, tea tree, red thyme, a tea tree/cinnamon leaf blend, a peppermint/nutmeg blend, and possibly aniseed and origanum. However, an integral part of the treatment process must be the use of a rinse containing the same essential oil as that used in the original application. The rinse solution used in these tests was essential oil/vinegar/water, but alcohol or water may also be effective. Phenols, phenolic ethers, ketones, and oxides appear to be the major components of essential oils which are most likely to be effective as lousicides. Neurotoxicity and skin irritancy are likely to be important factors as regards modes of action.

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REFERENCES

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-Humanity is a river of light running from eternity to eternity.

(Kahl Gibran: Sand and Foam)