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Review:

Importance of ticks and their chemical and immunological control in livestock*

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Abstract: The medical and economic importance of ticks has long been recognized due to their ability to transmit diseases to humans and animals. Ticks cause great economic losses to livestock, and adversely affect livestock hosts in several ways. Loss of blood is a direct effect of ticks acting as potential vector for haemo-protozoa and helminth parasites. Blood sucking by large numbers of ticks causes reduction in live weight and anemia among domestic animals, while their bites also reduce the quality of hides. However, major losses caused by ticks are due to their ability to transmit protozoan, rickettsial and viral diseases of live-stock, which are of great economic importance world-wide. There are quite a few methods for controlling ticks, but every method has certain shortcomings. The present review is focused on ticks importance and their control.

Key words: Tick, Tick fever, Tick control, Livestock, Ecto-parasites, Tick resistance
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INTRODUCTION

Parasitic diseases is a global problem and considered as a major obstacle in the health and product performance of animals. These may be due to endo-parasites that live inside the body, or ecto-parasites such as ticks, mites, flies, fleas, midges, etc., which attack the body surface. Among ecto-parasites, ticks are very important and harmful blood sucking external parasites of mammals, birds and reptiles throughout the world (Furman and Loomis, 1984). The medical and economic importance of ticks had long been recognized due to their ability to transmit diseases to humans and animals. Ticks belong to phylum, Arthropoda and make up the largest collection of creatures in order Acarina. Ticks are divided into two groups: soft bodied ticks (Argasidae) and hard bodied species (Ixodidae). Hard ticks feed for extended periods of time on their hosts, varying from several days to weeks, depending on such factors as life stage, host type, and species of tick. The outside surface, or cuticle, of hard ticks actually grows to accommodate the large volume of blood ingested, which, in adult ticks, may be anywhere from 200 to 600 times their unfed body weight (Sonenshine, 1991). Additionally, many soft ticks have an uncanny resistance to starvation, and can survive for many years without blood meal (Furman and Loomis, 1984). The outside surface, or cuticle, of soft ticks expands, but does not grow to accommodate the large volume of blood ingested, which may be anywhere from 5 to 10 times their unfed body weight (Sonenshine, 1991). Ticks cause great economic losses to livestock in the world and have adverse effect on livestock host in several ways (Snelson, 1975) and parasitize a wide range of vertebrate hosts, and transmit a wider variety of pathogenic agents than any other group of arthropods (Oliver, 1989). There are 899 tick species those parasitize the vertebrates including Argasidae (185 species), Ixodidae (713 species) and Nuttalliellidae (1 specie) (Barker and Murrell, 2004). Ticks are the most important ecto-parasites of livestock in tropical

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and sub-tropical areas, and are responsible for severe economic losses in livestock. The major losses, however, caused by ticks are due to their ability to transmit protozoan, rickettsial and viral diseases of livestock, which are of great economic importance world-wide. Tick-borne protozoan diseases (e.g. Theileriosis and Babesiosis) and rickettsial diseases (e.g. Anaplasmosis) and cowdriosis and tick-associated dermatophilosis are major health and management problems of livestock in many developing countries. The economically most important ixodid ticks of livestock in tropical regions belong to the genera of *Hyalomma*, *Boophilus*, *Rhipicephalus* and *Amblyomma* (Frans, 2000).

There are various ways to control ticks, but every method of tick control has certain shortcomings. Chemical control with acaricides was considered as one of the best methods, but it was shown recently that ticks have developed resistance against a range of acaricides (Martins *et al*., 1995). However these chemicals are toxic and costly. Problems of acaricide resistance, chemical residues in food and the environment and the unsuitability of tick resistant cattle for all production systems make the current situation unsatisfactory, which is why there is debate on the development of an alternate and absolute control method, such as through vaccine.

Tick ecology

Chaka *et al*.(2001) studied determination of the physiological age of *Rhipicephalus appendiculatus*. The age structure of a population of vectors of disease pathogens is a most useful characteristic for epidemiological studies. It has long been developed for insect vectors, where the success of an eradication programme can be plotted by the declining survival. Age grading of ticks requires theoretical adaptation because of the fundamentally different relationship between feeding and transmission opportunities of insect and ticks. Estrada-Peña (2001) reported that seasonal dynamics exert a major influence on the dynamics of transmission of tick-born pathogen.

DAMAGES CAUSED BY TICKS AND THEIR CONTROL

Ticks comprise veterinary problem because they transmit diseases, produce paralysis or toxicosis, and cause physical damage to livestock. Ticks' species are grouped into three families, Argasidae or soft ticks, Ixodidae or hard ticks and Nuttalliellidae (Klompen *et al*., 1996). Ticks are very important to man and his domestic animals, and must be controlled if livestock production is to meet world needs for animal protein. Knowledge of the nature and habits of the tick and the disease agents it transmit helps in control (Stewart *et al*., 1981).

Losses and control

A complex of problems related to ticks and tick-borne diseases of cattle created a demand for methods to control ticks and reduce losses of cattle (George *et al*., 2004). Control of tick infestations and the transmission of tick-borne diseases remain a challenge for the cattle industry in tropical and subtropical areas of the world. Tick control is a priority for many countries in tropical and subtropical regions (Lodos *et al*., 2000). Losses due to tick infestations can be considerable. In Australia alone in 1974, losses due to cattle tick (*Boophilus microplus*) were estimated to be USD 62 million (Springell, 1983). Brazil loses around USD 2 billion per year (Grisi *et al*., 2002). Such losses can be cut considerably by adopting effective tick control measures. There are three major reasons for controlling ticks in domestic animals: disease transmission, tick paralysis or toxicosis, and tick-caused physical damage. The main weapon for controlling ticks at present is the use of chemical acaricides (Drummond, 1983). Ticks are responsible for severe economic losses both through direct effect of blood sucking and indirectly as vector of pathogens and toxins.

1. Direct effect

Feeding by large numbers of ticks causes reduction in live weight and anemia among domestic animals, while tick bites also reduce the quality of hides. Apart from irritation or anemia in case of heavy infestations, tick can cause severe dermatitis (FAO, 1998). These parasites generate direct effects in cattle in terms of milk production and reduce weight gain (L'Hostis and Seegers, 2002; Peter *et al*., 2005).

(1) Tick-bite paralysis

It is characterized by an acute ascending flaccid motor paralysis caused by the injection of a toxin by certain ticks while feeding. Examples are paralysis caused by the feeding of *Dermacentor andersoni*, sweating sickness caused by *Hyalomma truncatum*, Australian tick paralysis caused by *Ixodes holocylus*, and tick toxicosis caused by *Rhipicephalus* species (Drummond, 1983). Tick paralysis is most common in late winter and spring when the adult ticks are active, but it can occur at any time if the weather is warm and humid (Stewart and de Vos, 1984). Paralysis in cattle caused by *Ixodes holocyclus* and *Dermacentor andersoni* had also been reported by Doube and Kemp (1975) and Lysyk *et al*.(2005) respectively.

(2) Physical damage

Ticks are attached to the body for a blood meal and may cause irritation and serious physical damages to livestock. Included are "tick worry", irritation, unrest, and weight loss due to massive infestation of ticks; the direct injury to hides due to tick bites, loss of blood due to the feeding of ticks (Drummond, 1983).

2. Vector of pathogens

Ticks can be carrier, of pathogens, which they transmit from host to host during blood sucking and cause a large variety of diseases (FAO, 1998). The major diseases include Babesiosis, Anaplasmosis, Theileriosis, and heart-water, East Coast fever; in addition, other diseases of lesser importance cause severe economic losses to the livestock industry (Drummond, 1983; Bram, 1983). The presence, dynamics and amount of parasite stock in ticks exert a major influence on the kinetics of transmission of tick-borne parasitic diseases (Morel, 1980). Generally the ticks become infested with the causative organisms of diseases while they are feeding on infected animals. Then the organism may be transmitted from stage to stage in the tick (an example is *Theileria parva* transmitted by *Rhipicephalus appendiculatus*), or from the female tick through the egg to the larvae—an increase of several thousand times in vector potential (an example is *Babesia equi* transmitted by Anocentor nitens). When the next stage or generation subsequently feeds on another animal, the organism is transmitted to that animal if it is susceptible to the disease (Drummond, 1983). Tick born diseases generally affect the blood and/or lymphatic system (FAO, 1998). Tick fever organisms, like *Anaplasma marginale*, are significant causes of cattle morbidity in Australia, USA, China and other countries (CRC-VT, 2001). Cattle tick *B. microplus*, economically impact cattle production by transmitting pathogens that cause Babesiosis (*B. bovis* and *B. bigemina*) and Anaplasmosis (*A. marginale*) (Peter *et al*., 2005).

Chemical control of ticks

There are several methods being applied for controlling ticks and tick-borne diseases. The main weapon for the control of ticks at present is the use of chemical acaricides. Acaricides used to control ticks on livestock or in the environment are applied in such a manner that the ticks are killed, but will not harm livestock or applicators, the tissues of treated animals will not contain chemical residues, and the environment will not be adversely affected (Drummond, 1983). The conventional control methods include the use of chemical acaricides with partially successful results but this treatment has certain implicit drawbacks, such as the presence of residues in the milk and meat and the development of chemical resistant tick strains (Willadsen and Kemp, 1988; Nolan, 1990). The use of acaricides has disadvantages, such as the selection of resistant tick populations and harmful effects on the animals, human beings and the environment (García-García *et al*., 2000). The development of new acaricides is a long and expensive process, which reinforces the need for alternative approaches to control tick infestations (Graf *et al*., 2004). Certain herbal mixtures with 70% efficacy for tick control have also been reported by Regassa (2000).

1. Acaricides

Control of tick infestation through the use of acaricides is one of the methods that can be used to reduce the tick-borne diseases (Spickett and Fivaz, 1992). A wide range of acaricides, including arsenical, chlorinated hydrocarbons, organophosphates, carbamates and synthetic pyrethroids are being used for controlling ticks on livestock. The performance of an acaricide in the control of ticks depends not only on the activity of a product, but on the quality and quantity of active ingredient deposited on cattle or delivered internally (George, 2000).

2. Arsenic

Use of arsenic was the first effective method for controlling ticks and tick-borne diseases, and was used in many parts of the world before resistance to the chemical became a problem (George, 2000). It was first used for tick control in 1893 in South Africa

(Bekker, 1960) that is inexpensive, stable, and water soluble, and there is an accurate vat-side test (Drummond, 1983). Arsenic was the first acaricides to be widely used which is cheapest and most effective agent. Mostly it is used in the form of water soluble compounds like sodium arsenite. Usually As_2O_3 have been used for many years in dipping vats to control ticks, especially ticks of the genus *Boophilus*. Arsenic dips were used successfully to eradicate *Boophilus* ticks from the southern United States. Unfortunately, arsenic has a very short residual effectiveness (less than one to two days), and in most areas of the world *Boophilus* ticks have become resistant to arsenic (Drummond, 1983).

3. Chlorinated hydrocarbons

These are synthetic acaricides. Resistance to arsenicals was developed in many species of ticks (Matthewson and Baker, 1975; Angus, 1996) and it was replaced by chlorinated hydrocarbons (Graham and Hourrigan, 1977). Chlorinated hydrocarbon acaricides are very persistent and have been used extensively throughout the world for controlling ticks. Of particular interest are benzene hexachloride toxaophene (Drummond, 1983). Their mode of action is by interfering with nerve conduction of ticks (Solomon, 1983). Because of their high toxicity and long lifespan, these compounds have mostly been withdrawn from the market (Spickett, 1998).

4. Organophosphorous compounds

Organophosphates were introduced around 1950, as a replacement for the chlorinated hydrocarbons to which significant resistance had occurred (Shanahan and Hart, 1966). These are esters of phosphoric acid and have a wide range of activities against ticks at very low concentration in companion and livestock animals. However, their residual effectiveness is usually shorter than that of chlorinated hydrocarbons, and the risk of causing acute toxicity in livestock is greater (Drummond, 1983). Resistance in ticks was first recognized in 1963 and several tick species are now known to be resistant to organophosphorous acaricides (Wharton, 1967).

5. Carbamates

These are esters of carbamic acids and closely resemble the organophosphates (Spickett, 1998). They are a little more toxic than the organophosphates for mammals and are much more expensive.

Application of chemicals

Various methods including dipping, spraying, ear tagging or pour on, have been used to apply chemicals to protect livestock against ticks. Direct application of acaricides to animals is the most popular method of controlling ticks on livestock (Drummond, 1983). Applications of acaricide to tick-infested cattle via dipping or sprayer can be equally effective under ideal conditions with proper handling of equipments without injuring animals and subsequent dilution of a product (George, 2000).

1. Dipping

In this method, animals are immersed in a dipping tub containing solution of chemicals. By 1893 in Australia, Africa, and the United States the use of “dipping-vats” to immerse tick-infested cattle in a variety of chemical agents was a component of the effort to control the ticks and tick-borne diseases affecting cattle (Mohler, 1906; Matthewson and Baker, 1975). A variety of tickicides including cottonseed oil, fish oil, crude petroleum, kerosene, creosote, tobacco extract, soap, and a combination of sulphur and kerosene were among the hundreds of possible acaricides tested for dipping (Mohler, 1906; Angus, 1996). Infested cattle should be dipped in the organophosphate acaricide coumaphos (0.3% active ingredient) (Bram *et al.*, 2002). In general, dipping vats provide a highly effective method of treating animals with acaricides for tick control. However, their immobility, high initial cost of construction, and the cost of the acaricides may make vats impractical for many small ranching operations. Also, dipping vats must be managed carefully so that the dips are maintained at the proper concentration and the cattle are dipped properly (Drummond, 1983).

2. Spray

The application of fluid acaricides to an animal by means of a spray has many advantages and has been successfully practiced for controlling ticks on most of the animals (Barnett, 1961). Spraying equipment is highly portable, and only small amounts of acaricides need to be mixed for a single application. However, spraying is generally less efficient in controlling ticks than immersion in a dipping vat because of problems associated with applying the acaricides thoroughly on all parts of the animal body (Drummond, 1983).

3. Spot treatment or hand dressing

There are predilections sites for certain tick species on part of the body which are not effectively treated by spray or dips. The inner parts of the ear, under part of the tail, the tail brush and the areas between the teats and the legs in cattle with large udder, are especially liable to escape treatment. Acaricides may be applied to these sites by hand is termed as hand dressing (Barnett, 1961) or spot treatment. The application of insecticides with aerosols and in oils, smears, and dusts by hand to limited body areas is time-consuming and laborious, but in certain instances it may be more effective and economical (in terms of cost of acaricide) than treating the entire animal (Drummond, 1983).

4. Some other applications

Some other methods of applying acaricides are ear tags, neck bands, tail bands and pour-one, particularly for the pyrethroids with long residual activity. A mechanical applicator was also developed (Duncan, 1991). In Kenya, an intraruminal ivermectin slow-release device provided 90 d protection against tick damage (Tatchell, 1992). Tick repellents used on livestock are limited (Mwase *et al*., 1990). Ivermectin has been delivered orally in the case of *Boophilus annulatus* on cattle by Millar *et al*.(2001) as a single or double ruminal bolus as daily capsules to *B. miroplus* infested cattle. The control levels against standard engorging female ticks reached 99%. Despite this, the level of control of ticks on pastures grazed by treated cattle was insufficient to prevent cattle from becoming infested when grazed there later on. Abdel-Shafy and Zayed (2002) examined the acaricidal effect of plant extract of neem seed oil (*Azadirachta indica*) on egg, immature and adult stages of *Hyalomma anatolicum excavatum*. This short communication on the potential use of azadirachtin for tick control is an extension from the large volume of literature on this material for control of crop pests and vectors of medical pathogens. Azadirachtin was applied at concentrations of 1.6% through to 12.8% in water and applied to ticks in vitro for 1 min. The ticks were examined up to 15 d post treatment for mortality and reduced viability. Abdel-Shafy and Zayed (2002) concluded that Neem can be used for tick control at economic concentrations of 1.6% to 3.2%. The work will need to be enlarged to test control of feeding ticks on cattle and possibly control of ticks by spraying the moulting and resting site of ticks in cattle pens.

Safety measures

Appropriate directions and precautions given on the label, should be taken while applying the acaricides. According to U.S. Department of Agriculture (1967), these acaricides can be toxic to livestock and humans, can create residues in tissues of animals, and may be destructive to the environment if they are not used and handled in a safe and correct manner. The safe use of acaricides is essential to an efficient, well-run program for control of ticks. To avoid accidents and misuse, it is necessary to continually review and employ safe use, precautions and procedures (Drummond, 1983). It is important to prepare dipping and spray fluids correctly to ensure that a dose of the active ingredient, lethal for the tick, is administered to cattle safely and without exceeding the limits for milk and meat residues. Licking behavior and environmental contamination arising from pour-on ivermectin for cattle was studied by Laffont *et al*.(2001) and was found to be associated with unexpected residues in meat and dairy products and as an environmental contaminant via cattle dung. They recommended that the route of potential contamination of parasiticides be taken into account during product registration.

RESISTANCE

Tick resistance to acaricides is an increasing problem and real economic threat to the livestock and allied industries. Most stock holders depend completely on acaricides to control ticks, but do not have access to guidelines on how to make a profit from their tick control program or how to detect and resolve problems with resistance to acaricides (George, 2000). Resistance has led to instability and increased costs in areas where the one-host cattle ticks *Boophilus microplus* and *B. decoloratus* have acquired resistance to a variety of toxic chemicals. The point has now been reached where such resistance must be expected in these ticks within five to 10 years of the introduction of any new type of acaricide, unless control practices are changed (Wharton, 1983). The evolution of tick resistance to acaricides has been a major determinant of the need for new products (George, 2000). Fernandes (2001) worked on toxicological effects and resistance to pyrethroids in *Boophilus microplus* from Goias, Brazil. According to his research ticks were resistant to deltamethrin and cypermethrin, and showed the required level of mortality only to high concentrations of permethrin. Considering the frequency with which synthetic pyrethroid resistance has been reported in Brazil, and elsewhere, the claim of resistance is very likely to be correct. Sseruga *et al*.(2003) studied the serological evidence of exposure to tick fever organisms in young cattle on Queensland dairy farms. They concluded that, in tick-infested areas, vaccination is the most effective means of protecting cattle against tick fever. Resistance detection, identification and characterization of resistance were briefly reviewed by Wharton (1983). Resistance is usually recognized because of failure to obtain a satisfactory kill of the parasitic stages on treated animals. Failure is frequently due to inadequate treatment and many reports of resistance are unfounded. There is no doubt about resistance when cattle continue to be infested with large numbers of engorged ticks after frequent treatments. But the response of parasitic ticks to under strength acaricides is very similar to their response to low-level resistance or to high-level resistance in the early stages of its development. Thus field-spraying tests must be conducted under standardized conditions where resistance is suspected (Baker and Shaw, 1965). A survey of cattle tick control practices in South Africa found that 35.7% of farmers using hand sprays have confirmed acaricide resistance compared with 25.8% and 23.9% of users of spray races and plunge-dips respectively (Spickett and Fivaz, 1992). Confirmation of resistance must be made by laboratory tests. The traditional test for diagnosing resistance to acaricides in single host ticks is the larval packet test, in which larvae are placed in envelopes impregnated with acaricide (Wharton and Roulston, 1970). Mainly chemical companies in screening programmes have developed many methods of testing the effects of acaricides. The stages most commonly used are the engorged females and the unfed larvae. The former usually provide the most useful information on potential acaricides, but unfed larvae are generally accepted as the logical stage to document resistance. Several engorged females provide sufficient larvae to test against a range of concentrations of several acaricides. The response of susceptible ticks provides the baseline when resistance is suspected (Wharton, 1983). Resistance in *B. microplus* populations in Australia and South Africa to arsenic was observed about 50 years after use of the chemical began (Matthewson and Baker, 1975; Angus, 1996).

Host resistance

Resistance to tick infestation varies among individuals and breed of cattle. It is known that in many subtropical and semi-arid environments in Africa indigenous dual purpose breeds are highly resistant to ticks, resulting in low infestation rates that cause significant direct losses (Norval *et al*., 1991). The phenomena of host resistance to ticks and enzootic stability to tick born diseases are well documented (Perry *et al*., 1985; Latif and Pegram, 1992).

ALTERNATIVE METHODS OF TICK CONTROL

Due to the present disadvantages of chemical acaricide products, the adoption of alternative methods could minimize such problems. Wharton (1983) briefly reviewed the alternative methods of tick control and concluded that the utilization of host resistance, while offering an attractive approach to tick control, raises many questions even with the relatively simple *B. microplus-Babesia* association. Resistance is an acquired characteristic and each animal develops its own level of resistance in response to tick challenge; the level may be high (as in most zebu cattle) or low (as in most European cattle), but a wide range of resistance occurs in all breeds of cattle. It is heritable, and selection and breeding for tick resistance are possible not only in zebu×European breeds, but also within European breeds. However, selection for resistance or culling for susceptibility must at present be based on tick numbers surviving on cattle exposed either naturally or artificially to tick challenge. This raises obvious problems for the cattle producer who is concerned about the effects of these ticks on production. Breeding of tick resistance cattle, pasture spelling, pasture burning and some special grasses have also been considered for tick control. Bock *et al*.(1997) compared two breeds of cattle and reported that *Bos indicus* had innate resistance to infection with *babesia bovis*, *B. bigemina* and *Anaplasma marginale* as compared to *Bos taurus* breed. Wharton (1983) reviewed that the most logical method of alleviating tick depredations would be to capitalize on host-parasite relationships that evolved in nature. Cattle survived in Asia and Africa despite *Babesia*, *Theileria* and their *Boophilus* and *Rhipicephalus* vectors. Host resistance, expressed by an animal's ability to prevent the maturing of large numbers of ticks, and disease immunity, are survival mechanisms for the host and for external and internal parasites. The problem is not only to utilize these attributes, but also to increase productivity. Resistance to *B*. *microplus* is associated primarily with zebu (*Bos indicus*) cattle. Considerable progress has been made in evolving resistant *Bos indicus*×*Bos taurus* beef and dairy cattle that limit the effects of ticks while retaining high productivity (Turner, 1975; Hayman, 1974; Mason, 1974). Pasture spelling, pasture burning and use of certain grasses and legumes are also practiced for inhibition or killing of ticks (Branagan, 1973; Sutherst *et al*., 1982; Chiera *et al*., 1984). Improvement of the nutrient value of pasture would allow cattle to develop a better resistance to tick infestation (Sutherst, 1983). Gladney *et al*.(1974) concluded that insect control based on sterile males or genetic manipulations offer little promise while pheromone attractants could be useful for domestic pets, or for ticks attached on specialized sites. Mbati *et al*.(2002) reported that farmers also used alternative methods such as used engine oil (12%), Jeyes fluid (24%), chickens (4%) and de-ticking (2%). Kaaya and Hassan (2000) reported that the use of entomopathogenic fungi to control ticks may reduce the frequency of chemical acaricide use and the need for treatment for tick-borne diseases. They also conclude that mycopesticides are safer for the environment than conventional acaricides.

Immunological control through vaccines

Several approaches have been used to actively immunize bovines against the cattle tick. The first attempts included the use of complex tick extracts (Willadsen *et al*., 1988). For both, ticks and tick-borne diseases, vaccines have been developed or are in the course of being developed. Although tick-borne diseases are important in all domestic animals, vaccine development and production has so far focused on the economically important tick-borne diseases of cattle, such as Babesiosis (*B*. *bovis*, *B*. *bigemina*), Theileriosis (*T*. *parva*, *T*. *annulata*), Anaplasmosis (*A*. *marginale*) and Cowdriosis (*C*. *ruminantium*). FAO has been implementing a coordinated multi-donor programme for integrated tick and tick-borne disease control in Eastern, Central and Southern Africa. Vaccine development, production and delivery were the main focus of that programme. A three strain *Theileria parva* stabilize vaccine, known as the Muguga cocktail was developed. This vaccine has been used in combination with an antibiotic treatment, known as the infection-and-treatment method. Later the mild Boleni strain was isolated for vaccine production in Zimbabwe and is currently being used without the treatment component (FAO, 1998). Scientists are working towards new and improved vaccine of tick fever to replace existing one. Existing vaccines have a high level of side effects, low coverage and can be expensive to make (CRC-VT, 2001). Willadsen (2001) worked on the molecular revolution in the development of vaccines against ecto-parasites. He warns that there is a long way to go before the full potential of anti-tick vaccines will be reached and they will very likely need to be multiple antigen formulation. However, he and his coworkers pioneering work on the Bm86 based vaccines remain the best example of a commercial recombinant vaccine in the tick and tick-borne pathogens field. The recombinant Bm86-containing vaccine against the cattle tick *Boophilus microplus* has proved its efficacy in a number of experiments, especially when combined with acaricides in an integrated manner (García-García *et al*., 2000). Tellam *et al*.(2002) studied the reduced oviposition of *Boophilus microplus* feeding on sheep vaccinated vitelline. He used both vitelline and the protein GP80 with which it has immunological cross reactivity. Two vaccines against the tick *Boophilus microplus* have been developed. They are being field tested in Brazil in collaboration with FAO. Although there is a vaccine available, their efficiency is not 100%, which is why there is need to have an improved and absolute vaccine that can help cure animal stock against ticks (FAO, 1998). Jenkins (2001) studied "Advances and prospects for subunit vaccines against protozoa of veterinary importance". Tick-borne diseases in his review were Babesiosis and Theileriosis. Because of the risk associated with using live parasites (such as the need for a cold chain, limited shelf-life, clinical reactions, reversion of attenuation), research towards subunit vaccines is rapidly advancing. But their development is complicated by several factors, such as antigenic variation and strain diversity. The generation of a protective immune response furthermore depends on other factors, for instance delivery, adjutant, age of the animal, etc. The identification of protective tick antigens remains a major limitation in the development of further anti-tick vaccines as well as a significant scientific challenge. García-García *et al*.(2000) reported the isolation of the Bm95 gene from the *B*. *microplus* strain A, and found that Bm95 antigen from strain A was able to protect against infestations with Bm86-sensitive and Bm86-resistant tick strains. He suggested that Bm95 could be a more universal antigen to protect cattle against infestations by *B*. *microplus* strains from different geographical areas. Almazán *et al*.(2003) conducted research on identification of protective antigens for the control of *Ixodes scapularis* infestation using cDNA expression library immunization.

CONCLUSION

It is concluded that ticks cause great economic losses to livestock in the world and adversely effect livestock host in several ways and parasitized a wide range of vertebrate hosts, and transmit a wider variety of pathogenic agents than any other group of arthropods. In the area of tick control, much has been achieved, but much more remains to be done. The availability of vaccine is very small. The ability to induce an effective, sustained immunological response is crucial but needs improvement. Problems of acaricide resistance, chemical residues in food and the environment and the unsuitability of tick resistant cattle for all production systems make the current situation unsatisfactory and require the development of absolute control through effective vaccine.

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