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Mechanism of Action of Essential Oil on Pediculus Humanus Capitis.

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ABSTRACT

Infestation with the head louse, Pediculus humanus capitis is one of the most common parasitic infestations of humans worldwide. Traditionally, the main treatment for control of head lice is chemical control that is based in a wide variety of neurotoxic synthetic insecticides and repeated use of these products has resulted in resistant populations of head lice. Thus, plant-derived insecticides such as the essential oils seem to be good viable alternatives as some have low toxicity to mammals and are biodegradable. So in this review, we mainly focus on to the mechanism of action some insecticise and plant derived oil or essential oils belonging to several botanical families.

Keywords: Neurotoxic, biodegradable

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INTRODUCTION

The 3 major lice that infest humans are:

- Pediculus humanus capitis **(head louse),**
- Pthirus pubis **(crab louse) and**
- Pediculus humanus humanus **(body louse)**.

Patients with louse infestation present with scalp pruritus, excoriations, cervical lymphadenopathy and conjunctivitis. A hypersensitivity rash also results from it. Head lice infestation crosses all economic and social boundaries and therefore, Lice infestation of any part of the body is known as “Pediculosis”.

Head lice or louse are tiny wingless parasites biologically known as *pediculus humanus capitis* that inhabit and thrive on hair and the scalp. They feed on very small amount of blood that they draw from the scalp. Head lice infestation is common in all over among children 3 to 12 years of age approximately 4 to 10 million have infestations each year. Head lice are not a health hazard or a sign of uncleanliness and are not responsible for the spread of any disease. The most common symptom is itching. Individuals with head lice infestation may scratch the scalp to alleviate itching and there rarely may be secondary bacterial skin infection. Head lice are the cause of much embarrassment and misunderstanding, many unnecessary days lost from school and work and millions of dollars spent on remedies.

Many Dermatologists says that, "Head lice problem occurs more in women than men, because women usually have longer hair. Loose long hair is more susceptible to lice. And managing a lice infestation is more difficult on a long-haired person, as it is difficult to comb, inspect and treat." Head lice are passed from person to person by direct contact with the hair of an infected person. Cosmetic dermatologist and trichologist says that, "Anyone who comes in close contact with someone who already has head lice or even their contaminated clothing and other belongings such as hats/caps, scarves, coats, sports uniforms or hair ribbons is at risk of an infestation too." Personal contact is common during play and sports activities and at school/college, home, slumber parties or camps amongst children and teenagers. One should refrain from using infested combs, brushes or towels and avoid lying on a bed, couch, pillow, carpet or keep away from stuffed animals that has recently been in contact with a person with lice.

But actually Trichologist says that, "Lice aren't dangerous and don't spread any particular disorder but are contagious and cause itching that can be terribly annoying and embarrassing. Lice bite may cause one's scalp to become itchy and inflamed and persistent scratching may lead to skin irritation and even infection. It can lead to a bacterial infection which causes the skin to become red and tender and also involves crusting and oozing of pus along with swollen lymph glands [1].

Symptoms

- Intense itching of the scalp.
- Small, red bumps on the scalp, neck, and shoulders (bumps may become crusty and ooze).
- Tiny white specks (eggs, or nits) on the bottom of each hair those are hard to get off.

The control of human head lice worldwide depends primarily on the continued applications of organochlorine (DDT and lindane), organophosphorus (malathion), carbamate (carbaryl), pyrethrin, pyrethroid (permethrin and 6-phenothrin) and avermectin (ivermectin-originated from Streptomyces avermitilis) insecticides [2-4]. The repeated use of permethrin and other insecticides for the control of head lice during past decades has resulted in the development of marked levels of resistance. Thus, new alternative insecticides are needed for the control of head lice.

Many modern pediculicides tend to fail because of low efficacy on lice eggs, whereas essential oil constituents are reputed to have good ovicidal capabilities [5]. They are responsible for the characteristic odors of plants such as eucalyptus, pine, mint, peppermint and lemon. Several plant products such as aniseed, coconut, neem and tea tree oils are used in different available compositions for the treatment of head lice infestation.

Plant essential oils have been suggested as an alternative source of materials for insect control because they constitute a rich source of bioactive chemicals and are commonly used as fragrances and flavoring agents for foods and beverages [6]. Because of this, much effort has been focused on mode of action of insecticides and plant essential oils.

Essential oil

Essential oils are extracted from various aromatic plants generally localized in temperate to warm countries like Mediterranean and tropical countries where they represent an important part of the traditional pharmacopoeia. These are natural and volatile compound which is characterized by a strong odor and are generated from aromatic plants as secondary metabolites. They are volatile liquid and rarely colored, lipid soluble and soluble in organic solvents with a generally lower density than that of water. They can be synthesized by all plant organs i.e. buds, flowers, leaves, stems, twigs, seeds, fruits, roots, wood or bark and are stored in secretory cells, cavities, canals, epidermic cells or glandular trichomes [7].

They are usually obtained by steam or hydro-distillation. They are known for their antiseptic i.e. bactericidal, virucidal, fungicidal and medicinal properties and fragrance. Due to their bactericidal and fungicidal properties they are more uses in pharmaceutical and food and more widespread as alternatives to synthetic chemical products to protect the ecological equilibrium. They are used in preservation of foods and as antimicrobial, analgesic, sedative, anti-inflammatory, spasmolytic and locally anesthesic remedies. Up to the present day, these

characteristics have not changed much except that more is now known about some of their mechanisms of action, particularly at the antimicrobial level.

There are also several advance methods for extracting essential oils. These may include use of liquid carbon dioxide or microwaves and mainly low or high pressure distillation employing boiling water or hot steam. For perfume uses, extraction with lipophilic solvents and sometimes with supercritical carbon dioxide is favoured. Thus, the chemical profile of the essential oil products differs not only in the number of molecules but also in the stereochemical types of molecules extracted, according to the type of extraction and the type of extraction is chosen according to the purpose of the use.

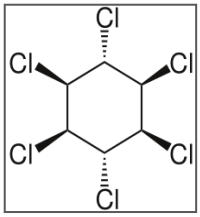
Mechanism of action

There are many different types of products formulated for treating head louse infestations and many different types of active ingredients. As several groups of insecticides that work against the insect nervous system by either blocking nerve impulses or by over stimulating them. A nerve impulse consists of electrical charges that travel along the nerve route. This electrical charge is produced by a complex process in which the nerve cell pumps ions in and out through the membrane that surrounds the cell.

The nerve ends do not touch but have synapses between them. The electrical impulse is not able to cross this gap. Most nerve impulses are able to cross the junction between nerve cells using what is known as a transmitter-substance as a bridge. The transmitter substance is secreted from the end of the nerve cell when it is stimulated by a nerve impulse. One of the most common transmitter-substances is acetylcholine. When a nerve impulse reaches the junction acetylcholine is released to bridge the gap so the impulse can pass over. After the impulse is passed on the acetylcholine is broken down by an enzyme called **acetylcholine esterase**.

Some insecticides are no longer used for head lice and others are considered not suitable for use on humans. Currently three types of insecticides are used to control head lice.

Lindane is an organochloride that has central nervous system toxicity in humans if used incorrectly; several cases of severe seizures in children using lindane have been reported [9,10]. It is available only by prescription as a shampoo that should be left on for no more than 10 minutes with repeated application in 7 to 10 days. It has low ovicidal activity (30% to 50% of eggs are not killed [8], and resistance has been reported worldwide for many years [11, 12]. For these reasons, it should be used very cautiously.



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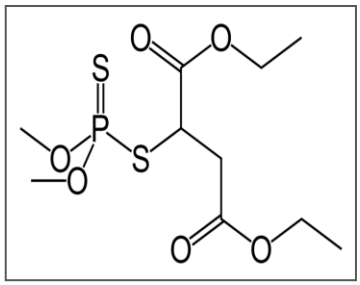
Mechanism of action

Lindane is a cyclodiene organochlorine as (g*amma*-hexachlorocyclohexane) insecticide which binds to the receptors of an alternative transmitter-substance chemical called gamma-aminobutyric acid (GABA) involved in transmission of nerve impulses across nerve junctions. The lindane then causes repeated stimulations at the receptor site which results in multiple nerve impulses and seizures.

Today, this insecticide is used in only a few countries because it is readily absorbed through the skin and can affect humans and other mammals.

Malathion is organophosphate (cholinesterase inhibitor) and 0.5% malathion has recently been reintroduced to the US market. It is available only by prescription as a lotion that is applied to the hair, left to air dry, and then washed off after 8 to 12 hours. Malathion has high ovicidal activity [13,14], but the product should be reapplied if live lice are seen in 7 to 10 days. The major concerns are the high alcohol content of the product, making it highly flammable, and the risk of severe respiratory depression if accidentally ingested. For these reasons, it should be used with extreme caution in the treatment of only those cases in which resistance to other products is strongly suspected [15].

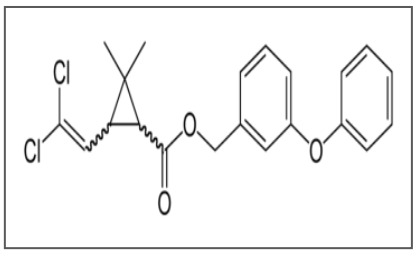


Mechanism of action

It is an organophosphate insecticide. Unlike many chemicals in this group, it is relatively safe for use in humans. It also acts at the nerve synapse but by inhibition of the enzyme acetylcholine esterase. The insecticide binds chemically to one part of the enzyme that links onto the acetylcholine as part of the breakdown process. The result is that acetylcholine is not broken down; therefore the nerve impulse continues long after it should have stopped, resulting in spasms and exhaustion of the insect.

Permethrin: 1% permethrin is currently the recommended treatment of choice for head lice[16-19]. It has even lower mammalian toxicity than do pyrethrins and does not cause allergic reactions in individuals with plant allergies. The product is a cream rinse applied to hair that is first shampooed with a non-conditioning shampoo and then towel dried. It is left on for 10 minutes and then rinsed off, and it leaves a residue on the hair that is designed to kill nymphs emerging from the 20% to 30% of eggs not killed with the first application [16]. However, it is suggested that the application be repeated if live lice are seen 7 to 10 days later. Some experts

recommend routine retreatment [18]. Resistance to 1% permethrin has recently been reported [20-22] but the prevalence of this resistance is not known.



Mechanism of action

Pyrethroids (permethrin, phenothrin, allethrin) are synthetic chemicals derived from the structure of the naturally occurring insecticide pyrethrin. Pyrethroids work in a different way against insect nerves. These chemicals bind onto chemicals on the membranes that surround the insect nerve cells and this causes a distortion in the membrane structure. The result is that the process by which the cell controls the flow of salts into and out from the cell is disrupted. This in turn results in a false stimulation of an electrical impulse within the nerve cell that continues as long as the insecticide is bound on [22]. The result is exhaustion of the insect nervous system.

All the insecticide chemicals are chemically breakdown by enzymes and other chemicals in the insect system. An insect that can break the insecticide down before it is killed can tolerate exposure to that insecticide. One problem with regular use of insecticides is that insects become tolerant, i.e. they have increasing in resistance activity as if they are exposed to a particular insecticide and thus they survive. Furthermore, there may be a range of insect variants which can break down insecticides more easily or that have different shaped chemical receptors within the nervous system. Insects that have these characteristics are referred to as resistant to insecticides.

Worldwide Market

In today's world there are numerous of product available for one problem so for head lice, starting from chemical product to natural formulation are available, from which some are orally taken or topically applied they are as:

PEDICULICIDES [27-30]

- Pyrethrins Plus Piperonyl Butoxide
- Permethrin (1%)
- Lindane (1%)
- Malathion (0.5%)

OTHER TOPICAL AGENTS [31, 32]

- Permethrin (5%)
- Crotamiton (10%)

ORAL AGENTS[33, 34]

- Sulfamethoxazole/Trimethoprim
- Ivermectin

Newer developments

- **Spinosad (0·9% cream)** is a recently introduced topical pediculicidal agent in the therapeutic armamentarium [35].
- The efficacy of **hexane flower bud extracts** of Syzygium aromaticum (Myrtaceae) against P. humanus capitis in a closed and open chamber method [36].
- The pediculicidal and ovicidal effects of 1 application of **a silicon-oil complex** composed of dimethiconol and castor oil [37].
- **Galenic meta-emulsion (Oxyphthirine®)** comprising of triglycerides, isohexadecane, sorbitane ester and water [38].
- **The efficacy of clove, Eugenia caryophyllata, and eucalyptus, Eucalyptus globulus**, essential oils and 15 formulations containing these essential oils alone against susceptible and pyrethroid/malathion-resistant head lice [39].
- **Dimeticone 4% lotion** is a physically acting pediculicidal compound based on 4% high molecular weight dimeticone in a cyclomethicone base [40].
- The insecticidal activity of essential oils from native and cultivated aromatic plants from **Argentina** for their activity against permethrin-resistant head lice [41].

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