

## Therapeutics of insects and insect products in South Indian traditional medicine

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Studies on the therapeutic use of animals, especially insects and insect products, have been neglected when compared to plants. An attempt has been made to study the utilization of insects and insect products as traditional medicine among the tribes spread over two districts of Kerala in South India. Detailed information was collected regarding traditional therapeutic use of six different insect species and their products for the treatment of over 15 kinds of diseases or ailments. The preparation and usage of the insects and insect products for various ailments like ulcer, rheumatics, anaemia, scabies, conjunctivitis, malaria, asthma, cough, throat infection, chest infection, chest pain, back pain and for other minor ailments like headache, cold, burns, body pain, bee bites, wasp bites, insect bites, etc. are presented. Further studies on validation of these therapies using modern scientific techniques with the cooperation of tribal communities would probably go a long way leading to the discovery of more novel drugs from bugs.

**Key words:** Ethnoentomology, Entomo-ethnomedicine, Insects, Insect therapy, Tribals, Zootherapy, Traditional medicine, South India

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India is gifted with enormous wealth of biodiversity. There are about 45,000 plant species and 81,000 animal species<sup>1</sup>. The tribals who depend on plants and animals for their day-to-day life and health problems are the real custodians of the knowledge of medicinally important plants and animals<sup>2</sup>. Most of the biodiversity, associated with tribals have either disappeared or are on the verge of extinction<sup>3</sup>. The traditional knowledge accumulated by the tribals on medicinal plants and animals are unknown to most of the scientific community. Therefore, the imperative concern of the scientific community is to document the traditional knowledge related to therapeutic use of plant and animal species and to devise strategies to preserve and tap the rich knowledge in a more sustainable way for the benefit of mankind. Animal based medicines have always played a significant role in the healing practices, magic rituals and religions of indigenous and western societies all over the world<sup>2,4-7</sup>. The medicinal use of animals and animal derived products called zootherapy is an important component of ethnozoology. Of the 252 essential chemicals, which have been selected by the World Health Organization (WHO), 11.1% come from plants

and 8.7% from animals<sup>8</sup>. Though, there have been many studies on ethnobotany<sup>9-14</sup>, less attention has been given to ethnozoology, particularly ethnoentomology<sup>15-18</sup>. Insect based traditional knowledge on medicinal importance, although in usage from ancient times, is still less explored and it is only recently scientific recognition has been accredited to entomo-ethnomedicine/ethnoentomology or use of insects in traditional medicines<sup>18,19</sup>. No comprehensive report of ethnoentomology of Kerala is available. In the present investigation, an attempt has been made to study the ethnoentomology of Kerala and the results obtained are presented.

Kerala state is bordered by the states of Karnataka on the North, Tamil Nadu on the East, the Arabian Sea on the West and the Indian Ocean in the South. The state has 14 districts and there are 37 scheduled tribes. Their number is only 1.26 % of the states population. In the present investigation, tribes of Palakkad and Wyanad districts of Kerala were selected. Palakkad district accounts for about 11.5 % of the total land area of Kerala state, with the share of 8.20 % population. The important scheduled tribes of Palakkad are *Irular*, *Mudugar*, *Kurumbar* and *Muthuvans*. They are inhabited in Attappady and Parambikulam areas. The scheduled tribe population

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comes to 35465, which is 1.48 % of the total population of Palakkad district. The tribal people living in Wyanad are *Adiyan*, *Kurichchan*, *Paniyar*, *Mullukkurumar*, *Theenkurumar*, *Bettu*, *Kurumar*, *Kallanadikal*, *Wynad Khan*, *Kunduvadiyan*, *Wynadan*, *Pallayan*, *Thachariadan*, *Muppanmar*, *Pathiyer*, and *Uridavar*. The scheduled tribe population comes to 28711, which is 42 % of the total population of Wyanad district. The list of tribes studied, their location and population is given (Table 1).

Table 1— Major tribes of Wyanad district, Kerala

Tribes	Location	Population (in numbers)
<i>Kurichchan</i>	Padigarethara, Wyanad district Kattikulam, Wyanad district	5048
<i>Kurumans</i>	Panamaram, Wyanad district	4885
<i>Paniyan</i>	Panamaram, Wyanad district. Padigarethara, Wyanad district	15, 793
<i>Irular</i>	Sambarkod, Agali, Attapadi, Palakkad district	8829
<i>Mudugar</i>	Chittor, Agali, Attapadi, Palakkad district	2065
<i>Kurumbas</i>	Agali, Attapadi, Palakkad district	24

### Methodology

The ethno-entomological surveys were carried out non-randomly during January to April, 2005<sup>2</sup>. The investigators surveyed, identified the key respondent and recorded the ailments, for which the animal/insect derived remedies were used, the manner in which the medicines were prepared and administered. Judgmental selection was used to identify tribal members who are aware about the animal medicine, identification, preparation and usage. The age of the tribals interviewed ranged between 20-70 yrs and included both men and women. Before each interview, Prior Informed Consent (PIC) was obtained from the tribals to record the conversations and take photographs. Wherever possible, medicinal raw-material samples were obtained, catalogued, identified and deposited in the laboratory.

### Results

Insect species and raw-materials used for various diseases by the tribes of Kerala are presented (Table 2). The insect resources used as medicines by the tribals consisted of honey and honeybee, termite, wasp, ants, mole cricket and black beetle. They have been using these insects for the treatment of over 15 kinds of diseases or ailments, including ulcer, rheumatics, anaemia, scabies, conjunctivitis, malaria,

asthma, cough, throat infection, chest infection, chest pain, back pain, head ache and cold. However, the tribals had a strong belief that the efficacy of the therapy will be lost if it is disclosed to strangers and many of them hesitated to disclose the preparation of some of the medicines that they have been using. A brief outline of the preparation and use of various insect therapies administered by the tribes is enumerated below:

#### Termite (*Odontotermes formosanus*)

Termite has been using for the treatment of ulcer by *Kurichchan* tribe. The *Irular* and *Mudugar* tribes have been using termite for the treatment of rheumatic diseases, body pain, better health and anaemia. For treating ulcer, decoction of termites and *Vitex negundo* (*Karinochi*) leaves is administered orally to the patient in the morning and evening after food till getting complete recovery. The patient should avoid salt, chillies, alcohol, fish and coffee during treatment period and is advised to have a good sleep. Winged termite (*Odontotermes formosanus*) is dried, powdered and stored in a container. Required quantity of powder is added into milk and consumed irrespective of time to improve health as well as to get rid of body pain. Winged termites are fried in pure coconut oil, powdered and is administered orally for rheumatic diseases till getting complete recovery. *Irular* tribe used both termite and termitorium for the treatment of anemia. Termite/termitorium are dried together or separately and consumed as such by pregnant women.

#### Ant (Order: Hymenoptera)

For scabies, *Paniyan* tribe uses the mud taken from the interior part of the anthill. The mud is applied topically at the affected area until it cures.

#### Black beetle (Order: Coleoptera)

For treating malaria, *Irular* tribes mix leaves of *Leucas aspera* (*Thumba*) and *Ocimum sanctum* (*Thulasi*) and add black coloured small black beetles (order Coleopteran), boil in a pot till it becomes a decoction. The decoction is either applied throughout the body or administered orally to the patient thrice a day before meals, till the disease is cured.

#### Wasp (*Eumenes* sp)

For treating headache, *Kurichchan* tribe uses the nest of the ant *Eumenes* sp. The nest of the ant made into a paste is applied topically on the forehead.

Table 2— Insect raw-materials used for the treatment of various diseases by the tribes of Kerala

Insect group	Common name	Zoological name	Parts used	Diseases	Tribes
Order: Hymenoptera Family: Apidae	Honeybee	<i>Apis indica</i>	Honey	Headache, mouth ulcer, burns, cold, asthma, chest infection, throat pain, health	All tribes
			Bee sting	Bee bite	<i>Irular</i>
			Bee hive	Bee poison	<i>Kurichchan</i>
			Bee eggs, larva	Back pain, chest pain, chest infection, better vision	<i>Irular</i> , <i>Mudugar</i>
Order: Hymenoptera Family: Eumenidae	Potter or mud wasp	<i>Eumenes</i> sp.	Wasp nest	Headache, burns	<i>Kurichchan</i>
Order: Hymenoptera Family: Formicidae	Tree ant <i>Neyyurumbu</i>	<i>Unidentified</i>	Ant hill	Scabies	<i>Paniyan</i>
Order: Hymenoptera Family: Coleoptera	Black beetle	unidentified	Full	Malaria	<i>Irular</i>
Order: Isoptera Family: Termitidae	Winged termite Eesal)	Odontotermes formosanus	Termite	Ulcer	<i>Kurichchan</i>
			Termitorium	Better health, body pain, Rheumatics, anemia Anemia	<i>Irular</i> , <i>Mudugar</i> <i>Irular</i>
Order: Orthoptera Family: Gryllotalpidae	Mole cricket	<i>Gryllotalpa gryllotalpa</i>	Full	Sprains	<i>Kurichchan</i>

Sometimes wasp nest is boiled with coconut oil and applied on the fore head. *Kurichchan* tribe roasts the egg of wasp and consume as such for treating wasp poison. For wasp bite, the wasp nest is made into a paste with water and applied topically on the affected area by the *Kurichchan* tribe.

### Mole Cricket (*Gryllotalpa gryllotalpa*)

For treating sprain, paste of use *Gryllotalpa gryllotalpa* (mole cricket) is spread over the affected area by *Kurichchan* tribe.

### Honey bee (*Apis indica*)

All the tribes surveyed use honey of *Apis indica* for the treatment of headache, mouth ulcer, burns, cough, asthma, chest infection, throat pain, body pain, fungus infection and for health. In addition to this, *Irular*, *Mudugar* and *Kurichchan* tribes also have been using honey for the treatment of cold, insect bite and conjunctivitis, respectively. *Irular* and *Mudugar* tribes use honeybee eggs and larva for the treatment of back pain, chest pain, chest infection and for better vision. *Kurichchan* tribes use beehive to treat bee poison whilst, *Irular* tribes use bee sting to treat bee bite. For curing headache, honey is applied directly on fore head. For curing mouth ulcer, honey is diluted using pure water and it is applied topically on the affected

area. It is applied on the tongue of newborn babies for better flexibility of tongue. During burns, honey is applied directly on the affected part. To treat asthma in kids cumin seeds (*Cuminum cyminum*) are fried, powdered, mixed with honey is administered orally till the disease is cured. For chest infection, honey mixed with lime water (calcium carbonate) is administered orally before going to bed till getting complete recovery. For treating throat pain, equal quantity of honey is mixed with the sap of *Sida* sp (*Kurunthoti*) and administered orally. Pure honey is consumed as a medicine for treating body pain. For fungus infection honey is applied directly on the affected part. For gaining health, honey mixed with *Amaranthus viridis* (*Cheera*) seeds, fried in a pot, powdered and made into a paste is consumed several times a day. For the treatment of back pain, honeybee egg or larvae is powdered and applied on the affected area or orally administered. For chest pain, honey bee egg or larvae powdered and mixed with honey is orally administered. For better vision, honey bee egg or larvae powdered and mixed with honey is orally administered. For the treatment of cold, leaves of *Ocimum sanctum* (*Thulasi*) and onion (*Allium cepa*) is crushed and sap mixed with honey is taken three times a day. For insect bite, honey is applied on the affected part followed by lime (calcium carbonate).

For treating honey bee poison, fried honey beehive is eaten. For treating conjunctivitis, honey mixed with *Phyllanthus niruri* (*Kizhar nelli*) sap and filtered is applied topically. For bee bite, paste of bee sting and *Datura fastuosa* (*Karu Oomathai*) leaves is applied on the affected area for three days.

## Discussion

Honey of the bee, *Apis indica* played a major role in tribal therapies. Honey or honey bee products of the bee, *Apis indica* are used as an ingredient in most of the tribal medicines used for the treatment of burns, mouth ulcer, headache, chest pain, asthma, cold, throat pain, fungus infection, conjunctivitis, body pain, etc. Apitherapy or therapy with bee-products like honey, propolis, fortified-honey and herb-honey is a part of traditional medicines. Honey is used for the treatment of cough and cold as well as for the treatment of asthma by most of the South Indian tribes of Tamil Nadu like *Irular*, *Kanikkaran*, *Kattunayakan*, *Kota*, *Kurimbas*, *Palliyan*, *Paniyan*, *Sholaga* and *Toda*<sup>2</sup>. *Muthuvan* tribes of Idukki were reported to use honey for the treatment of leucorrhoea, cold and burns and diarrhoea<sup>20</sup>. Because of their beneficial effects, these products, which are used as food and medicines by tribes, are receiving worldwide attention<sup>2</sup>. There are many medical reports about the effectiveness of honey in gastric and peptic ulcers or gastro-intestinal disorders in humans<sup>21-24</sup>. The importance of honey as the best universal topical medicine for wound healing and for blepharitis, catarrhal conjunctivitis, keratitis was also reported<sup>25-27</sup>. Propolis, a resinous wax like substance, which bees collect from plants, is claimed to be very useful for arthritis, measles in eyes and gastric ulcers<sup>28,29</sup>. Another interesting finds was that of the termite species, *O. formosanus*, which is being used for the treatment of anaemia by pregnant women of *Irular* and *Mudugar* tribes. The use of termite for ulcer (*Kurichchan* tribe), body pain, health and rheumatics (*Irular* and *Mudugar* tribes) is worth reporting. The termite, *O. formosanus* has also been used by the *Palliyan* and *Kanikkaran* pregnant female tribes as food for the enhancement of lactation<sup>2,7</sup>. The use of termite as human food in the South and Northeastern parts of India has been reported<sup>2,7,30-33</sup>. Insects represent the cheapest source of animal protein in Manipur and the termite *Odontotermes feae* Linn. formed one of the important insect foods<sup>32</sup>. The South Indian tribes roast the winged stage of the termites in

an earthen pot and consume as such in the evenings for 3 days as a remedial measure to treat asthma<sup>2,7</sup>. A respiratory viral infection is probably one of the most common causes of asthma<sup>34</sup>. Termites are reported to have antimicrobial properties<sup>35</sup>. Recently, two novel antimicrobial peptides, termicin and spinigerin have been isolated from the fungus-growing termite, *Pseudacanthotermes. Spiniger*<sup>35</sup>. Studies conducted on the termite, *P. spiniger* revealed that termicin, a cysteine-rich antifungal peptide has antibacterial properties also<sup>35</sup>.

Yet another interesting find is that of the treatment of scabies by applying mud from the interior part of the anthill by *Paniyan* tribe and use of wasp nest for the treatment of wasp bite by *Kurichchan* tribes. Arthropods (such as wasps, bees, mole crickets, scarab larvae, cicada nymphs and centipedes) that live in close proximity to each other are subject to microbial attacks and epidemic diseases. To limit disease activity, they incorporate antimicrobial compounds into their nests<sup>37</sup>. Soil-dwelling-ants also have been shown to use chemical defense against fungi and bacteria in their underground nests<sup>38</sup>. Wasp has also been reported to be used in medicine by various South American cultures and in ancient Mexico<sup>39,40</sup>. In South Korea, 17 insect species and their products are widely used for ailments like gonorrhoea, hearing problems, diabetes, impotence, lung diseases, stroke and arthritis<sup>41</sup>. In China, presently about 140 medicinal insects have been identified and of which some are even mass generated for the production of medicines<sup>19</sup>. 11 species of insects used as medicine to cure various ailments like urinary diseases, neurological problems skin and respiratory illness by tribes of Thirunelveli district of Tamil Nadu are also reported<sup>18</sup>. Independent of actual efficacy of these insects is an interesting folk logic of Koreans that relates some characteristics of the product to its medical use<sup>41</sup>. One reasoning sees the medical use in the negative interactions that the insect has with the people. For instance, blister beetles, which cause human skin to blister, are used to treat skin diseases by Koreans. Korean folk logic also relates reproductive parts or products to increase sexual potency. Thus, praying mantis egg cases are used to stimulate male sexual stamina. Other similar folk logic of the Koreans is the use of cicada (whose loud calls are prominent parts of Korea's summer) to treat hearing problems and the use of blood feeding horse flies (*Tabanus* sp.) to treat blood problems.

India, when compared to rest of the world is gifted with a rich faunal diversity. With a mere 2.4 % of the world's area, India accounts for 7.31 % of the global faunal total<sup>42</sup>. Providing education on domestication, conservation and preservation of the biological diversity in a more scientific and sustainable way will ensure the tribe's permanent and reliable source of medicine besides conservation and preservation of the biological diversity in a sustainable way<sup>2</sup>. Further, testing the validity of the claims made by these tribals using modern scientific techniques with the cooperation of tribal communities would probably go a long way leading to the discovery of more new drugs from bugs.

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### References

- 1 MoEF, *Biodiversity country studies, strategies and action plan*, (Ministry of Environment and Forests, Government of India), 1994, 48.
- 2 Solavan A, Paulmurugan R, Wilsanand V & Ranjith Sing AJA, Traditional therapeutic use of animals among tribal population of Tamil Nadu, India, *Indian J Traditional Knowledge*, 3 (2004) 198-2005.
- 3 Vedavathy S, Tribal Medicine-The Real Alternative, *Indian J Traditional Knowledge*, 1 (2002) 25-31.
- 4 Nadkarni AK, *Indian Materia Medica*, (Popular Prakashan Private Ltd, Bombay), 1954, 968.
- 5 Angeletti, LRU, Agrimi C, Curia D French & Mariani-Costantini R, Healing rituals and sacred serpents, *Lancet*, 340 (1992) 23-225.
- 6 Rosner F, Pigeons as a remedy (*segulah*) for jaundice, *New York State J Medicine*, 92 (1992) 189-192.
- 7 Wilsanand V, Utilization of termite, *Odontotermes formosanus* by tribes of South India in medicine and food, *Nat Prod Radiance*, 4 (2005)121-125.
- 8 Costa Neto EM, Traditional use and sale of animals as medicines in Feira de Santana City, Bahia, Brazil, *Indigenous know Dev Monitor*, 1999.
- 9 Bhandary MJ, Chandrashekar KR, & Kaveriappa KM, Medical ethnobotany of the *Siddis* of Uttara Kannada district, Karnataka, India, *J Ethnopharmacol*, 47 (1995) 149-58.
- 10 Rao N Rama & Hendry AN, *The Ethnobotany of Eastern Ghats in Andhra Pradesh, India*, (Vedam Books, New Delhi), 1996.
- 11 Samvatsar S & Diwanji VB, Plant sources for the treatment of jaundice in the tribals of western Madhya Pradesh of India, *J Ethnopharmacol*, 73 (2000) 1-2.
- 12 Katewa SS, Guria BD & Jain A, Ethnomedicinal and obnoxious grasses of Rajasthan, India, *J Ethnopharmacol*, 76 (2001) 293-297.
- 13 Singh AK, Raghubanshi AS & Singh JS, Medical ethnobotany of the tribals of Sonaghati of Sonbhadra district, Uttar Pradesh, India, *J Ethnopharmacol*, 81 (2002) 31-41.
- 14 Harsha VH, Hebbar SS, Shripathi V & Hegde GR, Ethnomedicobotany of Uttara Kannada District in Karnataka, India--plants in treatment of skin diseases, *J Ethnopharmacol*, 84 (2003)37-40.
- 15 Lalramnghinglova H, Ethnobiology in Mizoram state: folklore medico-zoology, *Bull Indian Inst Hist Med Hyderabad*, 29 (1999) 123-48.
- 16 Rajan S, Sethuraman M & Mukherjee PK, Ethnobiology of the Nilgiri hills, India, *Phytother Res*, 16 (2002) 98-116.
- 17 Patil SH, Ethno-medico-zoological studies on Nandorbar District of Maharashtra, *Indian J Traditional Knowledge*, 2 (2003) 297.
- 18 Ranjith Singh AJA & Padmalatha C, Ethnoentomological practices in Tirunelveli district, Tamil Nadu, *Indian J Traditional Knowledge*,3 (2004) 442-446.
- 19 Tyagi BK, A hand book of medically important insects and other arthropods. (Scientific Publishers, India, Jodhpur), 2003, 269.
- 20 Johncy Manihottam, Francis MS & Rao YS, Ethnomedicinal practices of Muthuvan tribes of Kerala. In: *Herbal medicines for diseases*, Vol 1, by Ali Khan I, Khanum A (Ukaaz Publications, Hyderabad), 223-252.
- 21 Kandil A, EL-Banby M, Abdel Wahed K, Abdel Gawwad M & Fayed M, Curative properties of true and floral and false non floral honey on induced gastric ulcer, *J Drug Res (Cairo)*, 17 (1987) 103.
- 22 Salem SN, Honey regimen in gastrointestinal disorders, *Bull Islamic Med*, 1 (1981) 358-362.
- 23 Haffejee IE & Moosa A, Honey in the treatment of infantile gastroenteritis, *British Med J*, 290 (1985) 1886-1887.
- 24 Ladas SP, Haritos DN & Raptis SA, Honey may have a laxative effect on normal subjects because of incomplete fructose absorption, *Am J Clin Nutr*, 62 (1995) 1212-1215.
- 25 Harris S, Honey for the treatment of superficial wounds: a case report and review, *Primary Infection*, 2 (1994) 18.
- 26 Vardi A, Barzilay Z, Linder N, Cohen HA, Paret G & Barzilai A, Local application of honey for the treatment of neonatal post operative wound infection, *Acta Paediatrica*, 87 (1998) 429.
- 27 Efem SEE, Udoh KT & Iwara CI, The antimicrobial spectrum of honey and its clinical significance, *Infection*, 20 (1992) 227.
- 28 Zielonka E, Zaborski W, Dymarezyk M & Kuziemska G, Role of propolis in the treatment of rheumatic diseases, *Biuletyn Apipo*, 78 (1987) 29-32.
- 29 Banerjee P, Sahoo KN, Biswas TK, Basu SK, Chatterjee J, Hui AK, Chakraborty NC & Debnath PK, Bees make medicine for mankind, *Indian J Traditional knowledge*, 2 (2003) 22-26.
- 30 Forbes J, *Oriental Memoirs: A Narrative of Seventeen Years Residence in India*, 2 Vols, (Richard Bentley, London), 1 (1813) 305.
- 31 Maxwell-Lefroy H, *Indian insect life: A Manual of the Insects of the Plains-Tropical India*, (Thacker, Spink & Co, Calcutta & Simla), 1909, 786.
- 32 Gope B & Prasad B, Preliminary observation on the nutritional value of some edible insects of Manipur, *J Adv Zool*, 4 (1983) 55-61.
- 33 Rajan BKC, Tiny wild fauna and human food, *My Forest*, 23 (1987)177-180.

- 34 Das PC, *Text Book of Medicine*, (Current Books International, Calcutta), 1988, 955.
- 35 Lamberty M, Zachary D, Lanot R, Bordereau C, Robert A, Hoffmann J & Bulet P, Insect immunity. Constitutive expression of a cysteine-rich antifungal and a linear antibacterial peptide in a termite insect, *J Biol Chem*, 276 (2001) 4085-4092.
- 36 Da Silva P, Jouvensal L, Lamberty M, Bulet P, Caille A & Vovelle F, Solution structures of termicin, an antimicrobial peptide from the termite *Pseudacanthotermes spiniger*, *Protein Sci*, 12 (2003) 438-46.
- 37 Beattie AJ, Turnbull CL & Hough T, Antibiotics production: a possible function for the metapleural glands of ants (Hymenoptera: Formicidae), *Annals Entomol Soc Am*, 79 (1986) 448-450.
- 38 Holldobler B & Wilson EO, *The Ants*, (Belknap Press of Harvard University, Cambridge), 1990, 732.
- 39 Posey DA, Topics and issues in ethnoentomology with some suggestions for the development of hypothesis generation and testing in ethnobiology, *J Ethnobiol*, 6 (1986) 99-120.
- 40 Ramos-Elorduy de Conconi J & Moreno JM, The utilization of insects in the empirical medicine of ancient Mexicans, *J Ethnobiol*, 8 (1988) 195-202.
- 41 Pemberton RW, Insects and other arthropods used as drugs in Korean traditional medicine, *J Ethnopharmacol*, 65 (1999) 207-216.
- 42 MoEF, *National Policy and Macrolevel Action Strategy on Biodiversity*, (Ministry of Environment and Forests, Government of India), 1999, 74.