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RECENT DEVELOPMENTS ON PERSONAL PROTECTION METHODS AGAINST VECTORS

L.R. SHOWYIN
Frentaupe Pty Ltd.

Abstract An outline of the role of, and the mechanism used by mosquitoes in transmission of the diseases dengue fever, malaria, yellow fever and West Nile encephalitis is discussed. The history of combative measures such as mass spraying and the importance of personal protection and the various products available to achieve protection is presented. The various formats of traditional personal insect repellents and mosquito coils are discussed along with the advantages/disadvantages of the formats. Identification of the major active ingredients commonly used in these products is presented. New developments such as electrical or battery operated devices, lamps, combination products along with interesting new patents or literature conclude the review of innovations and developments.
Key Words Insect repellents, mosquitoes, consumer products.

INTRODUCTION

Various species of mosquitoes are vectors of disease organisms. These include: Yellow fever and dengue fever transmitted by *Aedes aegypti*. This disease is cosmopolitan, in tropical/sub tropical stagnant water. Malaria is transmitted by *Anopheles* spp. Barmah Forest virus and West Nile virus are carried by *Culex* species, and Ross River virus is vectored by *Culex annulirostris*. Blood sucking insects, of which mosquitoes are the most frequent, are a great source of disease. However, it is important to understand that they do not cause the disease, they transport it from one place/person to another.

The female mosquito requires a blood meal to break down in order to use as a food source to mature her eggs. It is this biting process in which the mosquito utilizes her saliva that leads to transmission of disease. The chemicals in the mosquito saliva are designed to stop the blood clotting and help the flow. The saliva can be contaminated with materials such as the malaria plasmodia from the person being bitten and is then transported by the mosquito from this infected host to a non-infected host.

One can understand how transmission can occur from one country or area to another when air transport is used. A person can be bitten or infected by a disease carrying mosquito before leaving on a trip and bitten again on arrival at their destination by another mosquito which then picks up the disease and carries it to a new host. Equally possible is the actual transport within a plane of a mosquito carrying the disease and on arrival at another destination it escapes to bite an unaffected person. Such scenarios explain the emergence of Dengue fever in Cairns in Australia when previously it was unknown in that location.

CONTROL MEASURES

Mass spraying of buildings was a very common method used to try to combat/eliminate mosquitoes. Chemicals used included DDT (dichloro-diphenyl-trichloro-ethane). Spraying was generally carried out by government or council agencies, having been endorsed by WHO (World Health Organisation) and other bodies. Between 1950 and 1970, DDT chased mosquitoes and malaria out of Europe, the United States and Russia. Less of an effort was put into freeing the vast expanses of sub-Saharan Africa. Then mosquitoes learnt how to survive DDT, and for that matter many other insecticides, and the eradication program ground to a halt and was abandoned in 1969. Europe was declared free of malaria in 1975 and as malaria was geographically on the edge of viability the continent has kept clear. Some areas, however, have seen the insect return. In Africa and Asia, the disease is endemic (Moore, 2001). This method failed primarily because the mosquitoes developed resistance to the chemicals as massive amounts were used. In addition, there were the side effects of chemical exposure, odour and unpleasantness.

Coils and Bed Nets. Mosquito coils are probably the widest used product to combat mosquitoes. They are relatively inexpensive but produce a smoke that can be quite unpleasant or irritating. A more sophisticated version is the impregnated mat from which the insecticide is released by electrically heating the mat. A further development is the use of a bottle of liquid containing the insecticide, again in conjunction with an electrical device. All of these products are predominantly used indoors and from dusk to dawn. Bed nets which have been soaked in insecticide (normally permethrin) are used and are reasonably effective, and work by attracting the mosquitoes to the warm carbon dioxide exhaled by the sleeper beneath the net. After the failure of the spray programs WHO changed their recommendations to concentrate more on individual protection and use of nets and Personal Insect Repellents (PIRs) in particular. PIRs are available in various forms - roll on, pump spray, aerosol, lotion, gel. Recent reports on the efficacy of insect repellents include Fradin and Day (2002), Kim et al. (2004), and Barnard (2000).

Active Ingredients. The most common active used in PIRs is DEET (N,N Diethyl Toluamide) which has been in wide use since the 1950's. MGK 326 (Di-n-propyl-isocinchomeronate) and MGK 264 (N-octyl bicycloheptene dicarboximide), made by McLaughlin Gormley King have been widely used in many PIRs as agents that improve the repellency, particularly against flies. Di Butyl Phthalate (DBT) and Ethyl Hexane Diol (EHD) are two actives that were widely used in the past. Picaridin (1-(1methylpropylcarbonyl)-2-(hydroxyethyl)-piperidine), also known as KBR) developed by Bayer is a relatively new active with excellent activity against mosquitoes. It has the advantage over DEET in that it is not a plasticizer, and therefore does not affect items like glasses frames, mobile phones etc and has a much more pleasant odour.

Essential Oils. Various essential oils over the years have been touted as insect repellents. These include neem, cedarwood, citronella, tea tree, eucalyptus, geranium, peppermint, soy bean oil, and lavender. Citronella is probably the most widely used in commercially available products. P-menthane-3,8-diol which is derived from eucalyptus citriodora is another material that has repellency properties and S C Johnson have recently launched a product in the USA called Off Botanicals containing this active. The product Repel Lemon Eucalyptus also contains this active. The oils from turmeric, citronella grass, and hairy basil, especially with the addition of 5% vanillin, repelled the three species under cage conditions for up to eight hours **(**Tawatsin et al., 2001). Fennel oil-containing products could be useful for protection from humans and domestic animals from vector-borne diseases and nuisance caused by mosquitoes" (Kim et al., 2004).

Pyrethrum deserves a special mention as it is a long standing natural insecticide that has been used across a wide spectrum of products for both its kill and repellency properties. Almost always it is used in conjunction with the synergist Piperonyl Butoxide. Some products still contain this mixture.

It should be noted that whilst *Aedes aegypti* is a commonly used mosquito species in laboratory trials, different species of mosquitoes give different responses to the same formulation and active ingredient. Field trials are a better way of assessing the performance of products but factors such as humidity, temperature, degree of exertion, sweating as well as the individual person's chemistry (including diet) can affect the performance of any PIR.

Innovative Products. The consumer-use product, Off/Raid Mossie Lamp, is for outdoor use and relies on a candle flame to release insecticide (allethrin 20:80) from an impregnated cellulose type mat. In addition there is a Hanging Lantern product which is essentially another version of this product. The Therma Cell Mosquito Repellent is also designed for outdoor use and uses a flame from a small canister of hydrocarbon gas to heat an impregnated pad and release insecticide (Allethrin 20:80). Mountain Sandalwood Sticks are made from sandalwood that are burnt to repel insects. The declared actives are citronella oil (15.0 g/kg) and eucalyptus oil (15.0 g/kg). A new product which is an electric air ioniser that sends a flow of negatively charged ions over a gel pad soaked in a slowly released volatile insecticide. The ions charge the insecticide molecules, ensuring they stick electrostatically to target insects. And the draught from the ioniser ensures good vapour distribution.

CONCLUSION

Developments and experimentation obviously continues in this continual war against mosquitoes and insects and the future will undoubtedly bring more weird and wonderful methods of control, underpinned by increasing knowledge of insect behavior and the human host as well as discovery of properties of various chemicals.

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