NATURALS - PRESERVATIVES

A place of natural safety

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Consumers are increasingly on the lookout for products that contain no preservatives or that are preserved naturally, so manufacturers are increasingly in search of materials that will do just that

The need to control microbial activity is inherent in two major facets of personal care. The first area is that of antimicrobial care where the product helps to retard the growth of topical pathogens or eliminates them. The second is in the area of preservatives that retard the growth of microbes in product formulations.

Recently there has been increased dialogue related to natural antimicrobials as topical actives and preservatives in the personal care industry. Synthetic compounds long accepted as effective in controlling microbial growth have come under scientific and regulatory scrutiny. These efforts are mainly driven by safety and environmental concerns, and the increased incidence of antibiotic resistant microbial strains. Natural alternatives derived from botanicals are therefore being explored by researchers around the world.

Olive

Coleus forskohlii roots

Curcuma longa roots

Neem

Antimicrobial action

Like all biological materials, the skin harbours its own microflora. Under certain conditions and in some groups of people, the skin microflora grow invasively and trigger pathological processes resulting in acne, infections and skin eruptions. In addition, invasive growth of certain micro-organisms causes scalp infections and infections in the oral cavity. Certain micro-organisms found in the skin, scalp and nails may also generate malodour and irritation, affecting general health and well-being. Antimicrobials find applications in cleansing formulations, deodorants and topical protectant formulations.

Examples of skin pathogens include: *Propionibacterium acnes,* a micro-organism associated with acne and other skin infections; *Staphylococcus aureus*, a bacterial strain found in infected wounds and skin eruptions including acne; *Staphylococcus epidermidis*, a bacterial strain occurring in a variety of opportunistic bacterial skin infections and in acne; corynebacteria, and micrococci that cause body odour. Athlete's foot (*Tinea pedis*) and *onychomycosis* (nail fungus) are other infections affecting the skin and nails.

Examples of oral cavity pathogens include *Streptococcus mutans*, a bacterial strain associated with the progression of dental caries. Examples of scalp pathogens include *Pitysporum ovale (Malassezia furfur*, a yeast strain associated with dandruff).

Micro-organisms also affect dental health. Gum disease involves bacterial growth and production of metabolic substances that gradually destroy the tissue surrounding and supporting the teeth. These bacteria grow and attack the tissues causing gingivitis, characterised by inflamed gums that bleed easily. If left untreated the condition progresses to periodontal disease with severe inflammation, bone damage and tooth loss. The causative bacteria reside in plaque, the deposit that forms on the base of the teeth and hardens to form tartar.

Poor oral hygiene is the major cause of gum disease. Lifestyle, nutrition and ageing affect the immune response and increase the risk of gum disease. Antimicrobials target oral pathogens such as *Streptococcus mutans*, while anti-inflammatory and wound healing extracts offer support to healthy gums and teeth.

Antibiotic resistant strains of micro-organisms arise from non-judicious use of conventional antibiotics. There is therefore a need for natural products that effectively inhibit the growth of micro-organisms. Multifunctionality is an additional advantage of natural extracts. Several of them also offer anti-inflammatory, immunological and wound healing.

In the last few years, a number of laboratory studies have revealed the efficacy of plant extracts and phytochemicals as antimicrobials. These properties are attributed to the presence of secondary metabolites such as phenolics in essential oils and tannins in herbal extracts. Some examples of classes of natural materials that afford antimicrobial protection include: essential oils such as tea tree oil, rosemary oil and turmeric oil; plant extracts such as rosemary extract, sage extract, lemon balm extract, green tea extract, *Kaempferia galanga* extract, Neem leaf extract and oil, and isolated phytochemicals such as cinnamates, benzoates, eugenol.

Natural antimicrobials

Coleus oil [INCI: Coleus forskohlii root oil]

Coleus oil is an essential oil extracted from the roots of *Coleus forskohlii*, a plant from the Natural Order Labiatae (Lamiaceae), a family of mints and lavenders. This species is a perennial herb with fleshy, fibrous roots. This grows wild in the warm sub-tropical temperate areas in South Asia. The roots are eaten as a condiment or pickle in India. In recent years *Coleus forskohlii* has gained pharmacological importance as the only known plant source of the biologically active compound, forskolin, a coleus oil which is a useful by-product of forskolin extraction. The newly discovered antimicrobial properties of the oil (of specific composition obtained using a proprietary extraction process)[1] render it useful in topical preparations.

Compounds such as 3-decanone (about 7%), bornyl acetate (about 15%), sesquiterpene hydrocarbons and sesquiterpene alcohols in major concentrations impart pleasing spicy notes to the essential oil. ß-sesquiphellandrene (about 13%) and g-eudesmol (12.5%) were identified in experimental studies on the oil.

In laboratory studies, coleus oil was found to inhibit the growth of skin pathogens more effectively than the better known tea tree oil; the pathogens included *Propionbacterium acnes*, *Staphylococcus aureus* and *Staphylococcus epidermidis*. Additionally, coleus oil was found to inhibit the yeast culture *Candida albicans* more effectively than tea tree oil. The extract is safe to use in cosmetic formulations, it does not irritate the skin and its pleasant woody aroma blends with cosmetics.

Kaempferia galanga [INCI: Kaempferia galanga root extract]

Kaempferia galanga (lesser galangal, kencur), and *Alpinia galanga* (greater galangal) from the Zingiberaceae family are commonly used as spice ingredients and medicinal herbs in South East Asia and are valued for their protective topical effects when applied as pastes. *Kaempferia galanga* rhizome contains 1.5 - 2% essential oil, the main components being ethyl cinnamate (25%), ethyl-p-methoxycinnamate (30%) and p-methoxycinnamic acid. Kaempferia galanga is a good natural source of the biologically active ester ethyl p-methoxycinnamate. The antifungal action of ethyl-p-methoxycinnamate is reported in the literature.

In laboratory studies, the fraction of the extract rich in ethyl p-methoxycinnamate was found to effectively inhibit the growth of *Propionibacterium acnes*, producing significant zones of inhibition at concentrations even as low as 0.5%.

Turmeric oil [INCI: Curcuma longa]

Turmeric oil is obtained by steam distillation or solvent extraction of the powdered rhizome of species of the genus Curcuma (family: Zingiberaceae). Of these species, *Curcuma longa* is the most well known. *Curcuma longa* yields 0.3-7.2% (usually 4-5%) of turmeric oil following steam distillation. The chief constituents of the essential oil are turmerone (60%) and related compounds, and zingiberene (25%).

In India, turmeric has long been known for its cosmetic and wound healing properties. The essential oil has been used as a perfume component and studies have shown that it has antibacterial/antifungal, anti-inflammatory and insect-repellant properties, and is effective in the treatment of scabies. A primary skin irritation test conducted on rabbits with turmeric oil did not cause any irritation (primary skin irritation score = 0.00).

Oleuropein [INCI: Oleaeuropaea (olive) leaf extract]

Oleuropein is a polyphenolic compound found in plants belonging to the Oleaceae family, of which the olive tree is a member. The olive tree (*Olea europaea*) was known in biblical times as the Tree of Life. Oleuropein is the major phenolic constituent extracted from olive leaf, (constituting about 19% w/w) and from the polar fraction of virgin olive oil. Oleuropein is reported to be hydrolysed to another biologically active compound, hydroxytyrosol, *in vivo*. A variety of antimicrobial actions of oleuropein and its associated compounds have been demonstrated *in vitro*. The inhibitory action of oleuropein against the growth and toxin production of *Staphylococcus aureus, Bacillis cerus*, *Pseudomonas syringae* and several other bacterial strains, by oleuropein or its hydrolysis products in vitro, is documented. For example, the presence of low concentrations (0.1% w/w) of oleuropein delayed the growth of *Staphylococcus aureus* in nutrient media, while higher concentrations (0.4-0.6% w/w) inhibited growth completely. Concentrations of oleuropein greater than 0.2% w/w inhibited growth and enterotoxin production in both types of media.

Oleuropein had bactericidal effects against a broad spectrum of gram-positive and gram-negative bacteria, but no effect was observed against yeast. Antiviral properties are also reported *in vitro* and *in vivo*. Although the precise mechanism of antimicrobial action has as yet to be elucidated, oleuropein and related compounds appear to have surface-active properties that interfere with microbial cell membranes. Oleuro-pein could also interfere with the synthesis of amino acids that are crucial to viral replication and, in the case of retroviruses, neutralise the production of reverse transcriptase and protease. Additionally, oleuropein is also reported to stimulate phagocytosis or the immune response to infection by pathogens.

Neem oil and Neem leaf extract [INCI: Melia azadirachta]

The neem tree is traditionally labelled The Village Pharmacy because of its multifaceted healing properties. These range from immunomodulatory and anti-inflammatory effects to antimicrobial and pesticidal attributes. The leaves and seeds of neem yield limonoids with wide biological applications. These have antibacterial, antiviral, insect repellant, anti-protozoal and anti-helmenthic properties.

The seed oil at a concentration of 0.3% on agar plates was active against *Stahylococcus aureus* and at 0.4% was active against *Salmonella typhosa*. The seed oil at a concentration of 3% on agar plates was active against *E. coli* and Proteus species. A concentration of 6.0% was active against *Klebsiella pneumoniae*. Methanol and butyl-methyl-ether extracts showed antifungal activity against the strains of fungi including *Epidermaphyton floccosum*, *Microsporum canis*, *Microsporum gypseum*, *Trichophyton concentricum*, *Trichophyton entagrophytes, Trichophyton rubrum* and *Trichophyton violaceum*.

A recent study determined the efficacy of a muco-adhesive dental gel containing *Azadirachta indica* leaf extract (25mg/g) using commercially available chlorhexidine gluconate (0.2% w/w) mouthwash as a positive control. The results of the study suggested that the dental gel containing neem extract significantly reduced plaque index and bacterial count as compared to the control group.

Green tea extract [INCI: Camellia sinensis leaf extract]

The catechins in green tea were found to inhibit *Staphylococci* and *Yersinia entero-colitica*. Green tea extracts may make strains of drug resistant bacteria more sensitive to penicillin. *In vitro* studies on *Staphylococcus aureus* revealed that the addition of green tea extract induced a reversal of penicillin resistance. It was found that epicatechin gallate markedly lowered the minimum inhibitory concentration (MIC) of oxacillin and other beta-lactams. Extracts of green tea were found strongly to inhibit *Escherichia coli*, *Streptococcus salivarius* and *Streptococcus mutans*, micro-organisms found in the saliva and teeth of people suffering from dental caries. Green tea in combination with the synthetic anti-oxidant butylated hydroxyanisole (BHA) reduced the hydrophobicity of *S. mutans* and greatly inhibited ($p<0.001$) the formation of hyphae in *Candida albicans*. The increased antimicrobial activity of green tea is related to an impairment of the barrier function in micro-organisms and a depletion of thiol groups.

Natural preservatives

A preservative is essentially a chemical agent that will destroy or inhibit micro-organisms in finished formulations. There is ample scope for microbial contamination at the end user level. It is therefore important that the product be protected by a suitable preservative to ensure safety in use and adequate shelf life.

Water activity and pH of the formulation, and the solubility and stability of the preservative in the base composition are the factors that determine preservative efficacy. Additives such as glycerol, butylene glycol, salt (sodium chloride), sugars, soluble starches, dextrin, xanthan gum and others absorb water, thereby lowering the water activity of the composition. Parallels in the list of natural actives include glucans, mannans and other polysaccharides extracted from commonly used culinary materials such as tamarind seed and fenugreek.

In the area of chemical preservatives that stop or inhibit microbial growth, common classes of chemicals used include acids, aromatic alcohols, N-methylol containing compounds, halogenated compounds, isothiazolinones, quaternary nitrogen compounds, and 1,2 diols. A number of phytochemicals found in natural sources resemble these compounds in chemical structure and are natural preservatives. These classes of phytochemicals include essential oil constituents (such as eugenol, thymol, carvacrol, terpenoid compounds), flavonoids, phenolic compounds, tannins and alkaloids.

Some of these extracts when combined with ineffective antibiotics were found to be effective against antibiotic resistant strains.

Although no single natural extract has been found to be as effective as conventionally used preservatives such as parabens, combinations of naturals with synergistic activity have been identified. Such extracts could offer protection against the invasive growth of bacteria and fungi. Parabens, for example, are poorly soluble in water and their action is strongest against gram positive bacteria and fungi and weakest against gram negative bacteria. Combinations of synthetic pres-ervatives are therefore used in formulations and the safety and global regulatory acceptance of effective levels of such combinations is sometimes a problem. It is here that combinations of natural extracts may be useful. Very often such extracts also offer antioxidant action, with beneficial effects on product shelf life. One example is a proprietary natural extract of yellow curcuminoids from *Curcuma longa* (turmeric) roots and a colorless derivative Tetra-hydrocurcuminoids [INCI: tetrahydrodiferuloyl-methane, tetrahydrodemethoxydiferuloylmethane, tetra-hydrobisdemeth-oxydiferuloylmethane][1], that were found to offer more effective anti-oxidant protection than the conventionally used synthetic antioxidant butylated hydroxytoluene (BHT).

The skilled formulator thus has a plethora of natural options available for use as preservatives. Care should however be taken to ensure that these naturals are selected with physicochemical characteristics, global regulatory considerations and safety aspects in mind.

Reference

1. US Patent # 6,607,712, Sabinsa Corporation