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The Importance of Using Natural Product Compounds as an Alternative to Chemically Based Disinfectants and Germicides

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ABSTRACT

The need for using natural product compounds as an alternative to chemically based disinfectants and germicides has been so eminent due to its relevance and positive contributions to both human and the environmental. In order to effectively battle the evolution of bacteria acquiring antibiotic resistance while having little to no environmental adverse effects, new biocidal methods are required (Gomes [1]). This work aims to assess the efficacy of commonly used natural-based compounds as a disinfectant and it impacts as an alternative in controlling microbial infections. These products contain a wide range of active chemical agents (biocides), many of which have been in use for hundreds of years, such as alcohols, phenols, iodine, and chlorine (block, 1991). Although the majority of these active substances exhibit broad- spectrum antibacterial activity, less is known about their mechanisms of action when compared to antibiotics (McDonnell, et al. [2]). The efficacy of selected natural products compounds Lemongrass (Citral and Limonene), Orange Peel (D-Limonene, Citral), Neem leaves (Azadirachta indica) Pine oil (α-terpineol, terpene) Tea Tree (cineole and terpinene) used by different researchers as biocides effect were assessed and proved effective. The natural-based biocides are promising to be used in disinfectant formulations to help in minimizing high level of toxicity and other negative impact that using chemical base compounds impose on general wellbeing of both humans and fauna.

Keywords: Natural Product; Compounds; Disinfectants; Microbes; Chemical; Germicides; Biocides

Introduction

Disinfectants and Germicides are employed in the prevention of diseases of bacterial, parasitic, fungal and viral origin (Larson, et al. [3,4]). Disinfectants and Germicides can make a significant contribution to infection control in humans and animals. In this way, they help to reduce morbidity and mortality due to infections (Larson [3]). They also help in the food industry to prevent spoilage and are used to remedy annoyances such as odor and mould or deposit of algae (Block, 1991a; Denyer [5]). Disinfectants are the chemicals used in destroying organisms on non-living surfaces while Germicide are chemicals that can kill or inhibit the bacteria or fungi on living cell (Block, 1991a; Glardy, et al. [6]). Disinfectants and Germicides are antimicrobial agents used as preservative, sporicides, sanitizers e.t.c. chemical groups employed as disinfectants and germicides include halogen, acids, alcohol, aldehyde, hydrogen peroxide, phenolic and sulfur metal compounds (Rutala 1995; Denyer [5]). However, the excessive or improper use of disinfectants and germicides can have adverse effects. For example, people may be poisoned or develop allergy.

In addition, by using disinfectants resistance can develop to disinfectants themselves (Block, 1991a; Wang and Schellhorn, 1996). In order to effectively battle the evolution of bacteria acquiring antibiotic resistance while having little to no environmental adverse effects, new biocidal methods are required (Gomes [1]). Germicides and disinfectants are extensively used in hospitals and other health care settings for a variety of topical and hard-surface applications. A wide variety of active chemical agents (biocides) are found in these

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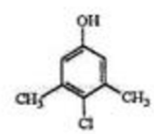
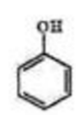
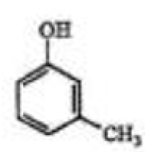
products, many of which have been used for hundreds of years, including alcohols, phenols, iodine, and chlorine. Most of these active agents demonstrate broad- spectrum antimicrobial activity; however, little is known about the mode of action of these agents in comparison to antibiotics (McDonnell, et al. [2]). A wide variety of active chemical agents (or "biocides") are found in these products, many of which have been used for hundreds of years for antisepsis, disinfection, and preservation (Block, 1991). The different plants that have been specifically researched include saponins, tannins, reducing sugars, anthraquinones, flavonoids, terpenoids, phlobatanins, and alkaloids in their crude extracts. All plant extracts displayed wide-ranging antibiosis against particular microorganisms that are gram-positive and gram-negative. (Adebayo et al, 2018). The Environmental Working Group (EWG) examined the safety data of over 1000 ingredients used in commercial household cleaning products; they found that more than half of those products contained ingredients harmful to the lungs. One in five had ingredients that can trigger asthma, even in healthy individual (McDonnell et al. [2]).

Considering the effects and damages resulting from the use of disinfectants and germicide, this study is timely as it will reveal some alternative to disinfectants, using natural products compounds which have less side effect on both man and animals (McDonnell et al. [2]). Natural products obtained from plant sources are in great demand as they are able to cure many infectious diseases (Jamshidi [7]). The advantage of using antimicrobial compounds of medicinal plants is their fewer side effect, better patient tolerance, relatively less expensive, acceptance due to long history of use and being renewable in nature (Mulat [8]). The present review deals with the use of natural products compounds such as citral, terpine-4-ol, limonene, triterpenoid found in Neem leaves oil, orange peel oil, lemongrass oil, pine oil and tea tree oil which make them alternative Disinfectants and Germicides. There was evidence of high Production as a result of the guava aqueous extract Martins et al, 2016 Disinfecting your home and office with natural, non-toxic disinfectants may seem like an overwhelming task, but it's actually surprisingly simple [9-15]. In fact, the majority of naturally antibacterial disinfectants can be found right in your kitchen and a fraction of the cost of those harsh chemical disinfectants (Firure 1). Natural disinfectants and germicide are not only better for your health but are safer for children, animals and the environment. A summary of the various types of sythetic biocides used in antiseptics and disinfectants, their chemical structures, and their clinical uses is shown in Table 1. It is important to note that many of these biocides may be used singly or in combination in a variety of products which vary considerably in activity against microorganisms.

Table 1: Chemical structures and uses of biocides in antiseptics and disinfectants (McDonnell, et al. [2]).

Halogen releasing	Chlorin compound	◇OCl-, HOCl, Cl_2	Disinfection
Agents			Antisepsis
	Iodin compounds	◇I_2	Cleaning
Halophenols	Chloroxylenol (PCMX)		Antisepsis Preservation
Heavy metal derivatives	Silver compounds	Ag	Preservation Antisepsis
	Mercury compounds	Hg	Disinfection
Peroxygens	Hydrogen peroxid	H_2O_2	Disinfection
	Ozone	O_3	Sterilization
	Peracetic acid	CH_2COOOH	
Phenols and cresols	Phenol		Disinfection
	cresols		Preservation

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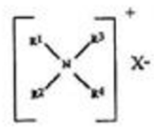
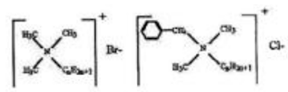
Quaternary	General structure		Disinfection Antisepsis
Ammonium			Preservation
compounds	Cetrimide, Benzalkonium Chloride		Cleaning

Definition of Terms

Disinfection is the application of chemicals to destroy most pathogenic organisms on inanimate surfaces while disinfectants are the chemicals used in destroying organisms on non-living surfaces. Germicide or antiseptic are chemicals that can kill or inhibit the bacteria or fungi on living cell. Some kinds of germicides are non-toxic to the fungi, but interfere with the process of fungus or affect the interaction of pathogen-host, improving the plant defence. Sterilization refers to a physical or chemical process that completely destroys or removes all microbial life, including spores [16-25]. Preservation is the prevention of multiplication of microorganisms in formulated products, including pharmaceuticals and foods. A number of biocides are also used for cleaning purposes; cleaning in these cases refers to the physical removal of foreign material from a surface (Block, 1991).

“Biocide” is a general term describing a chemical agent, usually broad spectrum that inactivates microorganisms. Because biocides range in antimicrobial activity, other terms may be more specific, including “-static,” referring to agents which inhibit growth (e.g., bacteriostatic, fungi static, and sporistatic) and “-cidal,” referring to agents which kill the target organism (e.g., sporicidal, virucidal, and bactericidal). Roughly speaking, a disinfectant and a germicides are the same thing in that both are used to kill germs and prevent their growth. In common usage, disinfectant is more likely to be used to refer to chemical used in cleaning, while germicide is more likely to be used to refer to a chemical applied to the skin to kill germs [26-36]. Disinfectants fall under the regulatory authority of the U.S Environmental Protection Agency and are subject to the agency’s rules for demonstration of effectiveness and use in the workplace. Germicides, because they are intended for application on living tissue, fall under the regulations of the U.S Food and Drug Administration (FDA) regarding effectiveness and clinical use. Table 2 give the Summary of mechanisms of antibacterial action of antiseptics and disinfectants.

Table 2: Summary of mechanisms of antibacterial action of antiseptics and disinfectants (McDonnell, et al. [2]).

Target	Antiseptic or disinfectant	Mechanism of action
Cell envelope (cell wall, outer membrane)	Glutaraldehyde	Cross-linking of proteins
	EDTA, other permeabilizers	Gram-negative bacteria: removal of Mg^{2+}, release of some LPS
Cytoplasmic (inner) membrane	QACs	Generalized membrane damage involving phospholipid bilayers
	Chlorhexidine	Low concentrations affect membrane integrity, high concentrations cause congealing of cytoplasm
	Diamines	Induction of leakage of amino acids
	PHMB, alexidine	Phase separation and domain formation of membrane lipids
	Phenols	Leakage; some cause uncoupling
Cross-linking of macromolecules	Formaldehyde	Cross-linking of proteins, RNA, and DNA
	Glutaraldehyde	Cross-linking of proteins in cell envelope and elsewhere in the cell
DNA intercalation	Acridines	Intercalation of an acridine molecule between two layers of base pairs in DNA
Interaction with thiol groups	Silver compounds	Membrane-bound enzymes (interaction with thiol groups)

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Effects on DNA	Halogens	Inhibition of DNA synthesis
	Hydrogen peroxide, silver ions	DNA strand breakage
Oxidizing agents	Halogens	Oxidation of thiol groups to disulfides, sulfoxides, or disulfoxides
	Peroxygens	Hydrogen peroxide: activity due to from formation of free hydroxy radicals (·OH), which oxidize thiol groups in enzymes and proteins; PAA: disruption of thiol groups in proteins and enzymes

History of Germicdes

In the end of 18th century to the 1850s, people strengthened the research on the organic germicide in order to seek the substitutes of copper and mercury preparations. The event of the greatest impact should be in 1934 when W. H. Tisdale reported the bactericidal effect of dithiocarbamic acid derivatives. This discovery opened up a new era of organic compounds as germicide. Following the discovery of bactericidal activity of ziram, ferbam, and thiram, in 1935, DuPont had further found the germicidal activity of sodium dithane in the dithane class. In 1943, people had put it into production. After 1960s, dithiocarbamate salt germicide had gradually developed into a class of germicide of the world's largest production. The different plants that have been specifically researched include saponins, tannins, reducing sugars, anthraquinones, flavonoids, terpenoids, phlobatanins, and alkaloids in their crude extracts. All plant extracts displayed wide- ranging antibiosis against particular microorganisms that are gram-positive and gram-negative. (Adebayo et al, 2018). To date, there are nearly 300 kinds of organic germicides that have been commercialized. Substituted benzene type contains hexachlorobenzene, chlorothalonil and dozens of other varieties. Trichloromethylthio type germicide mainly contains folpet and captan. After 1950s, there are a lot of varieties having achieved practical application, including organic mercury and quinones, organic tin, organic phosphorus and agricultural antibiotics.

In 1969 and 1970, the ethyl thiophanate and methyl thiophanate developed by Nippon Soda Company (Japan) are two best varieties with the latter one especially obtaining wide applications on fruit trees and vegetables. In the 1960s, Japan, during the development of germicide against rice sheath blight, had successfully launched organic arsenic germicides such as asomate and neoasozin. It is particularly worth mentioning that there have been a number of excellent germicides in the heterocyclic fungicides. The breakthrough of systemic germicide was actually started from the discovery of the systemic germicidal effect of carboxin made by the Uniroyal Company in 1960s. In 1966, carboxin and oxycarboxin had been simultaneously subject to commercialization. Later, it had successively appeared of benomyl, dodecyl morpholine, thiophanate-methyl, and triforine, etc. In 1970s, triazole-class systemic germicide with triadimefon as the representative had attracted broad attention. However, the above germicides have very poor efficacy in treating many kinds of important diseases caused by oomycete. In 1977, Ciba-Geigy Company (Switzerland) had successfully developed systemic germicide, metalaxyl with excellent efficacy in prevention of disease caused by oomycete. Metalaxyl is characterized by high efficacy, small usage amount and having bidirectional conduction properties, making the systemic germicide enter into a new stage of development. China is one of the earliest countries that had applied the elements and inorganic agents for control of plant diseases. This had been documented (see the history of pesticide development) in a variety of well-known ancient writings.

In 1950s, the most widely used germicides are still inorganic copper and mercury preparations. In order to effectively battle the evolution of bacteria acquiring antibiotic resistance while having little to no environmental adverse effects, new biocidal methods are required (Gomes [1]). Substituted benzene has also been applied. In 1960s dithiocarbamate salts and organic arsenic preparations had been widely used. In 1970s, it had been developed of carbendazim, and had developed into one of the germicide varieties with the largest production amount in China. Meanwhile, China's agricultural antibiotic, Jinggangmycin had also obtained widespread application in controlling the Rice Sheath Blight. Since the 1980s, many excellent germicides including organicphosphoruskitazine, fosetyl; heterocyclic germicides such as triadimefon, tricyclazole and isoprothiolane; substituted benzenes germicides such as methyl thiophanate, chlorothalonil and metalaxyl have been popularized.

Dangers of Some Synthetic Germicides and Disinfectants

Most of the compounds used in the production of these disinfectants are chemicals in nature and therefore harmful to both human and animals using them. Some have cancinogenic properties, while others are allergic with high toxicity. We shall study their effects using some of the compounds in disinfectants as case study.

1,4-Dioxane: This ingredient is suspected carcinogen found in many common detergents.

Quaternary Ammonium Compounds or "Quats": Quats are known asthma triggers often found in spray cleaners and fabric softeners.

Chlorine Bleach: Bleach fumes can contain chlorine and chloroform, which have been linked to respiratory and neurological effects and cancer. In addition, bleach is highly reactive and can form other dangerous gases when it comes in contact with ammonia or acids such as vinegar.

Formaldehyde: Used as a preservative, formaldehyde is a known carcinogen.

Perchloroethylene ("PERC"): Found in spot removers, home dry cleaning products, and upholstery cleaners, PERC is a probable carcinogen and neurotoxin.

Ammonia: Ammonia is a respiratory and skin irritant.

Antibacterial

Though the FDA banned triclosan and 18 other anti-bacterial compounds from hand and body soaps in 2016, these may still be found in cleaners. These banned substances have been linked to endocrine disruption and antibiotic resistance. Unfortunately, safety data on many of the antibacterials used as alternatives is scant.

2-Butoxyethanol (also 2-BE, BCEE, or Butyl cellosolve): Found in laundry stain removers, oven cleaners, and degreasers, 2-BE is a skin and eye irritant that made the list of toxic substances in the Canadian Environmental Protection Act.

Diethylene Glycol Monomethyl Ether (also DEGME or Methoxydiglycol): This ingredient is a solvent used in some degreasers and heavy-duty cleaners. Banned for use in cleaners in the EU, this compound has been linked to reproductive health effects.

Fragranc: The common ingredient known simply as "fragrance" may contain hundreds of different chemical compounds, including phthalates, an endocrine disruptor. Fragrances may also trigger asthma and allergies. In addition to the above effects, many common cleaning products will burn or irritate skin and eyes, and many are fatal if swallowed. Thankfully, none of these ingredients are necessary for cleaning your home. It's easy to make your own safe cleaning products using the formulas listed below. A growing number of commercial, non-toxic home cleaning products are also available as healthier and environmentally responsible alternatives. If you don't have the time or inclination to make your own, using these products helps promote the growth of green businesses that are contributing to a more sustainable economy.

Natural Product

Natural products (NPs) can be defined as biologically active chemical compounds that are found in nature even if the compound can be prepared by total synthesis. Natural products are produced by living organisms and are usually secondary metabolites. Secondary metabolites have functions that are not directly involved in the growth, development or reproduction of the organism (Krause & Tobin, 2013). They are generally produced as a defence mechanism against predators or to aid the organism adapting to its surrounding environment (Dias, Urban, & Roessner, 2012). Natural products have been evolving for a very long time in natural selection process adapting to various `abiotic and biotic stresses with. Therefore they possess optimized biologically active metabolites which can be highly potent and selective and have through the history been an important source of drugs and continue to deliver a great variety of structures for drug discovery (Clardy & Walsh, 2004; Croteau, Kutchan, & Lewis, 2000; Paterson & Anderson, 2005). Large portion of drugs on the market today are natural products or natural derived products and natural products have been an important source of active compounds and leads for the discovery and development of new drugs (Chin, Balunas, Chai, &Kinghorn, 2006; Newman & Cragg, 2016b; Patridge, Gareiss, Kinch, & Hoyer, 2015). It is estimated that more than 95% of the world's biodiversity has not been evaluated for biological activity so there is yet more to discover (David, Wolfender, & Dias, 2015).

Examples of Natural Products Compounds used as Germicides and Disinfectants

Neem Leaves (Triterpenoids, Phenolic Compounds, Carotenoids): Neem oil comes from the seeds and the fruits of the Azadirachta indica tree. It has an unpleasant odor and a bitter taste. The beneficial agents in Neem oil are triterpenoid compounds, antioxidants, phenolic compounds, carotenoids, steroids and ketones.

Triterpenoids: Azadirachtin and Nimbin are the best known triterpenoid compounds in neem oil that gives it many of it's beneficial property. Azadirachtin is one of the most known triterpenoid present in the neem oil. The phytochemicals are responsible for the bitter taste of neem oil for therapeutic value. The antiseptic, antimicrobial, antifungal are contributed to neem oil due to the presence of Nimbin triterpenoid.

Structure of Nimbin and Azadirachtin: (Structures 1 & 2) Fatty acid in neem oil build collagen and maintain elasticity of the skin. The high levels of carotenoids and other antioxidants found in neem oil protect skin from the damaging effects of free radicals, sun damage. Worthy of note of the carotenoid type found is xanophylls which are oxygen containg compounds and are found in dark leafy green plant which neem leaves falls. The neem leaves tree has been described as Azadirachta indica as early as 1830 by De Jussieu. The neem trees has been used traditionally for centuries in both agriculture and medicine (Allan 1991). Although neem is one of the most ancient and most widely used herbs on earth. Intense scientific investigation of the properties of neem are now being undertaken. Many preparations on neem extracts are reportedly efficacious against a variety of skin diseases, septic sores and infected burns. The leaves, applied in the form of poultices or decoctions are also recommended for boils, ulcers and eczema. The oil is used for skin diseases such as scrofula, indolent, ulcers and ringworms.

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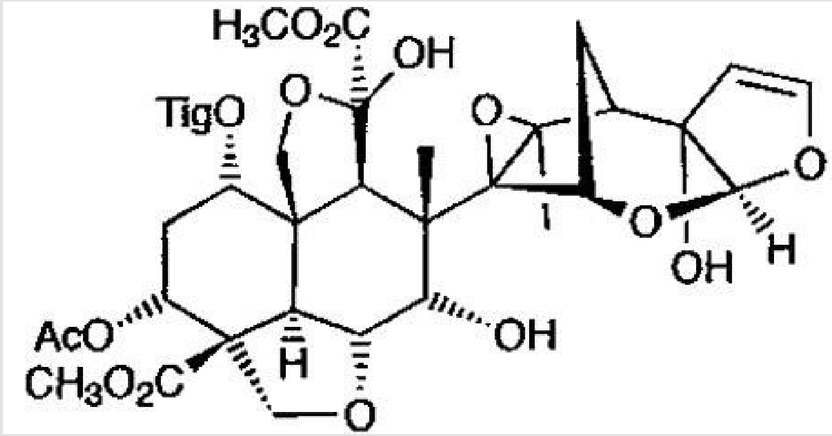
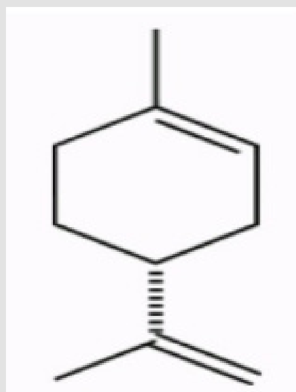


Structure 1: Azadirachtin.



Structure 2: Structure of Limonene.

Orange Peel (D-Limonene, Citral): Citrus oil are composed of monoterpenes, in particular D-limonene, citral, decanal, linglool,a terpineol aldehydes, ketones, acids, alcohols and ester which exhibit anti-bacterial and anti-fungal characteristics and even inhibit the growth of certain parasite as well. Principal components of essential oils in different species is given below; Mandarin (C. Reticulata L.) contain limonene (74.7%) and a-terpinene (15.7%), Lemon (C. Limon L.) limonene (69.9%) and b-pinene (11.2%) Orange (C. Sinensis L.) limonene (94.9%) myrcene (1.16%), Grape fruit (C. Paradisi L.) limonene (96.2%)myrcene (1.4%) . From our statistics it is very obvious that limonene is that most active compound of orange peel oil.

Limonen: Limonene is a clear, colourless liquid hydrocarbon classified as a cyclic monoterpene, and it's the major component in oil of citrus fruit peels (U.S National Liberary of Medicine, 2017). The D- isomer, occur more commonly in nature as the frangrance of oranges, it is a renewable solvent in cleaning products. The less common L-isomer is found in mint oils and has a pine turpentine like odor (Fahlbusch et al., 2003). D-Limonene is a chiral molecule, and biological sources produce one enantiomer, the most important developed, citrus fruits contain D-limonene. (+)- limonene which is the (R) enantiomer. Racemic limonene is known as dipentene. D-limonene is retrieved from citrus fruits through two primary procedures. Steam distillation and centrifugal seperation. It is commonly used as base in producing cleaning product as solvent and is also used in chemical synthetic. Sweet orange peel oil is the most important of the citrus oils. It yields up to 0.5% by cold-pressing. The aldehydes content is the measure of the oil. It posses upto 3% aldehydes of which an example is decadenal with extremely high aroma value. The difference between orange and grape fruit is the amount of (+)-valencene. Bitter orange peel oil differs from sweet orange oil less by its volatile composition then by its bitter taste caused by non-volatile. As soon as you break the skin of an orange, its sweet-tangy scent fills the air. Many, anxious to get the juicy seqments of the orange itself, consider the peels job done and discard it in the nearest compost bin. As some have now realised, once the orange is consumed, the orange peel has

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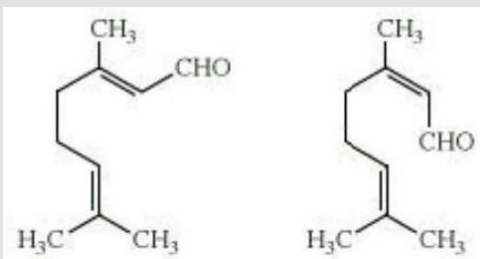
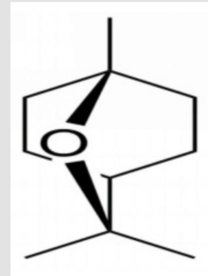
many uses on their own. The most effective orange peels to use is that of an organic orange, but other orange peels will still do the trick. Orange peel is an innovative solution for the toughiest industrial applications. Orange peel will effectively remove grease, grime and other contaminants from architectural concrete and other surfaces. Orange peel can also be used to dissolve and strip many types of carpet and tiles cutback adhesives safely and effectively. Dried orange peels can be used as homemade bath oils. Orange peels are rich in vitamins A and C, both of which are natural anti-oxidants that boost the overall health of the immune system and help fight infection. Orange peels versatility can eliminate the need to stock multiple cleaners' standard harsh cleaners and degreasers are made from chlorinated solvents or hydrocarbon solvents that can be harzardous to use and to dispose (Structure 3).



Structure 3: Structure of Citral.

Lemongrass (Citral and Limonene): Lemongrass is a herb that belong to the grass family of poaceae. Lemongrass oil has a light and fresh lemony smell with earthy undertones. The compounds that make up lemongrass essential oil are known to have antifungal and antiseptic properties. Lemongrass essential oil is a type of pure fat extracted from the lemongrass plant, which refers to a whole family of vegetation of which there several species which all have their own benefits in different proportion; the plant is dried through the use of traditional steaming or alcohol extraction, then distilled into oil. Lemongrass may prevent the growth of some bacterial and yeast and it has antioxidant property. The citral and limonene content in lemongrass oil can kill or stifle the growth of bacteria and fungi. This helps contacting infectious such as ringworm, athletes foot, or other types of fungus. The chemical composition of lemongrass essential oil varies according to the geographical origin. The compounds typically include hydrocarbon terpenes, alcohol, ketones, esters and mainly aldehydes. Also one major lemongrass essential oil benefit is its skin healing properties. Lemon grass oil is an effective cleanser for all skin types. Its antiseptic and astrigent properties make lemongrass oil perfect for getting even glowing skin. It can sterlise your pores, serve as a natural toner, and strengthen your skin tissue (Structure 4).



Structure 4: Cineole.

Geranial (Citral A) Neral (Citral B): Lemongrass oil contains 70-80% citral, which may be isolated by distillation. Citral has a molecular formula C10H16O. It's IUPAC NAME is 3,7-dimethyl-2,6-octadienal a mixture of terpenoids. The two compounds are double bond isomers. The E-isomer is known as geraniol or citral A. The Z-isomer is known as neral or citral B. Citral is insoluble in water but soluble in ethanol.

Tea Tree (cineole and terpinene): Tea Tree oil is an essential oil, steam-distlled from the australian native plant, melaleuca alternifolia. It has a minium content of terpinenen-4-ol and a maximum content of 1,8-cineole. Terpinen-4-ol is a major tea tree component which exhibits strong antimicrobial and anti- inflamatory properties. Although both are bactericidal and germicidal, cineole can be a powerful skin irritant. Therefore, tea tree oils with low cineole and high terpinen contents are preferred Tea tree oil exerts antioxidants activity and has been reported to have a broad-spectrum antimicrobial activity aganinst bacterial, viral, fungal, and protozoal infections affecting skin and mucosa.it also accelerates the wound healing process and exhibits anti-cancer activity.

Cineole: It is a major component (upto 90%) of the essential oil distilled from the leaves of most tea tree. Cineole is a colourless, oily, slightly water-soluble liquid. Its molecule structure is C10H18O. It have a camphor like odor which can be pungent and a spicy cooling taste. It can be extracted from eucalyptus hence the name Eucalyptol.

Structure of Cineole: This belong to a class of organic compounds known as menthane terpenoids. These are monoterpenoids with the structure base on the o-, m- or p-menthane backbone. P-menthane consists of the cyclohexane ring with a methyl group and a (2-methyl)-propyl group at the 1 and 4 ring positions, respectively. The o- and m- menthanes are much rarer, and presumably arise by alkyl migration of p-menthanes. It is slightly soluble in water and extremely acidic compound. Terpinen-4-ol is the main antimicrobial components but other components, such as a-terpineol also have antimicrobial activities similar to those of terpinen-4-ol (Structure 5).

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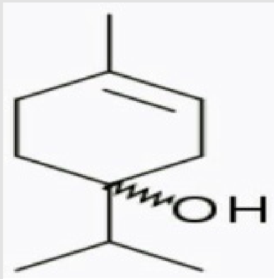

Structure 5:

Structure of Terpinen-4-ol: Tea tree has a marked oil-dissolving and dispersing action which can help alleviate overly oily skin. Combined with water, it works well as a facial skin astringent. A few drops of the oil massaged directly into the scalp will gently invigorate the scalp and help lift greasy deposits from the hair shaft before shampooing.

Pine Oil (A-Terpineol, Terpene): Pine oil is an essential oil obtained by the steam distillation of stumps, [boyle 1990] needles, twigs and cones [Maccioni et al., 2003] from a variety of species of pine, particularly Pinussylvestris. As of 1995, synthetic pine oil was the "biggest single turpentine derivative." Synthetic pine oils accounted for 90% of sales as of 2000. [Gscheidmeier et al., 2000]. In alternative medicine, it is said to be used in aromatherapy, as a scent in bath oils or more commonly as a cleaning product, and as a lubricant in small and expensive clockwork instruments. It may also be used varyingly as a disinfectant, sanitizer, mircobicide / microbistat, virucide, insecticide, and a massage oil. It is also used as an effective herbicide where its action is to modify the waxy cuticle of plants, resulting in desiccation [Coleby, 2004]. Pine oil is distinguished from other products from pine, such as turpentine, the low-boiling fraction from the distillation of pine sap, and rosin, the thick tar remaining after turpentine is distilled. Chemically, pine oil consists mainly of α-terpineol and other cyclic terpene alcohols. It may also contain terpene hydrocarbons, ethers, and esters. The exact composition depends on various factors, such as the variety of pine from which it is produced and the parts of the tree used.

Conclusion

Whenever a chemical is used to control the microbial population, not only is the environment polluted but also other desirable fauna is affected by the introduction of the toxicant in the ecosystem. Simultaneously, the target species is provoked to develop resistance against a wide range of germicides and disinfectants as well. The high cost of synthetic disinfectants and germicides and the environmental harzards as a result of synthetic disinfectants and germicides usage should encourage scientists to seek safe and low cost disinfectants groups. For this reasons, antimicrobial agents from natural product compounds such limonene, citral, cineole, terpinen-4- ol in neem oil, orange peel oil, pine oil and tea tree oil will be of great interest as they can be used as Natural disinfectants and germicide which are not only better for your health but are safer for children, animals and the environment.

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