

Deodorant is one of the most common personal hygiene products used in the household. Liquid deodorants are applied to the body, especially to the underarms, to eliminate body odour caused by bacterial breakdown of perspiration. The bacteria feed on the sweat from the apocrine glands and on dead skin and hair cells, releasing 3-methyl-2-hexenoic acid in their waste (Pierce *et al.*, 1995).

Deodorants are classified as over-the-counter (OTC) medicated cosmetics by the US Food and Drug Administration (FDA). Many deodorants are alcohol-based. Alcohol initially stimulates sweating, but may also temporarily kill bacteria. However, alcohol can also cause the skin to redden and become dry. Thus, we have formulated a liquid deodorant without alcohol (Figure 1). Deodorants can be formulated with other more persistent anti-microbials such as sophorolipid (SL), triclosan, or metal chelant compounds that can slow down or inhibit bacterial growth. Deodorants may also contain perfume, fragrances or natural essential oils intended to mask the odour of perspiration.



Figure 1. Sophorolipid liquid deodorant (SLD).

SOPHOROLIPID (SL) AS AN ANTI-BACTERIAL AGENT IN LIQUID DEODORANTS

Many types of yeast such as *Candida glogengieseri*, *Torulopsis magnoliae* and *Candida bombicola* can biosynthesize a class of compounds known as biosurfactants. Biosurfactants have advantages over synthetic surfactants (normally produced from petrochemicals) due to their high biodegradability and being non-toxic, and because they can be produced from renewable resources. SL is a biosurfactant which has anti-microbial characteristics. SL can be produced via a biotechnology process using palm oil as the substrate. Palm-based SL has shown anti-microbial activity against *Bacillus subtilis*, *Streptococcus mutans* and *Propionibacterium acne* at 4, 1, 0.5 ppm, respectively. Also, 100 ppm of SL inhibited 50% of cell growth of the plant pathogenic fungus, *Botrytis cineria*. Figures 2a and 2b show the growth inhibition of *P. acne* and *Streptococcus epidemides* by the palm-based liquid deodorant.

Supplementing with other surfactants showed no significant effects on the anti-microbial activity. The palm-based liquid deodorant also showed no irritation to the skin (Figure 3). These results show the potential use of the palm-based SL as an active ingredient in healthcare products.

ALUMINIUM IN ANTIPERSPIRANT DEODORANTS

Many liquid deodorants have anti-perspirant properties which attempt to stop or significantly reduce perspiration and thus, reduce the moist conditions in which bacteria thrive. Aluminium chloride, aluminium chlorohydrate and aluminium-zirconium compounds are most frequently used as anti-perspirant agents. Aluminium-based complexes react with the electrolytes in the sweat to form gel plugs in the ducts of the sweat glands.

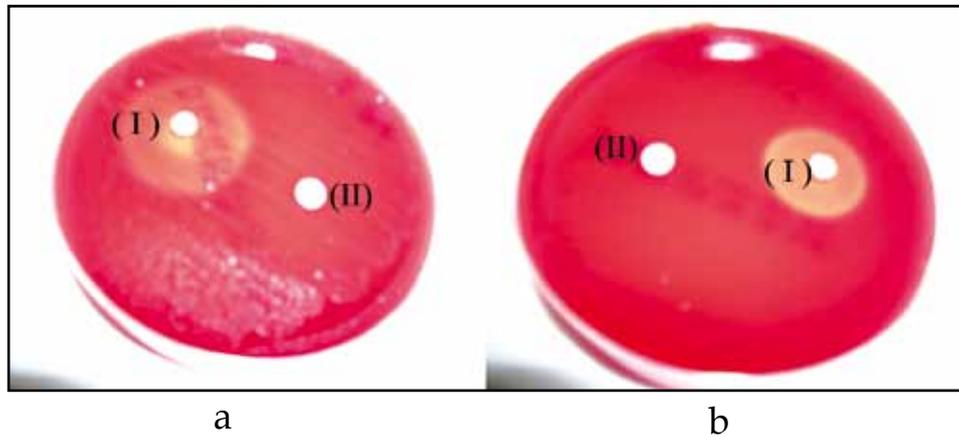


Figure 2. Inhibition of (a) *S. epidemides* and (b) *P. acnes* cultures by palm-based liquid deodorant. (I) Sample disc with liquid deodorant showing inhibition zone. (II) Sample disc without liquid deodorant showing no inhibition zone.

These plugs prevent the glands from excreting liquid and are removed over time by the natural regeneration of the skin cells.

However, aluminium is also a poisonous neurotoxin that can accumulate in the body. Recent research has identified aluminium fluoride as a particularly nasty substance, shown to cause the deposition of amyloid proteins (the proven cause of the tangled brain cells in most dementia cases) in the brains of rats when they are given drinking water with a concentration of only 0.5 to 1 ppm (Varner *et al.*, 1998). The cited work has found evidence that level of aluminium fluoride as low as 1 ppm had adverse affects on the brain development in rats.

The use of aluminium-containing anti-perspirants has been linked with the systemic accumulation of aluminium which increases the risk of developing Alzheimer's disease (Exley, 1998). Aluminium being a neurotoxin alters the function of the blood-brain barrier (Banks and Kastin, 1999), and it is one of the few abundant elements that appear to have no beneficial function to living cells (*i.e.* it is a non-essential metal) (Exley *et al.*, 2007).

DEODORANT AND SOPHOROLIPID MARKETS

The deodorant market consists of roll-on deodorants, aerosol anti-perspirants, body sprays, sticks

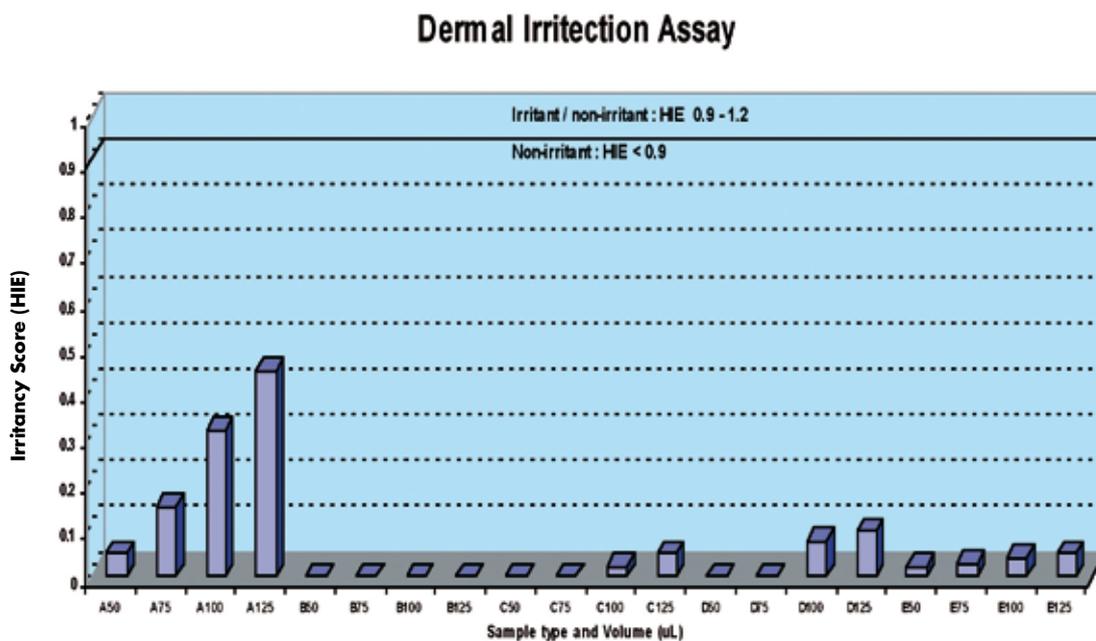


Figure 3. Dermal irritation assay of a commercial deodorant and sophorolipid (SL)-based deodorants (SLD) at different concentrations. Sample A: commercial deodorant (50-125 µl), Sample B: SLD without perfume (50-125 µl), Sample C: SLD without preservative (50-125 µl), Sample D: SLD without sophorolipid, perfume and preservative (50-125 µl), Sample E: SLD without perfume and preservative (50-125 µl). HIE (human irritancy equivalent unit). Non-irritant: 0-0.9, Non-irritant/irritant: 0.9-1.2, Irritant: > 1.2.

and solids, deodorant gels and deodorant creams. In 2008, the global deodorant market grew by 3.6% to reach a value of USD 11.5 billion. The market is forecast to be valued at USD 13.5 billion by 2013, an increase of 17.7%. In terms of units, the global deodorant market grew by 2.1% in 2008 to reach a volume of 3.4 billion units. Unilever accounts for a 31.6% share of the global deodorant market value.

SL is an emerging biosurfactant with wide applications in cleaning, cosmetic and personal care products. In the cosmetic and personal care sectors, it can be used in bactericidal products, acne prevention, cleansing and skincare products. It also has applications as an anti-dandruff agent and as a natural preservative. Sebapharma GmbH & Co. KG, a German company which produces and sells the skincare products under the brand name *Sebamed*, has incorporated SL as an active ingredient in one of their deodorant formulations.

ECONOMIC ANALYSIS

The return on investment (ROI) for the palm-based liquid deodorant is expected to be 25%, with a payback period of three to four years. Initial investment is estimated to be RM 300 000.

CONCLUSION

A palm-based liquid deodorant using a biotechnologically produced anti-bacterial agent, SL, has been produced as a substitute for aluminium-based liquid deodorants. This natural liquid deodorant, which is aluminium-free, will ensure no aluminium

toxicity-related issues with prolonged use. The sophorolipid liquid deodorant (SLD) shows non-irritant effects, and is thus good for people who have allergic reactions to the ingredients found in many commercial brands. Furthermore, being alcohol-free and made from plant materials (SL from palm oil), the SLD is halal.

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