



A mini review of methods to control ticks population infesting cattle in Chhattisgarh with special emphasis on herbal acaricides

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Received 30 November 2019; Revised 17 October 2020

Ticks infestation is a major concern for the cattle industry in India. In Chhattisgarh, *Hyalomma anatolicum* and *Rhipicephalus microplus* are the two main ixodid tick affecting the animals. Ticks cause deterioration of the animal's health and reduce their productivity. Controlling ticks is very much required for maintaining the wellbeing of animals and earning the livelihood by cattle rearing communities. The chemical acaricides have been used extensively for their promising results in controlling cattle ticks. However, these chemicals are comprised of certain side effects including reduction of meat quality, residues in body and affecting the environment. Most importantly, the ticks are getting resistant with almost all synthetic acaricides available in the market. Several organochlorine chemicals are banned due to their toxic effects. Chhattisgarh is the herbal state, numerous medicinal plants are growing in this geographical region that can be used as an effective and safe alternative to chemical acaricides against cattle ticks. Thus, in this review, we have introduced the type of ticks available in the Chhattisgarh. The possibility of herbal sources and other methods of controlling cattle ticks is also discussed.

Keywords: Cattle, Chemical acaricides, Chhattisgarh, Herbal acaricides, Ticks resistance.

IPC code; Int. cl. (2015.01)- AO1N

Introduction

Ticks infestation have become a worldwide problem and it is the most prevalent tropical and subtropical countries. Ticks are ectoparasite that exclusively feeds on animals blood via skin¹. Ticks infestation and tick-borne diseases are major constraints for daily industries in India including Chhattisgarh and affecting the economy of the country². Ticks can spread through hosts during their movement³. In Chhattisgarh, the most common tick species are *Hyalomma anatolicum* and *Rhipicephalus microplus*⁴. *H. anatolicum* is an endophilic tick with two- or three-host. They have a monotropic life cycle and are especially found on cattle. The adult ticks may also infest humans too⁵. *R. microplus* is considered most widely spread cattle tick with Asian origin⁶. This tick species is commonly found in Chhattisgarh and other states of India. The female ticks lay 2000-3000 eggs in her life span and died after laying eggs. A tick-borne viral disease Crimean-Congo haemorrhagic fever is distributed by *H. anatolicum* as principal vector⁷. *H. anatolicum* and *R. microplus* both acts as a vector for transmission of

Coxiella burnetii in India⁸. The other diseases transmitted by these ticks species are babesiosis, anaplasmosis, ehrlichiosis, borreliosis, and rickettsiosis⁹. It results in blood loss, weight loss, decreased leather quality, health deterioration, and decreased milk production from animals¹⁰⁻¹¹.

Chhattisgarh has emerged as a unique herbal state of India with the glory of medicinal plants and their ethnopharmacological use. Agriculture is the prime sector for the economy of the state with 5.888 million hectares area specially devoted for farming and agriculture¹². Chhattisgarh is well known for its milch animals and daily production of milk (70877 L/day). Rearing of cattle and farming are the major source of livelihood for poor rural communities. In this situation, an infestation of animals with ticks makes the condition worse. These people are facing difficulty to run their dairies and earn sufficient profits. However, they are employing numerous methods for controlling ticks including the most common, use of chemical acaricides. Although, the chemicals are effective and maintain productivity for a certain time of periods the excessive and uncontrolled use of these synthetic agents impose heavy health loss to the animals on long term use¹³. Several chemicals have been banned in many countries due to their toxic effects. The

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development of resistance in ticks against these chemical agents is a major concern related to their use. Therefore, the researchers are still finding some safe and effective techniques or drugs to treat the animals against ticks infestation.

Medicinal plants are the richest source of active compounds that can be used in the treatment of several disorders. The ethnic groups of Chhattisgarh have been practising numerous indigenous and traditional drugs for insect repellent and acaricidal effects. Natural and herbal acaricidal drugs are safe and equally effective as synthetic agents. The control of ticks by using herbal acaricides are easier, safer, and cost-effective due to their sustainable availability and biodegradability¹⁴. Thus, in this article, the medicinal plants and herbs that have the potential to be used as an acaricidal agent in controlling cattle ticks have been discussed. This review aims to be more informative, comprehensive, and authoritative for the readers due to the migration of people from synthetic acaricides to herbal medicinal drugs in the present world.

Resistance in ticks against conventional acaricidal agents

Development of resistance in ticks against chemicals and drugs is an inherited phenomenon. It is due to exposure of ticks to synthetic acaricidal agents and survival of ticks and reproduction that are less affected by the chemicals. The reproduced generation carry genes for these factors and become resistant. Ticks resistance may be due to reduced susceptibility of ticks on the recommended dose or infrequent and uncontrolled use of acaricidal agents. Resistance from chemical acaricides is most prevalent in India and around the globe. Organophosphates (OP) and synthetic pyrethroids (SP) are widespread in use and resistance from amitraz has been also reported with other conventional chemical acaricides including OP and SP¹⁵. The mechanic of resistance against SP in ticks is due to the lack of suitable metabolizing enzymes in *R. microplus*. Resistance in ticks occurs due to genetic change that leads to modification of the target site and increased sequestration of acaricide. Ticks also reduce the penetrating ability of acaricide due to their outer protective layers. The most resistant tick ever reported is *R. microplus* prevalent in Asia, South America, Australia, and Africa that has achieved a wide spectrum of resistance from conventional synthetic drugs. The first incidence of resistance was reported in 1937 for arsenicals. Other incidences include in 1950 for chlorinated cyclodiene compounds,

in 1954 for DDT, and finally in 1964 for carbamate and organophosphates¹⁶. Thus, there is a need for alternative approaches or new drugs to control the spread of ticks and their infestation safely and effectively. According to World Acaricide Resistance Reference Centre (WARRC), Berlin, Germany, larval packet test (LPT) and adult immersion test (AIT) are the *in vitro* methods for determining the presence of resistance in ticks.

Chemical acaricidal agents

Chemical acaricides have been used widely due to their potency, reliability, and effectivity to control ticks population. It has several advantages, to use over a large population, industrial application, and minimal lag time¹⁷. However, the inadvertent and unbalanced use of chemical acaricides leads to a negative impact on the health of animals, resistance in ticks, the resurgence of insect populations, and outbreaks of secondary insects¹⁸. DDT is banned in many countries due to their hazardous use with a half-life of fifty days. The emergence of more potent chemical compounds in terms of selectivity, effectivity, and target specific have proven their utilities. Additionally, making strong efforts in the implementation and development of anti-resistance strategies for controlling acaricides is appreciable¹⁹. Instead of this, the disappointment associated with the use of these chemicals is that these chemicals affecting non-target species such as animals, wildlife, humans, and aquatic species. Development of resistance against chemicals by ticks is also a challenging task for the researchers' community. Due to these reasons, natural herbal drugs are gaining importance in the production of acaricidal drugs²⁰.

Mechanism of action

Most of the chemicals used for killing insects and ticks generally increase the level of acetylcholine (ACh) in the brain²¹. The molecular mechanism of chemicals such as carbamates and organophosphates is based on inactivation of acetylcholinesterase (AChE) enzyme and preventing breaking of ACh into acetate and choline, thus, increasing the level of ACh at neuromuscular junctions²². These chemicals are immunotoxic and also cause impairment of macrophages signalling through interleukins. The use of these chemicals imposes damaging effects on the health of exposed animals²³.

Consequences of chemical acaricides

Frequent and chronic use of synthetic chemicals for controlling ticks and pests may cause its accumulation in soil, animals meat and also polluting

the environment²⁴. In past few decades, change in dosage forms have been giving good results, for instance, water-based dispersion formulation technology for oil-in-water emulsions and as well as other formulations such as dry product formulations and emulsifiable gel have also shown promising effects²⁵. Resistance in ticks for a single drug can be overcome by the synergistic effect to two or more drugs in combination. It can delay the development of resistance in ticks. Synergistic drugs can interfere with the detoxification mechanisms of ticks and leading to death²⁶.

Control management

Several methods have been employed to control ticks infestation in animals in which integrated pest management (IPM) program is one of them. IPM can control parasites, insects, and pathogens. Unfortunately, due to the modern climate era, the reproductive explosion of ticks and mites made them highly resistant to traditional and conventional methods of ticks controlling process. Efforts have been made by the researchers to develop new techniques and drugs that can deal with the phenomenal expansion of ticks and mites. The current status of the ticks expansion should be reviewed, the limitations of traditional controlling methods should be analyzed, and safe and effective medicines against ticks should be developed that are eco-friendly and harmless to the animals and human beings²⁷⁻²⁸.

Vaccines for controlling ticks

Vaccination is a very good technique in controlling ticks population that can effectively reduce ticks' capacity to transmit pathogens. During vaccination, a plasmic DNA molecule is inserted into the body that remains lifelong inside the episomal DNA and protects the body from antigens²⁹⁻³⁰. GavacTM and Tick Gardplus are the two recombinant vaccines available in the market against *R. microplus*. These vaccines are based on concealed tick midgut protein, Bm86. Vitellin has been identified as a novel vaccine candidate due to its promising results on sheep by reducing the number of attached female ticks and reduction in tick oviposition³¹. Several other vaccine antigens have been investigated against ticks such as ferritin-like protein, glutathione S-transferase, aquaporin, trypsin inhibitor, and cathepsin³².

Herbal acaricides

Herbal acaricides is one such method utilized in the present time due to their effectiveness, safety, and eco-friendly properties. In the present time, medicinal plants based acaricidal drugs are given more importance. The combination of herbal drugs in the form of polyherbal formulation has shown promising effects to control ticks. Herbal acaricides may act in one or more ways such as inhibition of egg development, antifeedant effects, the antagonistic effect on regulatory hormones, disruption of sexual communication and mating, act as repellent and inhibition of chitin formation³³. More than 80% of today's world population are dependent on

Table 1 — Acaricidal activity of medicinal plants against ticks infecting cattle in Chhattisgarh

S. No.	Plants	Tick species	Acaricidal activity	References
1	<i>Acorus calamus</i>	<i>R. microplus</i>	It showed 100% acaricidal activity at 10% concentration	35
2	<i>Allium sativum</i>	<i>R. microplus</i>	It showed 69% larvicidal activity at 100 mg/mL concentration	36
3	<i>Annona squamosa</i>	<i>R. microplus</i>	It showed 100% acaricidal activity in the concentration of 2000 ppm	37
4	<i>Artemisia absinthium</i>	<i>H. anatolicum</i>	It showed 100% acaricidal activity in the concentration of 200 mg/mL	38
5	<i>Azadirachta indica</i>	<i>R. microplus</i> , <i>H. anatolicum</i>	It showed 80% acaricidal activity at the dose of 8 mg/mL	39-40
6	<i>Carica papaya</i>	<i>R. microplus</i>	It showed 82.2% larvicidal activity at 100 mg/mL concentration	36
7	<i>Citrus leminum</i>	<i>R. microplus</i>	It showed 20.8% acaricidal activity at the concentration of 8%	41
8	<i>Curcuma longa</i>	<i>R. microplus</i>	It showed 10% acaricidal activity at the concentration of 8%	42
9	<i>Cymbopogon winterianus</i>	<i>R. microplus</i>	The inhibition of oviposition was 58.01% at the dose of 50 mg/mL	43
10	<i>Datura stramonium</i>	<i>R. microplus</i>	It showed 73.33% larvicidal activity in 100 mg/mL concentration	36
11	<i>Murraya koenigii</i>	<i>R. microplus</i>	It showed 100% acaricidal activity at the concentration of 10%	44
12	<i>Nicotiana tabacum</i>	<i>R. microplus</i>	It showed 45.8% acaricidal activity at the concentration of 8%	45
13	<i>Ocimum basilicum</i>	<i>R. microplus</i>	It showed 100% larvicidal activity at 100 mg/mL concentration	46
14	<i>Pongamia pinnata</i>	<i>R. microplus</i>	It showed 16.66% acaricidal activity at the concentration of 100 mg/mL	47
15	<i>Ricinus communis</i>	<i>R. microplus</i>	It showed 95% larvicidal activity at 100 mg/mL concentration	48
16	<i>Solanum trilobatum</i>	<i>H. anatolicum</i>	It showed 100% acaricidal activity at the concentration of 10 mg/mL	49
17	<i>Withania somnifera</i>	<i>R. microplus</i>	The inhibition of oviposition was 40.22% at the dose of 50 mg/mL	50

herbal products for primary health care. It has been used in India since ancient time more specifically in the rural areas, where the major population of the nation lives. The popularity of herbal medicines has been increasing day-by-day as compared to synthetic acaricides due to later's health risk and environmental hazards. The herbal products are water-soluble, contains lesser toxic effects, and fewer chances for development of resistances in tick populations³⁴. Different medicinal plants found in Chhattisgarh having acaricidal effects on *R. microplus* and *H. anatolicum* are listed in Table 1.

Acaricidal activity of several herbal drugs have been checked by many researchers, some of these are *Artemisia absinthiu*³⁸, *Ocimum gratissimum*⁵¹, *Tephrosia vogelii*⁵², *Hyptis suaveolens*⁵³, *Lantana camara*⁵⁴, *Ammi visnaga*⁵⁵, *Cinnamomum verum*⁵⁶, *Eucalyptus globulus*⁵⁷, *Foeniculum vulgare*⁵⁸, *Glycyrrhiza glabra*⁵⁹, *Laurus nobilis*⁶⁰, *Lavandula angustifolia*⁶¹, *Thymus vulgaris*⁶², *Syzygium aromaticum*⁶³, *Mentha arvensis*⁶⁴, *Origanum majorana*⁵⁵, *Peumus boldus*⁵⁵, *Silybum marianum*⁶⁵, *Zingiber officinale*⁶⁶, *Tetrastigma leucostaphylum*⁶⁷, *Achillea biebersteinii*⁶⁸, *Valeriana officinalis*⁶⁹, *Lepidium sativum*⁷⁰, *Peganum harmala*⁷¹, *Pimpinella anisum*⁷², *Schizonepeta tenuifolia*⁷³, *Chrysanthemum coronarium*⁷⁴, *Citrus aurantium*⁷⁵, *Cotinus coggygria*⁷⁶, *Haplophyllum Tuberculatum*⁷⁷. The mechanism of herbal acaricidal drugs may be due to the increase in the concentration of ACh in the synganglion (neurons) of ticks that lead to excessive salivation, lacrimation, paralysis, and ultimately mortality of the ticks⁷⁸. However, topical application of herbal drugs may cause irritation, dermatitis, and decreased penetration in the applied area.

Conclusion

Tick-borne diseases are the main cause of great economic losses worldwide, in terms of mortality and morbidity of livestock animals. Therefore, proper ticks control measures are required. Chemical acaricides are more toxic to both animals and humans; most of the chemicals are banned to be used on animals. The resistance in ticks against chemicals may be due to gene mutations from drug susceptibility. It results in an increasing dose of the drug for the acaricidal activity that causes more side effects. Herbal acaricides may be a suitable alternative over chemical and synthetic drugs due to lesser side effects and non-toxic to humans and other living organisms with biodegrading capacity. The use of herbal acaricides in generational treatment will be very helpful to avoid the development of resistance in the next generation. The combination of acaricides may be the best step to reduce the development of

resistance in ticks. At times the acaricidal activities may not be effective in killing ticks due to different epidemiological conditions, thus controlling ticks is the only option for primary care of cattle. *R. microplus* is a single host tick having only one way of spreading through the bovine host. Thus, there is a need to develop a working model and protocol to remove ticks cattle infestation and evaluate present methods of controlling ticks about its effectiveness and resistance to ticks.

Conflict of interest

The authors declared no conflict of interest.

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