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Antibacterial activity of essential oils, hydrosols and plant extracts from Australian grown *Lavandula* spp.

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Summary Although there is considerable anecdotal information about the antibacterial activity of lavender oils, much of this has not been substantiated by scientific or clinical evidence. In this study we assessed the activity of lavender essential oils, hydrosols and aqueous and ethanolic foliage extracts from a range of Australian grown Lavandula species. The results support the anecdotal use of lavender oils as antibacterial agents and demonstrated that some oils which had previously not been investigated (e.g., *Lavandula heterophylla*) display good antibacterial activity against a range of bacteria including *Streptococcus pyogenes*, *Staphylococcus aureus*, MRSA, *Citrobacter freundii*, *Proteus vulgaris*, *Escherichia coli*, VRE and *Propionibacterium acnes*. *Pseudomonas aeruginosa* was the only bacterium not susceptible to any essential oil. There was considerable variability in the activity of the essential oils however; no one oil produced the highest level of antibacterial activity against all bacteria. No correlation was observed between the percentage of major chemical components and antibacterial activity. The lavender hydrosols and aqueous foliage extracts did not have any antibacterial activity. Six of the ethanolic extracts displayed activity against *Pr. vulgaris* but no activity against any other organism. Further work is required to determine whether these in vitro results will be realised in a clinical environment but it is clear that not all lavenders are equal in terms of their antibacterial properties.

Introduction

Within the scientific and medical literature lavender essential oils have been investigated for a number of properties, for example, *Lavandula multifida* extracts have demonstrated anti-inflammatory

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activity (Sosa et al., 2005) while others have reported positive effects on mood following inhalation of lavender oils or fragrance (Field et al., 2005; Morris, 2002). However, perhaps the best-known use of lavender is as an antiseptic or antibacterial agent. Lavender essential oils are advocated for their use as an antibacterial agent in both early and modern aromatherapy texts (Gattefosse, 1995; Lawless, 1992). Gattefossé, for example, in his 1937 aromatherapy text describes the use of essences of lavender essential oils as an antiseptic mouthwash and in embalming (Gattefosse, 1995). Hammer et al. (1999) included two *L. angustifolia* oils (identified by the authors as French lavender and Tasmanian lavender) in their study of a range of essential oils and found that both oils exhibited antibacterial activity with minimum inhibitory concentrations (MIC) in the range of 0.5% to >2% (v/v), with little difference between the two oils. Dadalioğlu and Everendiliek (2004) showed that *L. stoechas* (Spanish lavender) had a strong antibacterial action against *Escherichia coli* O157:H7, *Listeria monocytogenes*, *Salmonella typhimurium* and *Staphylococcus aureus*. Similarly Lis-Balchin and Deans (1997) and Lis-Balchin et al. (1998) showed that lavandin, French lavender, spike lavender, Bulgarian lavender and generic 'lavender' (type unspecified) essential oils all have activity against a large number of bacteria and fungi. For example, Bulgarian lavender essential oil inhibited 23 of 25 different bacteria while lavandin inhibited 17 of 25 bacteria. Unfortunately, although in both studies the authors did GC/MS analysis of the oils, they did not seek to verify the plant source of each of the lavender oils, relying only on common names. These studies suggest that the anecdotal use of lavender as an antibacterial agent may be justified and that products, for example toiletries and cosmetics, incorporating these essential oils may have some additional value as therapeutic products.

In Australia the best-known lavender essential oil is that from Bridestowe Lavender in Tasmania. This essential oils is distilled from *L. angustifolia* (also known as True or English lavender); however a study of the Australian lavender industry (Peterson, 2002) has demonstrated that most lavender growers grow several varieties (e.g., *L. x intermedia* (lavandin), *L. stoechas* and *L. x allardii*), often depending on favorability of local growing condition. Unlike *L. angustifolia* essential oil which has value as a perfumery product these other lavender essential oils are often incorporated into products such as shampoos, soaps, lip balms and other cleansing products, or the flowers are dried for use a pot-pourri. In addition, the by-products of distillation (the hydrosol) are gaining popularity as a cosmetic and therapeutic product in their own right (Catty, 2001).

In this study we examined the antibacterial activity of a range of Australian grown lavender essential oils, hydrosols and aqueous and ethanolic extracts.

Materials and methods

Essential oils and lavender extracts

A range of lavender essential oils, and some hydrosols, were obtained directly from growers/distillers or purchased commercially. All but one of the *L. angustifolia* oils were distilled from Australian grown plants. A complete list of the plants used and the products tested in this study are listed in Table 1. Samples of fresh foliage were obtained from the lavender collection at Charles Sturt University for production of aqueous and ethanolic extracts. Flowers heads were removed and the foliage dried at room temperature for one week. The dried foliage was then ground to a fine powder using a commercial coffee/spice grinder (grinding time 40—50 s). The powder was then sealed in sterile glass jars and stored at room temperature in the dark until required.

Ethanol extracts were prepared by shaking 5 g foliage powder in 50 mL ethanol for 16 h at 45 °C and 160 rpm. The extract was cooled and filtered though Advantec #1 filter paper to remove particulate matter and freeze-dried in 100 mL Quickfit flasks attached to a rotary evaporator. The resulting solid was removed from the flask using a sterile spatula and a minimum volume of ethanol (approximately 12× the weight of sample). Each sample was centrifuged at 2000 rpm for 3 min and the supernatant used in the disc diffusion assay.

Aqueous extracts were prepared by boiling, in a covered beaker, 5 g foliage powder in 250 mL sterile nanopure water for 5 min. The cooled extract was then filtered using Advantec #1 filter paper and a 0.45 μm membrane filter (Sartorius, Australia). The resulting extract was stored at −20 °C until required.

Microorganisms

Lavender essential oils and hydrosols were assayed against the following microorganisms: Gram positive bacteria — *Enterobacter aerogenes*, *Propionibacterium acnes*, *Staph. aureus*, MRSA, *Streptococcus pyogenes* & *VRE*; Gram negative bacteria — *Citrobacter freundii*, *Escherichia coli*, *Proteus vulgaris*,