Entomology, Ornithology & Herpetology: Current Research

Waniek, Entomol Ornithol Herpetol 2014, 3:3
http://dx.doi.org/10.4172/2161-0983.1000e109

Editorial Article Open Access

Pathways of Insect Protein Digestion: Triatominae (Kissing Bugs)

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Rec date: June 25, 2014; **Acc date:** June 26, 2014; **Pub date:** June 28, 2014

Editorial

The majority of insects use serine proteinases like trypsin and chymotrypsin as main enzymes to digest their food [1]. These types of peptidases develop their maximum activity under alkaline to neutral pH conditions [2]. In some insect groups the intestinal lumen is acidic and the digestion switched to cysteine-like proteinases such as cathepsin D or L [3,4]. Some Coleoptera groups (e.g. Bruchidae, Tenebrionidae) developed a digestive system based on such proteinases [2,5]. But the major group using acid proteinases are the Hemiptera. This taxon uses cysteine proteinases because ancestral groups were using plant seeds containing serine proteinases inhibitors as a food source and therefore had to evolve their digestive system [6,7]. The conquest of this food source was a challenge for the digestive system [8] but it certainly contributed to the success of this insect group opening up new niches.

One of the best analyzed hemipteran groups considering their digestion is the Triatominae (Heteroptera, Reduviidae) subfamily. Many species of this group – especially from the genera *Triatoma*, *Rhodnius* and *Panstrongylus* [9] – are medically important because they are able to transmit *Trypanosoma cruzi* (Kinetoplastida, Trypanosomatidae), the causative agent of Chagas disease [10]. In contrast to mosquitoes which develop from egg to adult in few weeks and frequently show low rates of parasitic infection, some long-lived triatomine species needs several months to complete their life cycle [1]. Besides this, kissing bugs takes huge amounts of blood from their vertebrate host at each nymph stage and, consequently usually show higher infection rates (up to about 80%) [1,11-15]. In this insect group several digestive enzymes and their respective genes were identified and characterized. In the beginning of the 1980s activities of cathepsin B and D, aminopeptidase and carboxypeptidase have been shown [16,17]. Later, when the appropriate molecular biology methods were available, different isoforms of genes from different triatomine species have been identified encoding cathepsin B, L and D and serine carboxypeptidase [18-22]. At the same time Borges et al. [23] have demonstrated a significant increase of cathepsin D activity in *Rhodnius prolixus* infected with *T. cruzi.*

However, despite the numerous studies concerning the Triatominae, many questions about their digestive system and its interactions with the parasite are still unanswered. For example, it is quite possible that there are further types of luminal digestive enzymes waiting to be discovered in triatomines. A recent transcriptome analysis of the *R. prolixus* intestine has revealed many genes related to digestive physiology including digestive enzymes lacking some amino acid residues important for enzymatic activity [24]. Furthermore, it would be very important to know whether or not microbiota plays a role in the digestion of triatomines and how strong the influence of *T. cruzi* on the digestive system might be. It would also be interesting to know what modifications in the structure of proteinases were necessary when reduviids changed to hematophagy. Cathepsin B possesses both exo- and endopeptidase activity and its main functions in the triatomine digestion is yet uncertain. The relationship of luminal and lysosomal cathepsins is still an important matter to be clarified. Answering these questions could not only shed new light on the physiology and biochemistry of Triatominae but also opening up new approaches for vector control. An answer to these questions might also answer basic questions of evolution and development of blood-sucking in insects in general.

Acknowledgments

To Dr. Catarina AC Araújo for some ideas and revision of the manuscript.

References

1. Lehane MJ (2005) The Biology of Blood-Sucking in Insects. Cambridge University Press, Cambridge.
2. Terra WR, Ferreira C, Jordão BP, Dillon RJ (1996) Digestive enzymes, In: Lehane MJ, Billingsley PF (eds.), Biology of the Insect Midgut. Chapman & Hall, London, 153–194.
3. Cristofoletti PT1, Ribeiro AF, Terra WR (2005) The cathepsin L-like proteinases from the midgut of Tenebrio molitor larvae: sequence, properties, immunocytochemical localization and function. Insect Biochem Mol Biol 35: 883-901.
4. Padilha MH1, Pimentel AC, Ribeiro AF, Terra WR (2009) Sequence and function of lysosomal and digestive cathepsin D-like proteinases of Musca domestica midgut. Insect Biochem Mol Biol 39: 782-791.
5. Terra WR, Ferreira C (1994) Insect digestive enzymes: properties, compartmentalization and function. Comp Biochem Physiol B 109: 1-62.
6. Schofield CJ (1996) Overview – biosystematics of the Reduviidae, pp. 483-516. In: Schofield CJ, Dujardin JP, Jurberg J [eds.], Proceedings of the International Workshop on Population Genetics and Control of Triatominae. Santo Domingo de Los Colorados, Ecuador, Mexico City, INDRE.
7. Schofield CJ (2000) Biosystematics and evolution of the Triatominae. Cad Saude Publica 16 Suppl 2: 89-92.
8. Mello MO, Silva-Filho MC (2002) Plant-insect interactions: an evolutionary arms race between two distinct defense mechanisms. Braz J Plant Physiol 14: 71-81.
9. Coura JR1, Viñas PA (2010) Chagas disease: a new worldwide challenge. Nature 465: S6-7.
10. WHO/CTD, 2014. Chagas. http://www.who.int/mediacentre/factsheets/fs340/en/.
11. Taylor KA1, Koros JK, Nduati J, Copeland RS, Collins FH, et al. (1990) Plasmodium falciparum infection rates in Anopheles gambiae, An. arabiensis, and An. funestus in western Kenya. Am J Trop Med Hyg 43: 124-129.
12. Gonçalves TC, de Oliveira E, Dias LS, Almeida MD, Nogueira WO (1998) An investigation on the ecology of Triatoma vitticeps (Stal, 1859) and its possible role in the transmission of Trypanosoma cruzi, in the locality of

Triunfo, Santa Maria Madalena municipal district, state of Rio de Janeiro, Brazil. Mem Inst Oswaldo Cruz 93: 711-717.

13. Yamèogo L, Toè L, Hougard JM, Boatin BA, Unnasch TR (1999) Pool screen polymerase chain reaction for estimating the prevalence of Onchocerca volvulus infection in Simulium damnosum sensu lato: results of a field trial in an area subject to successful vector control. Am J Trop Med Hyg 60: 124-128.
14. Coura JR (2007) Chagas disease: what is known and what is needed--a background article. Mem Inst Oswaldo Cruz 102 Suppl 1: 113-122.
15. Bouyer J1, Koné N, Bengaly Z (2013) Dynamics of tsetse natural infection rates in the Mouhoun river, Burkina Faso, in relation with environmental factors. Front Cell Infect Microbiol 3: 47.
16. Houseman JG, Downe AER (1981) Identification and partial characterization of digestive proteinases from Triatoma phyllosoma pallidipennis Stal (Hemiptera, Reduviidae). Comp Biochem Physiol B 70: 713-717.
17. Houseman JG, Downe AER (1982) Characterization of an acidic proteinase from the posterior midgut of Rhodnius prolixus Stal (Hemiptera, Reduviidae). Insect Biochem 12: 651-655.
18. Lopez-Ordoñez T, Rodriguez MH, Hernández-Hernández FD (2001) Characterization of a cDNA encoding a cathepsin L-like protein of Rhodnius prolixus. Insect Mol Biol 10: 505-511.
19. Kollien AH, Waniek PJ, Nisbet AJ, Billingsley PF, Schaub GA (2004) Activity and sequence characterization of two cysteine proteases in the digestive tract of the reduviid bug Triatoma infestans. Insect Mol Biol 13: 569-579.
20. Waniek PJ, Pacheco Costa JE, Jansen AM, Araújo CAC (2012) Cathepsin L of Triatoma brasiliensis (Reduviidae, Triatominae): sequence characterization, expression pattern and zymography. J Insect Physiol 58: 178-187.
21. Waniek PJ, Araújo CA, Momoli MM, Azambuja P, Jansen AM, et al. (2014) Serine carboxypeptidases of Triatoma brasiliensis (Hemiptera, Reduviidae): Sequence characterization, expression pattern and activity localization. J Insect Physiol 63: 9-20.
22. Balczun C, Siemanowski J, Pausch JK, Helling S, Marcus K, et al. (2012) Intestinal aspartate proteases TiCatD and TiCatD2 of the haematophagous bug Triatoma infestans (Reduviidae): sequence characterisation, expression pattern and characterisation of proteolytic activity. Insect Biochem Mol Biol 42: 240-250.
23. Borges EC, Machado EM, Garcia ES, Azambuja P (2006) Trypanosoma cruzi: effects of infection on cathepsin D activity in the midgut of Rhodnius prolixus. Exp Parasitol 112: 130-133.
24. Ribeiro JMC, Genta FA, Sorgine MHF, Logullo R, Mesquita RD (2014) An insight into the transcriptome of the digestive tract of the bloodsucking bug, Rhodnius prolixus. PLoS Negl Trop Dis 8: e2594.