



Review Article

ASSESSMENT OF DIFFERENT ACARICIDES RESISTANCE AND USES OF ETHANOBOTANICAL AGENTS FOR CONTROLLING TICKS ACTIVITY: A REVIEW

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ABSTRACT

Ticks are obligate blood feeding ectoparasites of vertebrates incurring huge production loss in livestock industry & creating serious public health problems in the world. This review explores the acaricides resistance & ethnoveterinary practices to control ticks infestation. Long-term use of acaricides has generated resistance in many tick species. The use of phyto extract might play an important role in addressing the ticks manifestation as ethnoveterinary plant has demonstrated repellent & toxic effects on ticks. They are of course less expensive, but they are often regarded as being more effective & therefore can be developed further for tick control & management. In regard to our literature survey the biological & parasitic activities of the plant species & status of acaricides resistance are given herein. It is hoped that our review would help to facilitate selection for further investigation of Plants & Acaricides with relatively high levels of potency & a wide range of biological activities.

Keywords: Ticks, Acaricides resistance, Ethnoveterinary plants, Livestock, Adult Immersion Test.

INTRODUCTION

All over the world, almost all the cattle population are suffering from tick infestation which results in tremendous losses of production either through establishment of anemic state, general stress & irritation, depression of immune functions and/or by transmission of various pathogenic organisms. Besides its effect on growth & production, tick infestation also poses significant threat to the availability of good quality hides & skin for leather industry estimated a 20-30 % reduction in the cost of leather due to tick bite marks (Biswas, 2003). Ghosh *et al.* (2007) found that among the species of ticks infesting cattle in India, *Rhipicephalus (Boophilus) microplus* the most widely distributed tick & serves as the major vector of economically important pathogens like *Babesia bigemina* & *Anaplasma marginale*. As per the predictions, the epidemiology of tick infestations & their vectorial potential are likely to change with the changing environmental conditions due to global warming, thus in this scenario the

control of tick infestation is considered a major factor for sustainable livestock production worldwide & especially in tropical countries like Mexico, Columbia, Brazil & India etc. Use of acaricides is one of the important methods that reduce the tick-borne diseases. A wide range of acaricides, including arsenicals, chlorinated hydrocarbons, organophosphates, carbamates, amitraz & synthetic pyrethroids are being used for control of ticks. It has researchers studied various application methods of conventional acaricides & found that conventional acaricides may be applied as dips or sprays & pour-on, at various frequencies (Dautel, 2004). Studies carried out by workers (Maunder, 1949; Whitnall *et al.* 1951) use DDT & benzenehexachloride (BHC) making them first of this group of chemicals to be used as acaricides.

Status of Acaricides Resistance

The first report about development of resistance in *B. decoloratus* against arsenicin South Africa (Whitehead,

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1958), & later reports development of resistance in *B. microplus* against arsenic in Australia (Newton, 1967). Chlorinated hydrocarbon acaricides are very persistent & have been used quite extensively throughout the world for controlling ticks since then, of particular interest are benzene hexachloride toxaphene. But as the case with other acaricides, resistance against chlorinated hydrocarbon acaricides has also been observed. Some studies reported the use of organophosphates which were introduced around 1950, as a replacement for the chlorinated hydrocarbons to which significant resistance had occurred (Shanahan & Hart, 1966). Solomon (1983) studied another class of acaricides i.e. pyrethroids, whose mode of action is by interfering with nerve conduction of ticks. Fernandes (2001) worked on toxicological effects & resistance to pyrethroids in *Boophilus microplus* from Brazil & found that ticks were resistant to deltamethrin & cypermethrin. Rodriguez-Vivaset *al.* (2006) revealed development of resistance in tick population to almost all major families of acaricides. Increasing level of resistance creates problems for the scientific community as well as cattle producers to manage ticks & tick-borne diseases affecting their animals (Davey & George, 1998). Foil *et al.* (2004) reported that ticks developed resistance to several classes of acaricides due to abandoned use of acaricides such as pyrethroid, deltamethrin, diazinon, amitraz, & cypermethrin.

Resistance to acaricides in *R. (B.) microplus* was reported in almost every region of the world. Nolan *et al.* (1989) discussed the causes behind the development of resistance in *R. (B.) microplus* species & concluded that this species is particularly susceptible to selection pressure because of their prolonged association with the host. Further Klafke *et al.* (2006); Perez-Cogollo *et al.* (2010) reported populations of *R. microplus* resistant to ivermectin in Brazil & Mexico. Other studies also carried out on double-resistant, triple-resistant & multi-resistant acaricides that *R. microplus* generated resistant against double resistant i.e., organochlorines & organophosphates (Aguirre & Santamaria, 1996), synthetic pyrethroids & organophosphates (Ortiz *et al.*, 1995), triple-resistant to organophosphates, synthetic pyrethroids & amidines (Benavides *et al.*, 2000; Soberanes *et al.*, 2002; Rodriguez-Vivas *et al.*, 2007) & multi-resistant from the different acaricides (Fernández-Salas *et al.*, 2012 a). Petermann *et al.* (2016) conducted study in New Caledonia & reported that *Rhipicephalus (Boophilus) microplus*, has developed resistance to amitraz & deltamethrin slowly. Gaur *et al.* (2016) noted that *Rhipicephalus (Boophilus) microplus* & *Hyalomma anatolicum* ticks produced resistance against deltamethrin & diazinon in Hisar district (Haryana) & Churu city in Rajasthan. Ziapour *et al.* (2016) reported that susceptibility status of the cattle tick, *Rhipicephalus (Boophilus) annulatus* showed resistance to pyrethroid insecticides in north of Iran. Wharton (1983) reviewed resistance detection, identification & characterization of resistance. Resistance is characterized by when cattle continue to be infested with large numbers of engorged ticks even after frequent treatments. Baker & Shaw (1965) recognized the importance of field-spraying tests

& stated that field-spraying tests must be conducted under standardized conditions where resistance is suspected because nonstandard conditions may result in faulty or ambiguous observations. Wharton & Roulston (1970) examined that larval packet test is the traditional test for diagnosing resistance to acaricides in single host ticks, in which larvae are placed in envelopes & impregnated with acaricide. The stages most commonly used to study resistance are the engorged females & the unfed larvae. The engorged females usually provide the most useful information on potential acaricides, but unfed larvae are generally accepted as the logical stage to document resistance.

Kumar *et al.* (2011) reported use of so many acaricides in India eg- organophosphates (op), synthetic pyrethroids (sp), amidines & macrocyclic lactones. Continuous use of OP compound resulted in an increase in the environmental load of diazinon nevertheless it is found that it has increased resistance factor in the tick that is collected from tropical middle-gangetic plains. Singh *et al.* (2014) evaluated the cypermethrin resistance in *Rhipicephalus (Boophilus) microplus* & *Hyalomma anatolicum* collected from Muktsar & Mansa, India by using adult immersion test (AIT). The resistance levels were categorized using various variables like mortality, egg mass weight, reproductive index, & percentage inhibition of oviposition. *R. (B.) Microplus* showed resistance to cypermethrin where as, *H. anatolicum* showed susceptible status. Alonso-Diaz *et al.* (2006) reported that mainly resistance has been developed for the particularly classes OP, SP & amitraz in the regions where cattle are prominent. Sharma *et al.* (2012) assessed the prevalence of synthetic pyrethroids (SP) resistance in *Rhipicephalus (Boophilus) microplus* in India, he selected 27 areas located in six agro-climatic regions for the collection of engorged ticks using two stages stratified sampling procedure. Adult immersion test (AIT) & larval packet test (LPT) were used to determine susceptible line of *R. (B.) microplus* (IVRI-I) in laboratory reared condition i.e., determination of 95% lethal concentration (LC₉₅) of deltamethrin (29.6ppm in AIT & 35.5ppm in LPT) & cypermethrin (349.1ppm in AIT & 350.7ppm in LPT). The AIT with a discriminating dose was used to detect deltamethrin & cypermethrin resistance in the field isolates of *R. (B.) microplus*. Kumar *et al.* (2011) reported resistance against diazinon from the tropical middle gangetic plain in India has a very high density of animal population where farmers use diazinon for tick control, agricultural practices & mosquito control. Due to the continuous use of OP compounds (diazinon) ticks developed resistant against diazinon. Perez-Gonzalez *et al.* (2014) studied the effects of synthetic carbamates on four strains of *Rhipicephalus microplus* (fully engorged females) & compared it. It is demonstrated that carbamates inhibit efficacious of tick strains. Artificial feeding assay (AfA) showed a *Rhipicephalus microplus* larval hatching rate of fluzuron with the Jaguar strain & very less percentage of larva is found to be susceptible at fluzuron concentration. Muyobela *et al.* (2015) indicated that *Rhipicephalus appendiculatus*, *Amblyomma variegatum*, & *Rhipicephalus*

(*Boophilus microplus*) were resistant to amitraz & cypermethrin acaricides, in Zambia. Ahanger *et al* 2015 found significant resistance level against deltamethrin in *Rhipicephalus (Boophilus) microplus*. Puerta *et al.* (2015) examined that *Rhipicephalus microplus* showed a high degree of resistance towards the cypermethrin, amitraz & also the combination of chlorpyrifos + cypermethrin but did not find any resistance against fluzuron.

Several studies documented that ticks developed resistance against various acaricides i.e., amitraz and chlorfenvinphos (Chitombo *et al.*, 2021), cypermethrin (Klafke *et al.*, 2017; Singh *et al.*, 2014), ivermectin (Rodríguez-Vivas *et al.*, 2017; Rodríguez-Vivas R *et al.*, 2014; Cruz *et al.*, 2015), fluzuron (Recket *et al.*, 2014; Maciel *et al.*, 2016), amitraz (Murigu *et al.*, 2016; Stone *et al.*, 2014; Muyobela *et al.*, 2015; Singh *et al.*, 2015), deltamethrin (Gupta *et al.*, 2016; Jyothimollet *et al.*, 2014), pyrethroid (Ziapouret *et al.*, 2016; Wyket *et al.*, 2016), amitraz & deltamethrin (Petermann *et al.*, 2016), fipronil (Lopes *et al.*, 2014), amitraz & cypermethrin (Fernández-Salas *et al.*, 2012 b) & permethrin & amitraz (Li *et al.*, 2007; deltamethrin and cypermethrin (Godara *et al.*, 2019).

Status of Herbal Acaricides/Ethnoveterinary plants

Feyereisen (1995) reviewed effective insecticides & concluded that the list is rapidly shrinking; meanwhile introduction of new insecticides in the market became almost negligible, largely because of the high costs associated with research, development & registration of the new products. It has been reported that 80% of world-wide cattle are at risk for ticks & tick-borne diseases causing a global annual loss of US\$ 7000 million. Minjauw & McLeod (2003) suggested that cost of management of ticks is as high in India as US\$ 498.7 million per annum. Thus, in this present scenario there is an urgent need of an alternative safe method for tick control. Habeeb (2010); Rates (2016) discussed the advantages related with herbal acaricides over synthetic acaricides & stated that herbal acaricides are eco-friendly & cheaper & are with minimum environmental & mammalian toxicity. Benner (1996) stated that these compounds are produced by plants as a defensive chemical molecules against attack by pests & belong to a range of secondary metabolites such as terpenoids, alkaloids, polyacetylenes, flavanoids & unusual amino acids & sugars. Athanasiadou *et al.*, (2007); Masood *et al.* (2013) reported that ethnoveterinary bioactive products & essential oils of plants has efficacy of acaricidal activity. Habeeb (2010) studied the various modes of action of these plant extracts & found that there are several ways by which they exert acaricidal property, some of them are preventing blood feeding, molting, fecundity, & hatching of eggs. Chabra & Saxena, (1998) studied this trend of using plant extracts as acaricides in Indian subcontinent & found that plants are being used effectively for controlling the acaricides. Babar *et al.* (2012) noticed that there is a renewed interest of scientific community in the use of botanicals for safe, effective & cheap control of cattle ticks. Zaman *et al.* (2012) also noticed that the application of

botanicals to livestock in order to control the ectoparasites of veterinary importance is widespread particularly in the developing countries.

There is a plethora of literature regarding many botanical products that can kill ticks or inhibit oviposition. A few candidate plants with acaricidal properties include *C. aurea*, *S. molle*, *V. amygdalina*, *R. communis*, *C. macrostachyus*, and *N. tabacum* (Kemal *et al.*, 2020), *Commiphora erythraea* (Carroll *et al.*, 1989), *Artocarpus saltilis* (Williams, 1993), *Stemona collinsae* (Jansawan *et al.*, 1993), *Margaritaria discoidea* (Kaaya *et al.*, 1995), *Ocimum suave* (Mwangi *et al.*, 1995), peel oil of *Citrus* spp. (Chungsa marnyart & Jansawan, 1996), *Pimentadiaoica* (Brown *et al.*, 1998), *Gynandropsis gynandra* (Lwande *et al.*, 1999), *Cleome hirta* (Ndungu *et al.*, 1999), custard seed oil (Kalakumar *et al.*, 2000), *Stylosanthes scabra* (Khudrathulla & Jagannath, 2000), *Tamarindus indicus* (Chungsamarnyart & Jansawan, 2001), *Eucalyptus* spp. (Chagas *et al.*, 2002), *Copaifera reticulata* (Fernandes & Freitas, 2007), *Senna italica* subsp. *Arachoides* (Maganoe *et al.*, 2008), & *Lippia javanica* (Madzimure *et al.*, 2011), *Calendula officinalis* (Godara *et al.*, 2015), *Cissusqua drangularis* (Wellington *et al.*, 2017), *Cissusqua drangularis*, *Lippiaja vanica*, *Psydrax livida* & *Aloe* spp. (Nyahangare *et al.*, 2015), *Neoglaziovia variegata* (Dantaset *et al.*, 2015), *Ocimum species* (Hüe *et al.*, 2015), *Datura stramonium*, *Azadirachta indica*, & *Calotropis procera* (Shyma *et al.*, 2014), *Eupatorium adenophorum* (Nong *et al.*, 2013), *Solanum incanum* & *Strychnos spinosa* (Madzimure *et al.*, 2013). Above mentioned reports clearly suggest that various plant extracts have the potential for controlling ticks. Morais-Urano *et al.* (2012) studied the acaricidal property of fungus *Beauveria felina* used as a potential substitute to synthetic acaricides currently used for *R. (B.) microplus*. Moreover, Tendonkeng *et al.* (2005); Cetin *et al.* (2009) reported acaricidal activity from essential oils of leaves & flowers of *Ageratum houstonianum*, *Origanum monites* & *O. minutiflorum* against *R. (B.) annulatus* & *R. turanicus*. Rosado-Aguilar *et al.* (2010) elucidated the chemical nature of active acaricidal compounds from the root & stem extracts of the *Petiveria alliacea* & found that their potent acaricidal activity reside in benzyltrisulfide (BTS) & benzyldisulfide (BDS) metabolites. Porter *et al.* (1995) observed that the Cadina-4, 10 (15)-dien- 3-one, isolated from the leaves & stem of *Hyptis verticillata* disrupted the oviposition & hatching of *R. (B.) microplus* eggs.

More & more attention is now being paid to explore the huge potentiality of the medicinal plants as acaricides & India is not an exception of that. (Khudrathulla & Jagannath, 2000) studied the effect of a methanolic extract of *Styloxanthes scabra* on ixodid ticks. Choudhury *et al.*, (2004) reported that the leaves of tobacco (*N. tabacum*) are quite effective against *R. haemaphysaloides* while in a study Magadam *et al.*, (2009) found that the ethanolic extracts of *Annona squamosa* seed & *Azadirachta indica* leaves, bark & seed have high efficacy of 70.8% & 80%, respectively, against *R. (B.) microplus*. Additionally, Ravindran *et al.* (2011) tested crude ethanolic extract of aerial parts of *Leucas aspera* for its acaricidal properties

against *R. (B.) annulatus* & observed that at the concentration of 100 mg/ml significant adult tick mortality was achieved & even at lower dilutions of the extract, it is possible to inhibit eclosion of eggs from the treated ticks. Shymaet *et al.*, (2014) using the crude methanolic extracts of leaves of *Datura stramonium*, *Azadirachta indica* & seeds of *Allium sativum* & *Carica papaya* reported significant anti-tick activity.

Zorloni *et al.* (2010) analyzed acetone, hexane & water leaf extracts of *Calpurnia aurea* collected in southern Ethiopia for acaricidal properties on unfed adult *Rhipicephalus pulchellus* ticks. They reported *C. aurea* extracts did not show any repellent properties, but had a slight attractant capacity. With 20% & 10% acetone extracts, all ticks were either killed or their mobility severely compromised after 1 ml of extract was topically applied on the abdomen. At a 5% concentration, 85% of ticks were still affected. A 10% aqueous solution also had a marked effect. It is reported that use of ethno botanical plants help in protection against insect bite & treatment of livestock health problems (Bekele *et al.*, 2012). 27 traditional medicines gave information on the native plants used as insecticides insect repellents & for various ethno veterinary purposes. Interestingly, Andreotti *et al.* (2013) suggested that *T. minuta* oil is a potential *R. microplus* tick control agent that can be used to mitigate the economic losses associated with tick infestation. Some studies have investigated that acaricidal effect of *Zataria multiflora* & *Artemisia annua* have high potential acaricidal effects on the engorged stage of *R. (Boophilus) annulatus* in vitro (Kheirabadi & Silva, 2011). Zamanaet *et al.* (2011) examined the efficacy of anti-tick property in combined aqueous herbal extracts of *Azadirachta indica* leaves, *Nicotiana tabacum* leaves, *Calotropis procera* flowers & *Trachyspermum ammi* seeds using adult immersion test, larval packet test & ear bag method. Their study revealed lethal effects on egg laying (index of egg laying = 0.371404 ± 0.00435), hatching (22.35%) & total larval mortality at 50 mg ml⁻¹ & reduced tick intensity on the infested calves (18 detached out of 35 at 45% (w/w) suspension, topically applied). The herbal extract exerted dose- & time-dependent response against all the developmental stages of *Rhipicephalus (Boophilus) microplus* considered in their study, thus justified their use.

Importance of Ethno-veterinary medicine

Ethno veterinary science deals with the practices & skills Ethno-veterinary medicine (EVM) that is used for curing diseases & maintaining health of animals (Mathias-mundy & McCorkle, 1989; Tabuti *et al.*, 2003). Forest areas are basically depending upon the forest resources for the completion of their requirements such as fibre, food, medicine, hunting & fishing, agriculture equipments & household etc. Although they mainly depend upon forest resources for their livelihood but they also raise domestic animals such as cows, buffaloes, oxen, goats, sheep, hen, dogs, pigs etc for milk, agriculture & commercial purposes. Poor tribal people cannot afford the modern medicine & unable to use complicated technology for the preparation of

EVM, therefore, they use traditional veterinary practices to prevent & treat common animal ailments & diseases with the help of locally available plants. Although the use of chemical compounds as acaricides is quite common through the world but is associated with certain practical demerits such as these are expensive thus not readily available to the resources-limited farmers. In addition, nondegradable residues contained in conventional acaricides may pollute the products (milk & meat) & harmful to the environment, or too expensive for resource-limited farmers & ticks have developed resistance to them. The tribal people have been using this traditional system for a very long time. They have acquired this valuable knowledge from experience & trial & error methods. They diagnose & cure their animal for different tick's diseases through their own ethno veterinary practices. In this way they have a rich store of indigenous technology on medicinal plant use which is found effective over the years. The traditional medicine plays an important role for their life because access to modern health services is very limited, tribal people also have good knowledge about the uses of various plants & other products (Yadav & Gupta, 2014). This knowledge has passed down from one generation to next generation orally. According to World Health Organization currently, at least 80% of people in developing countries depend largely on these practices for the control & treatment of various diseases (Mahima *et al.*, 2012). Ethno veterinary medicine is cost effective, dynamic, easily accessible, easily administered, mostly given orally or topically, less toxic, herbal, ecofriendly & biodegradable (Rastogi *et al.*, 2015; Parthiban *et al.*, 2016). EVM complements modern veterinary medicines so effectively that it can be used as alternative medicines for livestock treatments & cures, but before that their proper validation is required. However, some of the knowledge have scientific reasons & proven to be beneficial for low inputs & sustainable agriculture (Phondani *et al.*, 2010).

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