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VENOM COMPOSITION AND TOXIC EFFECT OF SOME TICKES FROM IXODIDAE

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Abstrakt

The value of rat LD_{50} for the venomes of tikes *H. plumbeum*, *H. scupense* and *H. asiatikum* has been found. These levels 165±4,8, 172±5,5, 186±5,4, 215±4,7, 223±4,3, 227±4,6 mg/kg respectively. The venom of the ticks exhibits the phospholipase, protease, hemorrhagic and neurotoxic activities. The neurotoxic effect is prevailiring in tze intoxication process.

Key words

Ixodes, HaemaphysaIis. Boophjfus, Dermacentor, Rhipicephalus, Hyalomma, biology, salivary glands of ticks.

СОСТАВ И ТОКСИЧНОСТЬ СЕКРЕТОВ СЛЮННЫХ ЖЕЛЕЗ КЛЕЩЕЙ СЕМЕЙСТВ IXODIDAE

Аннотация

В ходе исследований была определена летальная доза ядов, продуцируемых иксодовыми клещами. Установленные показатели LD_{50} составили 165 ± 4,8; 172 ± 5,5; 186 ± 5,4; 215 ± 4,7; 223 ± 4,3 и 227 ± 4,6 мл/кг соответственно. Ядовитая субстанция характеризуется выраженной фосфолипазной, протеазной, геморрагической и нейротоксической активностью, при этом нейротоксический компонент играет ведущую роль в формировании общего токсического эффекта.

Ключевые слова

Ixodes, HaemaphysaIis. Boophjfus, Dermacentor, Rhipicephalus, Hyalomma, биология, слюнных желез клещей.

Introduction

Despite the considerable diversity of tick species, many aspects of their biology remain insufficiently studied. In particular, there are significant gaps in data regarding the biochemical composition and mechanisms of action of both whole saliva and its individual components on biological structures, including biomembranes.

The study of ticks as venomous animals represents a relatively new direction in arachnoentomology and toxicology. In recent years, scientific investigations have confirmed the

widespread assumption that the saliva of certain tick species, which is injected into the host's skin during attachment and provides local anesthetic and anticoagulant effects, contains toxic substances.

The functions of tick salivary glands are closely related to the physiological role of their secretion—saliva. Various aspects of the physiological activity of salivary glands and the biochemical composition of saliva have been extensively discussed in numerous specialized studies [1, 4, 5, 7, 8, 9].

In addition, data are available on the toxicity of ticks of the genus *Ornithodoros* belonging to the family *Argasidae*. Argasid ticks are predominantly distributed in regions with hot and arid climates. In the territory of the CIS countries, they are mainly characteristic of Central Asia and Transcaucasia, where approximately 20 species have been described.

Unlike ixodid ticks, which are primarily pasture parasites actively searching for hosts in open biotopes, argasids are refuge-dwelling forms. They inhabit caves, rock crevices, abandoned animal burrows, and human dwellings, where relatively high humidity is maintained.

Morphologically, argasid ticks differ from ixodids by the absence of a dorsal scutum; their mouthparts are located on the ventral side beneath the anterior margin of the body. Most representatives of this family are characterized by a broad host range, from reptiles to humans.

Materials and methods

The venom of the studied tick species, similar to other animal-derived toxins, is inactivated by ethyl alcohol, ether, chloroform, concentrated acids and alkalis, as well as by exposure to high temperatures. At the same time, at low temperatures (–20 to –30 °C), the toxic properties of the venom persist for a long time and are only slightly reduced.

In experiments investigating the composition of tick venom, we detected the activity of the following enzymes:

Hyalomma plumbeum: phospholipase A — 0.38 mol/min·mg, protease — 0.14 mol/min·mg, protein content — 78–82%; *Hyalomma scupense*: phospholipase A — 0.35 µmol/min·mg, protease — 0.11 mol/min·mg, protein content — 80–85%;

Hyalomma asiaticum: phospholipase A — 0.32 mol/min·mg, protease — 0.10 mol/min·mg, protein content — 75–80%. Biochemical studies demonstrated that the venom of ticks of the family *Argasidae* also possesses phospholipase activity. The following enzymes were identified: *Argas persicus*: phospholipase A — 0.48 mol/min·mg, protease — 0.20 mol/min·mg, protein content — 75–80%;

Argas reflexus: phospholipase A — 0.40 mol/min·mg, protease — 0.15 mol/min·mg, protein content — 75–80%; *Argas vespertilionis*: phospholipase A — 0.32 mol/min·mg, protease — 0.18 mol/min·mg, protein content — 75–80%.

Due to the absence of detailed information in the available literature regarding the toxico-morphological effects of tick venoms, LD_{50} values were determined in experiments conducted on laboratory mice and rats.

Toxicity assessment was performed using mice and rats. Each animal was weighed prior to the experiment, after which experimental groups were formed according to body mass. Before administration, venom preparations were diluted with physiological saline and injected intraperitoneally using a microsyringe. LD_{50} values were calculated using the Litchfield–Wilcoxon statistical method [2]. Results were expressed as doses (mg) causing death in 50% of animals per 1 kg of body weight.

Results and discussion

Administration of tick venom to mice and rats induced the development of paralytic symptoms, initially affecting the hind limbs and subsequently the forelimbs. Increased respiration rate and convulsive reactions were observed. The intensity and rate of symptom development were directly dependent on the administered dose of venom. Characteristic clinical signs of intoxication included restlessness, increased muscle tone, and tonic convulsions.

At high doses (LD_{100}), animals died from asphyxia against the background of pronounced convulsive syndrome. A comparative analysis of the toxic activity of venoms from ixodid and argasid ticks studied by us is presented in the table, using literature data on other arthropod groups [4].

Determination of the toxicity of venoms from certain tick species when administered intraperitoneally, in comparison with the venoms of other arthropods.

Family Ixodidae	Species	Experimental animals			
		Mice	Rats	Mice	Rats
		LD_{50} (mg.kg)		LD_{50} (mg.kg)	
Ixodidae	*H.plumbeum*	165±4,8	185±4,1	195±3,8	215±4,7
	H.scupense	172±5,5	194±4,9	205±4,3	223±4,3
	H.asiatikum.	186±5,4	190±4,5	215±4,8	227±4,6
Spider *Lycosa singoriensis*		(Orlov and Gelashvili, 1985)			
Spider *Argiopa lobato*		175 (Nosirov K.E, 1991)			
Spider *Areneus grossus*		190 (Nosirov K.E) 1991			

Note: LD_{50} in mg/kg for mice.

The comparison shows that the toxicity of venoms from spiders *Pterinochilus* and *Lycosa singoriensis* significantly exceeds that of the studied tick species and approaches the toxicity levels of *Eresus niger*, *Argiope lobata*, and *Araneus grossus*. Differences compared with *Pterinochilus* sp. venom range from 60–100 times, and with *Lycosa singoriensis* venom from 10–60 times.

Thus, the clinical picture of intoxication in warm-blooded animals caused by tick venoms largely resembles the effects of spider venoms, with the neurotoxic effect apparently playing a leading role. In general, the toxicity of tick venoms is comparable to that of *Argiope lobata* and *Araneus grossus* spiders [2, 3, 5, 6], which allows the studied tick species to be classified as venomous arthropods with a predominantly neurotoxic mechanism of action.

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