Health hazards of mosquito repellents and safe alternatives

V. P. Sharma

Repellents such as vaporizers, diethyl toluamide, and herbs are widely used in the country to combat mosquito nuisance and malaria. A multicentric questionnarie-based study revealed that repellents are harmful to human health, and their use should be avoided and discouraged. In this study 11.8% people using various types of repellents complained of ill health effects, and some required medical treatment. Although symptoms disappear shortly after withdrawl, those who do not suffer acute toxicity symptoms and continue to use these repellents for extended periods may suffer neurotoxic and immunotoxic hazards. Safe alternatives are discussed for use by the communities and local bodies.

In most urban and rural areas of the country, mosquito populations are menacing throughout the year, except for some attenuation during summer and winter. Mosquitoes transmit diseases such as malaria, filariasis and many viral diseases such as the Japanese encephalitis, dengue haemorrhagic fever, yellow fever (in Africa), etc. Mosquito coils containing DDT and other organophosphorus compounds were not effective in repelling mosquitoes. Buzzers and electrocuting devices are also useless, just as mosquito repellents1–4. Currently a variety of repellents are marketed in India in the form of mats, coils, lotions and vaporizers. These repellents use allethrin group of compounds, herbs, oils or diethyl toluamide (DEET). The protection provided by these repellents generally lasts for 2 to 4 h.

Indian scenario

The current Indian market for various repellents is in the range of Rs. 500–600 crores (US $ 12–15 million) with annual growth of 7 to 10%. This increase in growth rate is the result of constant environmental degradation, leading to the creation of mosquito-breeding grounds and also the fact that people’s capacity to buy repellents is increasing steadily. Marketing of repellents in India is well organized, so that many brands can be found throughout the country. Introduction of insecticides in the country is subject to registration by the Central Insecticide Board, an autonomous institution under the Ministry of Agriculture, Government of India. Insecticides, for registration, should be safe to human health, wildlife and non-target species. Permission to market a product means that the product has cleared the safety requirements as specified by the Central Insecticides Board. Once the insecticide has been cleared, there is no provision of post-monitoring the adverse health effects of these insecticides, if any.

Health hazards due to mosquito repellents

Researchers are now providing data on the harmful effects of repellents used against mosquitoes. The main site of action of the pyrethroids is the sodium channel, which is kept open for long periods of time, causing prolonged sodium current to flow, leading to hyper-excitation of the nervous system5. Synthetic pyrethroids, e.g. allethrin cause sub-normal or super-normal excitability by affecting the sodium channel opening time. Cheng et al.6 exposed male ICR mice to mosquito coil smoke with d-allethrin and reported histopathological lesions, including the loss of cilia and an increase in vascularity of the alveolar wall. Liu and Sun7 reported that mosquito coils also contain aromatic and aliphatic hydrocarbons, which are combustion products of wood dust, fillers and dyes in the mats. An exposure of rats to the mosquito coil smoke for 60 days resulted in focal deciliation of the tracheal epithelium, metaplasia of epithelial cells and morphological alterations of the alveolar macrophages. Liu et al.8 analysed mosquito coils from Asia and South America and reported that smoke from heating (or burning) contained sub-micron particles (< 1 micron) coated with considerable amount of heavy metals, allethrin and a wide range of vapours such as phenol O-cresol. Furthermore, allethrin used in the mats increased blood brain barrier (BBB) permeability, suggesting a delayed maturity of BBB and biochemical changes causing health risks, especially at an early age in life9. Moya-Quiles et al.10,11 reported aggregation of allethrin in the bilayer core. Eriksson et al.12 and Ahlbom et al.13 reported changes in the density of muscarinic acetylcholine receptors (MACHRs) in cerebral cortex of mice treated neonatally with DDT, who later as
Results of questionnaire-based survey

Repellents use Type I synthetic pyrethroids. These insecticides are heat stable and used in the treatment of mats, coils and vaporizers, e.g. allethrin and bioallethrin 4%; glion of Indian populations. Allethrin has no effect on insect cholinesterase activity, but has stimulating action by releasing acetylcholine (Ach) from the cholinergic ganglion. Diel et al. reported the immunotoxic properties of s-bioallethrin caused by inhibiting lymphocyte proliferation in a dose-dependent manner. D-transallethrin, through hormonal pathways, may contribute to reproductive dysfunction, development impairment and cancer.

Table 1. Results of questionnaire-based survey on health risks of commonly used repellents

<table>
<thead>
<tr>
<th>Complaint</th>
<th>Number of people affected out of 5920 persons interviewed</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breathing problem</td>
<td>248</td>
<td>4.20</td>
</tr>
<tr>
<td>Eye irritation</td>
<td>165</td>
<td>2.80</td>
</tr>
<tr>
<td>Cough, cold and sneezing</td>
<td>99</td>
<td>1.67</td>
</tr>
<tr>
<td>Headache</td>
<td>78</td>
<td>1.32</td>
</tr>
<tr>
<td>Asthma</td>
<td>28</td>
<td>0.47</td>
</tr>
<tr>
<td>Bronchial irritation</td>
<td>27</td>
<td>0.46</td>
</tr>
<tr>
<td>Itching</td>
<td>20</td>
<td>0.34</td>
</tr>
<tr>
<td>Ear, nose and throat pain</td>
<td>18</td>
<td>0.30</td>
</tr>
<tr>
<td>Others*</td>
<td>19</td>
<td>0.32</td>
</tr>
<tr>
<td>Total</td>
<td>702</td>
<td>11.80</td>
</tr>
</tbody>
</table>

*Giddiness, vomiting, nausea, allergy, etc.

Note: A variety of repellents were used routinely to protect from mosquito nuisance. Of the total 5920 persons (including 286 medically qualified doctors) interviewed, 5218 (88.20%) did not report any complaint of adverse health impact in the use of repellents.

Alternative measures to combat mosquitoes

There are completely safe alternate measures to the use of chemical-based repellents. Use of these requires personal attention, action by the community and the local bodies. They are (i) Source reduction: weekly emptying and drying of all standing water sources, however small they may be, in and around houses and other structures. Water should be stored in containers that can be easily cleaned and the opening should be well protected from the entry of mosquitoes; (ii) Good drainage: proper gradient should be provided to eliminate standing water in drains, low-lying areas, ditches, borrow pits, etc; periodical de-siltation of drains, sewers and storm water drains before the onset of monsoon to enable the drains to maintain steady flow; (iii) Minor engineering works: overhead and underground water tanks, wells and sumps should be sealed hermetically and provided with ventilating shafts, made mosquito-proof. Man hole covers should be in place; (iv) Biological control: surface drains, temporary water collections and traps, etc. should be sprayed with Bacillus thuringiensis H-14 at fortnightly intervals; larvivorous fishes should be released in ponds, lakes, rice
fields, drains, etc. (v) Personal protection methods: mosquito nets, preferably treated with synthetic pyrethroid insecticides (treated nets are safe); wire mesh doors, windows and ventilators can be used; and (vi) Neem oil can be extracted from the seeds of *Azadirachta indica* and used as neem cream\(^1\); neem oil 5 parts and 95 parts edible oil like coconut or mustard oil\(^2\) or mats treated with neem oil\(^3\) or burning neem oil in kerosene\(^4\) would be a cost effective alternative to chemical repellents. Neem oil is safe when used as mosquito repellent\(^5\).


ACKNOWLEDGEMENTS. I thank Dr Sarala K. Subbarao, Director, Malaria Research Centre (MRC), New Delhi and the scientific staff of the MRC field stations for the questionnaire-based surveys carried out in various parts of the country.

Received 9 July 1999; revised accepted 13 November 2000

---

**Facilitating innovation in Indian small and medium enterprises – The role of clusters**

**V. P. Kharbanda**

The present-day knowledge economy demands knowledge-intensive enterprises which only can survive in the ongoing process of globalization and increased international competition. Knowledge as a factor for competitive advantage has replaced traditional factors like labour and capital. As knowledge resides only in the human mind, it can only be harnessed by focusing on increasing human capabilities through the process of increased communication, cooperation and linkages, both within the enterprise as well as across enterprises and knowledge-producing organizations. This paper dwells upon a few case studies, how enterprises in India are facing this challenge, and particularly, how small-scale enterprises are moving towards clusters for international competition.

In most developing countries, small and medium enterprises (SMEs) constitute the bulk of the industrial base and contribute significantly to their exports as well as to their GDP or GNP. For instance, India has nearly three million SMEs, which account for almost 50 per cent of industrial output and 42 per cent of India’s total exports. It is the most important employment-generating sector and is an effective tool for promotion of balanced regional development. These account for 50% of private sector employment and 30–40% of value-addition in manu-

---

*V. P. Kharbanda is in the National Institute of Science Technology and Development Studies, Dr K.S. Krishnan Marg, New Delhi 110 012, India. (e-mail: kharbandavp@yahoo.com)*

CURRENT SCIENCE, VOL. 80, NO. 3, 10 FEBRUARY 2001 343