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Popular Article

Therapeutic strategies of ectoparasitism in farm animals

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Abstract

Worldwide, a variety of ectoparasitic arthropod groups significantly increase the morbidity and mortality rate among livestock. Because ectoparasites infest their hosts in a variety of ways to collect nutrients and complete their life cycle, as well as acting as infection vectors, they have an impact on the health and productivity of livestock. Effective management of animal ectoparasites requires approaches that integrate the use of several technologies, all while meeting social expectations about food safety and environmental health.

Keywords: Parasite, Receptors, Livestock

Introduction

Ectoparasites are responsible for economic losses to cattle and sheep producers (Seyoum et al., 2015). Direct losses are a result of discomfort and damage caused by the parasites. Discomfort results in drops in milk production and retarded growth rates (Strydom et al., 2023). Ticks, blowflies, sheep keds and mites cause direct damage to hides and wool or damage resulting from rubbing and scratching due to pruritis (Muhammad et al., 2021). Indirect losses are due to diseases transmitted by ectoparasites. Tick borne diseases like babesiosis, anaplasmosis, dermatophilosis, theileriosis and heart water. Flies transmit mastitis and keratoconjunctivitis, trypanosomiasis and other diseases. Midges transmit blue-tongue, African horse sickness and other diseases (Nyabongo et al., 2021).

Chemotherapeutic agents

Most ectoparasiticides are neurotoxins, exerting their effect on the nervous system of the target parasite (Waal and Danaher, 2014).

Organochlorines

Organochlorine compounds have been withdrawn in many parts of the world because of concerns regarding environmental persistence (Tzanetou and Karasali, 2022). Organochlorines fall into three main groups: 1) chlorinated ethane derivatives, such as DDT (Dichlorodiphenyl Trichlorethane) 2) cyclodienes, including chlordane, aldrin, dieldrin, hepatochlor, endosulfan and 3) hexachlorocyclohexanes such as benzene hexachloride (BHC) which includes the γ-isomer, lindane. Chlorinated ethanes cause inhibition of sodium conductance along sensory and motor nerve fibers by holding sodium channels open, resulting in delayed repolarization of the axonal membrane. The cyclodienes cause inhibition of γ-aminobutyric acid (GABA)-stimulated Cl^- flux and interference with Ca^{2+} flux. The resultant inhibitory postsynaptic potential leads to a state of partial depolarization of the postsynaptic membrane and vulnerability to repeated discharge. DDT and BHC were used extensively for flystrike control but subsequently replaced in many countries by more effective cyclodiene compounds, such as dieldrin and aldrin. Both the development of resistance and environmental concerns led to their withdrawal.

Pyrethrins and Synthetic Pyrethroids

Natural pyrethrins are derived from pyrethrum, a mixture of alkaloids from the *Chrysanthemum* plant (Farag et al., 2021). Pyrethrins are lipophilic molecules that generally undergo rapid absorption, distribution, and excretion. Pyrethroids are synthesized chemicals. They are more stable, thus have longer residual activity, and have a higher potency than natural pyrethrins. The mode of action of pyrethrins and synthetic pyrethroids appears to be interference with sodium channels of the parasite nerve axons, resulting in delayed repolarization and eventual paralysis (Ray et al., 2000; Forshaw et al., 2000; Clark and Symington, 2012; Ramchandra et al., 2019). Some preparations contain a synergist (eg. piperonyl butoxide), which inhibits breakdown of pesticides by microsomal mixed-function oxidase (cytochrome P450) systems in insects (Bingham et al., 2011). Pyrethroids are generally safe in mammals and birds but are highly toxic to fish and aquatic invertebrates. Some of the more common pyrethroids used include, cypermethrin, deltamethrin, fenvalerate, flumethrin phenothrin, permethrin.

Organophosphates and Carbamates

Organophosphates inhibit the action of acetylcholinesterase (AChE) at cholinergic synapses and at muscle endplates (Reiner et al., 2007). AChE is unable to break down accumulating ACh at the postsynaptic membrane, leading to neuromuscular paralysis. Chronic toxicity results from inhibition of an enzyme known as neuropathy target esterase (NTE) or neurotoxic esterase. NTE hydrolyzes the fatty acids from the membrane lipid, phosphotidylcholine, and inhibition of NTE appears to cause structural changes in neuronal membranes and a reduction in conduction velocity, which may be manifest as posterior paralysis in some animals. Cases of organophosphate toxicity are treated with oximes or atropine. Organophosphates used topically include coumaphos, diazinon, dichlorvos, malathion. These compounds are generally active against fly larvae, flies, lice, ticks, and mites on domestic livestock. Carbamate insecticides are closely related to organophosphates and are anticholinesterases (Lee and Barron, 2016). Unlike organophosphates, they appear to cause a spontaneously reversible block on AChE without changing it. The main carbamate compound used in veterinary medicine is propoxur. Carbaryl, another carbamate previously used in veterinary medicine.

Macrocyclic Lactones (Avermectins and Milbemycins)

Avermectins and the structurally related milbemycins, collectively referred to as macrocyclic lactones, are fermentation products of *Streptomyces avermitilis* and *S cyanogriseus*, respectively. A number of macrocyclic lactone compounds are available for use in animals and include the avermectins abamectin, doramectin, ivermectin, and selamectin, and the milbemycins moxidectin and milbemycin oxime. These compounds are active against a wide range of nematodes and arthropods and are often referred to as endectocides. Macrocyclic lactones bind to glutamate receptors of glutamate-gated chloride channels, triggering Cl– ion influx and hyperpolarization of parasite neurons, leading to flaccid paralysis (Geary et al., 2012). These molecules have low affinity for mammalian ligand-gated chloride channels and do not readily cross the blood-brain barrier.

Formamidines

Amitraz is the only formamidine used as an ectoparasiticide. It appears to act by inhibition of the enzyme monoamine oxidase (Araújo et al., 2023). Monoamine oxidase metabolizes amine neurotransmitters in ticks and mites. Amitraz has a relatively wide safety margin in mammals; the most frequently associated adverse effect is sedation, which may be associated with an agonist activity of amitraz on α2-receptors in mammalian species (Costa, 2020). Amitraz is available as a spray or dip for use against mites, lice, and ticks in domestic livestock. In dipping baths, amitraz can be stabilized by the addition of calcium hydroxide. Amitraz is contraindicated in horses.

Insect Growth Regulators

Insect growth regulators (IGRs) are relatively new category of insect control agents. They constitute a group of chemical compounds that do not directly kill the adult parasite but interfere with growth and development. Because they act mainly on immature parasite stages, IGRs are not usually suitable for rapid control of established adult parasite populations.They are widely used for blowfly control in sheep but have limited use in other livestock. Based on their mode of action, IGRs can be divided into chitin synthesis inhibitors e.g. benzoylphenyl ureas, chitin inhibitors e.g. triazine/pyrimidine derivatives and juvenile hormone analogues e.g. S-methoprene, pyriproxyfen (Gad et al., 2021). Chitin is a complex aminopolysaccharide and a major component of the insect's cuticle. During each molt, it has to be newly formed by polymerization of individual sugar molecules. Benzoylphenyl interfere with the assembly of the chitin chains into microfibrils. When immature insect stages are exposed to these compounds, they are not able to complete ecdysis and die during molting. Benzoylphenyl ureas show a broad spectrum of activity against insects but have relatively low efficacy against ticks and mites. The exception is fluazuron, which has greater activity against ticks and some mite species. Diflubenzuron and flufenoxuron are used to prevent blowfly strike in sheep. Fluazuron is available in some countries for use in cattle as a tick development inhibitor. When applied as a pour-on, it provides longterm protection against the 1-host tick, *Rhipicephalus microplus*. Triazine and pyrimidine derivatives are closely related compounds that are also chitin inhibitors. They appear to alter the deposition of chitin into the cuticle rather than its synthesis. Cyromazine, a triazine derivative, is effective against blowfly larvae on sheep and lambs and also against other Diptera such as houseflies and mosquitoes. Dicyclanil, a pyrimidine derivative, is highly active against dipteran larvae. The juvenile hormone analogues mimic the activity of naturally occurring juvenile hormones and prevent metamorphosis to the adult stage. S-Methoprene is with very low mammalian toxicity that mimics a juvenile insect hormone and is used as for hornfly *(Haematobia*) control on cattle.

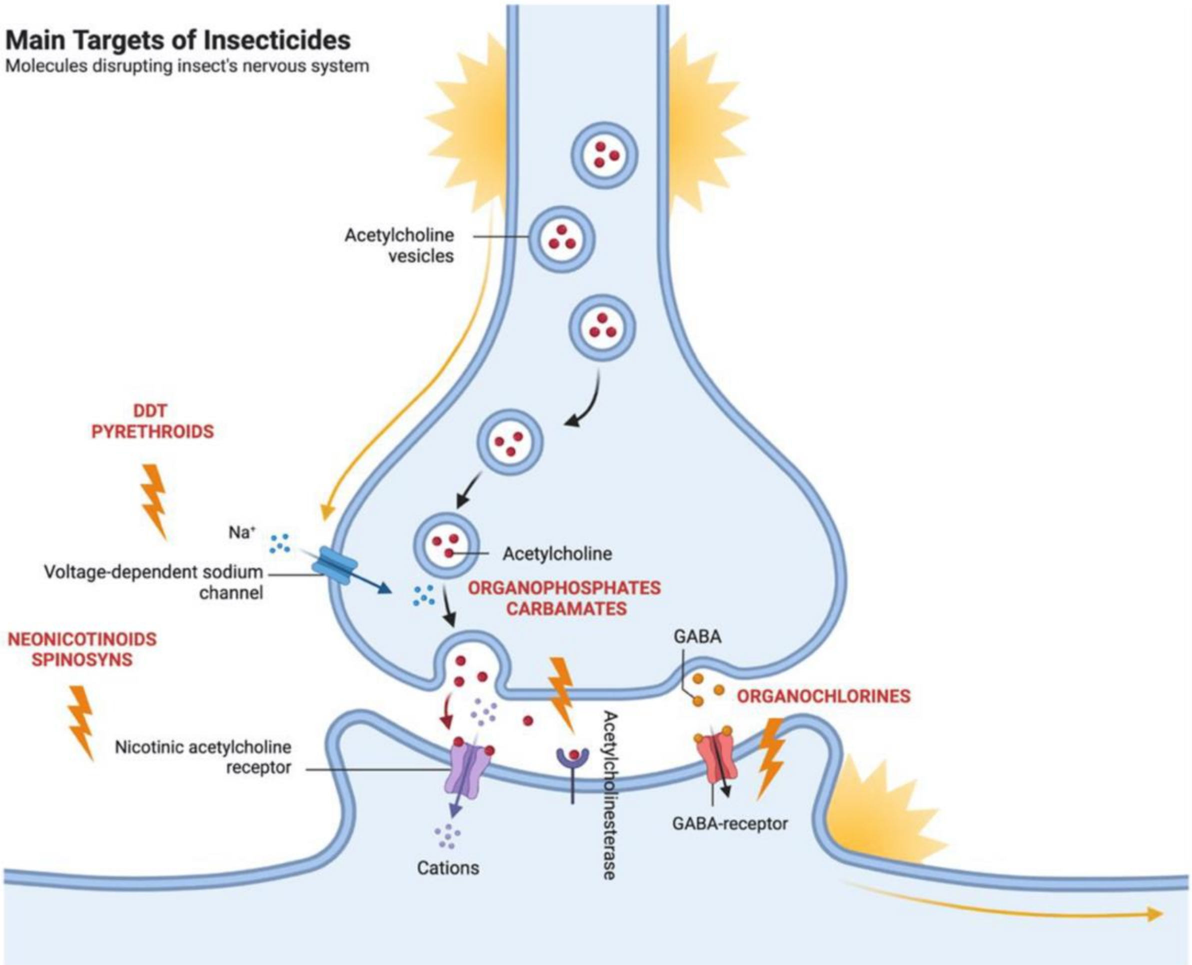

Fig. 1. Site of action of various chemotherapeutic agents

Commonly used ectoparaciticide in farm animals:

1) Deltamethrin (1.25% w/v) Butox®: Used as body spray @ 2mL/L in water & on animal shed @ 5mL/L in water. Avoid direct contact with eyes, prevents licking.
2) Cypermethrin (10% w/v) Clinar®, Ectomin®, Tikkil®: Used as body spray @ 1mL/L water & on animal shed @ 20mL/L water
3) Flumethrin (1% w/v) X-Gon®, Fiporin®, Bayticol®, Poron®: Used as pour-on evenly along midline of back from neck to tail @ 1mL/10kg b.w.
4) Amitraz (12.5% w/v) Virtraz®, Taktic®: Used as body spray @ 2mL/L in water for ticks & fleas @ 4mL/L in water for mites & on animal shed @ 4mL/L in water. Not recommended in horses, cats and pups. In horses may cause depression, ataxia, muscular weakness and progressive large instestinal impaction.
5) Ivermectin (1% w/v) Neomec®, Hitek®: Used @ 0.2mg/kg b.w. SC for scabies, @ 0.3-0.6mg/kg b.w. SC for demodicosis. Hitek Bolus (80mg) @ 0.2mg/kg bw PO. In horses, used only by oral route. Not recommended for calves less than 12 weeks and puppies less than 6 weeks of age.
6) Doramectin (1% w/v) Dectomax® : Used @ 0.2mg/kg b.w. SC or IM OR @ 1mL/50kg b.w. SC. For sheep scab and pigs @ 0.3mg/kg b.w. IM OR @ 1mL/33kg b.w.
7) Closantel (15% w/v) Zycloz®, Zenvet®: Used @ 7.5-15mg/kg b.w. orally for ruminants.

Biological control

The use of naturally occurring biologic pathogens, such as nematodes, bacteria, fungi, and viruses, offer an interesting approach to ectoparasite management (Hogsette, 1999). *Bacillus thuringiensis* has been used on sheep to prevent blowfly strike and body lice. The use of fungal pathogens such as *Metarhizium anisopliae* has also been investigated for control of ticks on livestock and mites on cattle and sheep.

Conclusion

Ectoparasites negatively affect animal performance and productivity. All of these species are exposed to a wide range of infections through the different ectoparasites. Even after movement control is implemented, a variety of ectoparasites are still common because of owners' ignorance of the severity of the issue, the lack of control methods, and the abysmal effectiveness of chemical control. In addition to supporting the work of veterinarians, this evaluation may help veterinary professionals, researchers and organisations plan future studies.

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