ejpmr, 2016,3(10), 110-115.

SJIF Impact Factor 3.628

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Review Article

ISSN 3294-3211

EJPMR

METHODS OF TICK CONTROL: CONVENTIONAL AND NOVEL APPROACHES

Dilpreet Kaur, Kamal Jaiswal [1] and Suman Mishra[1*]

Dept. of Zoology, Govt. Degree College, Hata, Kushinagar-274207 (U.P).

[1]Dept. of Applied Animal Sciences, B.B. Ambedkar University Lucknow-226025(U.P).

***Correspondence for Author: Dr. Suman Mishra**

Dept. of Applied Animal Sciences, B.B. Ambedkar University Lucknow-226025.

Article Received on 25/07/2016 **Article Revised on 15/08/2016** **Article Accepted on 05/09/2016**

Ticks have a major impact on livestock industry as they are responsible for substantial economic losses. They have been controlled by chemicals for past several decades. Chemical acaricides are effective against ticks, however, pose undesirable effects on host organisms and the environment. Problems like environmental contamination, residues in food and feed, high costs, residual in milk and meat, development of acaricide resistance in tick have been reported in literature. The development of resistance by ticks stimulated interest in tick control by immunological as well as other means. A vaccine against ticks which enhances the natural immunity often acquired by animals in response to tick infestation was developed, however, it has not proven to be successful in the developing countries. Ethnoveterinary practices, performed by rural people in many indigenous communities for the ancient times, is successful in combating many ailments in human and livestock including tick infestation. Plant extracts used in ethno-veterinary medicine represent a cheaper and easily accessible medicine for tick control. The plants used by the rural people should be identified and extracted followed by their phytochemical profiling in the laboratories.

KEYWORDS: Tick control, Acaricides, Vaccination, Ethnoveterinary practices, Plant extract etc.

INTRODUCTION

Ticks are known to be voracious blood suckers, causing heavy blood losses, toxicosis, hide damage, irritation, and weight loss resulting in lower productivity (Corrier *et al.*, 1979), as well as mortality (Niyonzema and Kiltz, 1986). Ticks have been found to affect the appetite, body condition, blood composition and respiratory rate of the animals, besides spreading tick-borne diseases like theleriosis, babesiosis etc. (Springell, 1974). Jonsson (2006) reported that on an average, each engorging tick was found responsible for the loss of 1.37 ±0.25 g body weight in *B. taurus* and 1.18 ± 0.21 g in *B. taurus* X *B. indicus* cattle. In addition, the ticks may cause immune suppression in the host (Inokuma *et al.*, 1993; Ferreira and Silva, 1998). Ticks contribute significant loss of production to the livestock, dairy and leather industries due to their multifarious effects on the host animal (Jongejan and Uilenberg, 2004). Due to the impact of tick and tick borne diseases in livestock, the developing world should focus on effect tick control. The present paper discusses the methods that have been reported for the control of tick infestation throughout the world.

Genetic Control

The selection of tick resistant breed in the livestock production may be helpful in the development of tick resistant high lactating animals. According to Frisch *et al.* (2000), genetic changes in response to selection for increased tick resistant in *Bos taurus* are reported. Northern Australian beef industry is using mostly non-chemical method to control cattle ticks over the last 20 years by improving host resistance through increasing *Bos indicus* content (Sutherst and Utech, 1981).

Prophylactic Measures/ Grooming

Grooming has been found very effective in the control of ticks as determined by Mooring *et al.* (1996). Oral grooming and scratch grooming significantly increased from baseline during ticks seeding and significantly declined following removal of the ticks with acaricides.

Biological control

Poultry has been considered as good source of biological control of cattle ticks. From an experiment conducted in Rusinga island, Kenya, it was concluded that a good reduction of ticks on cattle can be achieved through tick predation by chickens over a three to four hour period (Hassan *et al.*, 1994).

Another potential biological method of tick control is based on entomopathogenic fungi which has been discussed by Samish and Rehacek (1999) with promising results. Use of *Metarhizium anisopliae* (Metschnikoff) Sorokin, an entomopathogenic fungus, has been successfully demonstrated against various developmental stages of cattle ticks at standard temperature (Bittencourt *et al.*, 1994; Gindin *et al.*, 2001). A single spray of *Metarhizium anisopliae* in pen trials did not cause significant changes in the *Rhipicephalus (Boophilus) microplus* population (Correia *et al.,* 1998). However, more than 50% reduction in population was found in a single spray of another isolate by de Castro *et al.* (1997). Biological control for pests is a natural, less expensive, convenient and more effective measure than chemical control but the inconsistent level of controlling and slow rate of mortality are significant factors of concern (Whipps and Lumsden, 2001).

Chemical control

Organochlorine insecticides were the first synthetic organic insecticides to be marketed and many of them were formulated for the control of ticks on cattle. DDT and benzenehexachloride (BHC) were the first of this group of chemicals to be used as acaricides (Cobbett, 1947; Maunder, 1949; Whitnall *et al.,* 1951). Dieldrin and aldrin, cyclodiene compounds, and toxaphene, a polychloroterpine product, also were widely used for the control of ticks on cattle.

The organophosphates are generally the most toxic of all pesticides to vertebrates (Ware, 2000). The development of organo-phosphate acaricides was primarily for the control of organochlorine resistant *Boophilus* ticks (Shaw, 1970). Ethion, chlorpyrifos, chlorfenvinphos and coumaphos are four of the most widely used organophosphates for the treatment of tick-infested cattle.

The formamidines, chlordimeform, clenpyrin, chlormethiuron and amitraz are members of a small group of chemicals that are effective against ticks. Synthetic pyrethroids e.g. permethrin and fenvalerate, were the first of these materials available for control of ticks on cattle (Davey and Ahrens, 1984; Ware, 2000).

Two classes of macrocyclic lactones with acaricidal activity are ivermectin and milbemycins. They are very active at low doses for controlling ticks. The subcutaneous injections of ivermectin, doramectin and moxidectin are efficacious for the control of ticks on cattle (Gonzales *et al.,* 1993).

Another class of pesticide is the spinosyns for eg. spinosad, a fermentation metabolite of the actinomycete *Saccharopolyspora spinosa*. Spinosad provides about 90% control of *Boophilus microplus* on cattle infested with all the three parasitic stages *i.e.* larvae, nymph and adults (George *et al*., 2004).

Synthetic acaricides are the mainstay of tick control world-wide. Despite being the preferred choice for tick control, indiscriminate use of acaricides has contributed to the development of resistance in the ticks (FAO, 2004). Large scale resistance to Organophosphate (OP) compound, diazinon, has recently been experimentally validated in Indian isolates of *Rhipicephalus (Boophilus) microplus* by Kumar *et al.* (2011). Singh and Rath in 2014 conducted experiment to detect the resistance levels against cypermethrin and deltamethrin, the most commonly used synthetic pyrethroids (SP), in *Rhipicephalus (Boophilus) microplus* using adult immersion test. By this experiment, on the basis of the data generated on variables (mortality, egg mass weight, reproductive index and percentage inhibition of oviposition), they categorized the different levels of the resistance.

Vaccination

Vaccination is an environment friendly and effective strategy for tick control. It can reduce vector capacity to transmit pathogens. Due to concerted research efforts in this field, two recombinant vaccines (Gavac TM and Tick GARDPLUS) against *Rhipicephalus (Boophilus) microplus* are available commercially. Both the vaccines are based on the concealed tick midgut protein, Bm86. In India, much of the earlier work was focused on immunization of animals using crude and partially purified antigens to develop a protective immune response against ticks. Several immunodominant antigens were identified from the crude larval and nymphal extracts of *Hyalomma anatolicum* and *Rhipicephalus (Boophilus) microplus* with varied efficacy against challenge infestations. However, none of the studies have reached to the development of immune-prophylactic measure against the target tick species.

Pasture Burning, Rotation and Some Special Grasses

Other methods like pasture burning and some special grasses have also been considered for tick control (Sutherst and Utech, 1981). Pasture burning in many countries like Australia (Jonsson and Matschoss, 1998), South Africa (Spickett *et al.,* 1992), Zambia (Baars, 1999) and USA (Davidson *et al.,* 1994; Cully, 1999) is done to induce a “green flush” in the dry part of the year (winter). It is a widely used practice for controlling ticks.

Burning pasture is a named component of the Cuban government directed integrated tick management program (Cordoves *et al.,* 1986). Regular monitoring of burning pasture is pertinent for controlling all stages of ticks because ticks recolonize burnt areas (Davidson *et al.,*1994). However, the burning of pastures on a routine basis may be difficult for the resource-poor livestock raisers in the developing countries.

Pasture alternation and/or rotation management approach consists of keeping grazing areas free of cattle until the larvae die. Pasture alternation and/or rotation combined with applications of chemical acaricides has been proved as an effective way for the control of cattle ticks (Stachurski and Adakal, 2010). Barnard *et al.* (1994) studied a number of integrated pest management (IPM) strategies for *Amblyoma americanum* in forage areas utilized by *Bos taurus, B. indicus* and crossbred cattle (*B. taurus* × *B. indicus*) over a five years period. Pasture rotation combined with acaricide applications or habitat conversion was the most economically feasible IPM strategy in reducing tick burden ranging from 77% to

89%. In contrast to pasture burning method, rotation and/or alternation of pastures can also be adopted by the resource- poor farmers.

Another attractive measure is the growing of grasses that repel or do not favor the development of ticks. Among species recognized as inhibiting the development of ticks are *Stylosanthes spp., Melinis minutiflora* and *Andropogon gayanus* (Jonsson and Piper, 2008; Soares *et al.*, 2010) but the main drawback with such type of grass species is that they do not have the proper nutritional characteristics for cattle.

Ethno-veterinary Practices (EVP)

Ethno-veterinary practices (EVP) are still a very much important method of treatment of livestock illness and pests especially in developing countries. Farmers and indigenous people have a long history of relying on a system of curing and treatment of animals which is basically based on folk beliefs, traditional knowledge, skills, methods, practices and use of medicinal plants as its integral component (Mc Corkle *et al.*, 1996 and Tabuti *et al.*, 2003); and they also have deep knowledge of their environment (Nfi *et al.*, 2001). This practice is typically community-based and, as a result, the plant species used for such purposes may vary from one community to another. Furthermore, knowledge of such practices is orally transferred from one generation to another.

The use of plants or plant-based products for the control of arthropod ectoparasites on livestock is widespread among small scale livestock keepers in India as well as in other developing countries. Plants/plant parts and their extracts have been used in many parts of the world to kill or repel insects (Secoy and Smith, 1983). More than 2400 plant species have been reported to have some pest control properties (Grainge and Ahmed, 1988). The ingredients of plants and herbs are known to possess insecticidal, growth inhibiting, anti-molting and repellent activities (Habeeb, 2010). Approximately 80% of the people in developing countries rely even today mainly on traditional medicines. An estimated 14–28% of the 422,000 plants occurring on Earth have been used by human cultures for medicinal purposes at one time or another (Farnsworth and Soejarto, 1991).

The low cost of the medicinal plants is particularly appealing to farmers, although seasonal availability, harvesting timing vis-a-vis application time, variable efficacy, uncertainty over dosages and standardization may be the drawbacks (Martin *et al.*, 2001). Several plants have been documented by workers which are used in EVP for the control of ticks in different parts of the country. These plants/parts include root decoction of *Lagerstroemia microcarpa* and leaf decoction of *Cleistanthus collinius* (Kulkarni *et al.*, 2014), roots of *Jatropha curcas* (Deshmukh *et al.*, 2011), leaf of *Nicotiana tabacum* (Satapathy, 2010; Pragada and Rao, 2012), seed and leaf of *Annona squamosa* (Satapathy, 2010; Pragada and Rao, 2012), leaf of *Senna occidentalis* (Pragada and Rao, 2012), bulb of *Allium cepa* (Dar *et al.*, 2011) and seeds of *Brassica campestris* (Farooq *et al.*, 2008) among many more.

Research on Phytoextracts for Tick Control

Research on plants for use in tick control has been developed in an attempt to find extracts with acaricidal properties that can be used in association with or even as replacements for synthetic compounds. One advantage from the use of these compounds is that resistance develops slowly as there is usually a mixture of different active agents with different mechanisms of action (Balandrin *et al.*, 1985; Chagas *et al.*, 2003; Olivo *et al.*, 2009).

A number of studies have so far been conducted to validate the use of plants for tick control. Some plants have been tested and were proved to be capable of causing tick mortality (Sutherst and Utech, 1981; Carroll *et al.*, 1998), tick repellent (Carroll *et al.*, 1998) and/or tick immobilization (Sutherst and Utech, 1981). Many workers have reported botanical products that kill parasites or inhibit oviposition (Chhabra and Saxena, 1998; Van Wyk and Wink, 2004; Moreira *et al.*, 2009; Olivier *et al.*, 2010). Acaricidal plants are reportedly widespread and there is even the potential for their cultivation (Martin *et al.*, 2001).

Kalakumar *et al.* (2000) have evaluated acaricidal activity of custard seed oil (*Annona squamosa)*, neem oil (*Azadirachta indica*) and pyrethrins against three tick species *Boophilus microplus*, *Hyalomma anatolicum* and *Rhipicephalus haemaphysalis*, both *in vitro* and *in vivo*. Nchu *et al.* (2005) demonstrated the toxic effects of dichloromethane extracts of garlic (*Allium sativum*) bulb on adults of *Hyalomma marginatum rufipes* and *Rhipicephalus pulchellus*. Thorshell *et al.* (2006) demonstrated that oils of citronella, lavender, lily of the valley and peppermint have similar repellent effects as the commercially traded DEET (N, N-diethyl-m-tuluamide).

Elango *et al.* in 2009 and 2010, conducted experiments on the adulticidal and larvicidal effect of indigenous plant extracts against the adult cattle tick *Haemaphysalis bispinosa* Neumann, 1897 (Acarina: Ixodidae), sheep fluke *Paramphistomum cervi* Zeder, 1790 (Digenea: Paramphistomatidae), fourth instar larvae of malaria vector, *Anopheles subpictus grassi* and Japanese encephalitis vector, *Culex tritaeniorhynchus* Giles (Diptera: Culicidae). The study reported that indigenous plants have potency to control ticks and other parasites. Similarly, Magano *et al.* (2007) studied the anti-tick properties of the root extracts of *Senna italica* subsp. a*rachoides* against adults of *Hyalomma marginatum rufipes*. Of the hexane, chloroform, dichloromethane, ethyl acetate and methanol extracts tested, only ethyl acetate extracts proved to be potent against adults of *H. marginatum rufipes*. The acaricidal activity of the ethyl acetate root extract of *S. italica* subsp. *arachoides* increased significantly (P < 0.05) with concentration when tested against *H. marginatum rufipes*. Schwalbach *et al.* (2003) evaluated the efficacy of Neem seed extract (10% water solution) for tick control in goats in the Kilimanjaro area of Tanzania. Survey of literature shows that although many plant species have been used to control ticks by the rural people/ small holder farmers, still their scientific validation has not yet been widely established.

Studies to evaluate anti-tick property of different plants has been carried out by various workers, but the field is still in nascent stages and still more research needs to be done in the area to explore more and more plants and plant products with the aim to develop a low-cost, effective and potent acaricide with little or no side-effects.

CONCLUSION

A sustainable approach like integrated tick control strategy is highly required which involve variety of tick control methods like brushing of the animal at regular intervals, use of chemical acaricides, vaccination as well as herbal treatment of livestock for the removal of ticks. It is of utmost need to control the indiscriminate and frequent use of chemical acaricide so that the chances of development of resistance should be checked.

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