Gut Chitinase Activity from Reticulitermes virginicus (Isoptera: Rhinotermitidae)

Authors: Arquette, Timothy J., and Rodriguez, Jose M.

Source: Florida Entomologist, 96(3) : 1186-1187

Published By: Florida Entomological Society

URL: https://doi.org/10.1653/024.096.0362

GUT CHITINASE ACTIVITY FROM *RETICULITERMES VIRGINICUS* (ISOPTERA: RHINOTERMITIDAE)

TIMOTHY J. ARQUETTE[1,*] AND JOSE M. RODRIGUEZ[2]
[1]Mississippi State University South Branch Experiment Station, Poplarville, MS 39470, USA

[2]State Chemical Laboratory, Mississippi State, MS 39762, USA

*Corresponding author; E-mail: tja68@msstate.edu

Subterranean termites (family Rhinotermitidae) of the southeastern United States ingest chitin, which if digestible would provide the insect with dietary nitrogen (Waller & LaFage 1987). Gut chitinase has been detected qualitatively in a few termite species (Noirot & Noirot-Timothee 1969; Mishra & Sen-Sarma 1981) but not in others (Mishra & Sen-Sarma 1981). The current study aimed to identify whether chitinase is present in nonmolting workers of a subterranean termite, *Reticulitermes virginicus* Banks, and subsequently to determine the specific activity of chitinase along with that of cellulase for comparison.

Wood infested with *R. virginicus* was collected in Oktibbeha County, Mississippi. Workers selected for assay were similarly large in size and had darkened abdomens. This appearance indicated molting was not occurring, as termites appear milky white during a molt (Laine & Wright 2003). Therefore, measurable chitinase activity would likely be from enzymes in the digestive tract. Assay procedures are described in Arquette (2011). Chitinase was determined to be present in crude extracts, and subsequently assays for pH optima and specific activity of chitinase as well as cellulase were carried out. Cellulase specific activity was about 6-fold higher than that of chitinase (Fig. 1).

Invertebrates produce many billions of tons of chitin annually (Tasch 1973). It is the most abundant polysaccharide in the insect body (Kramer & Muthukrishnan 2009) and is also synthesized by fungi. Termites ingest chitin from various sources, including fungi in decayed wood, and other termites via cannibalism and necrophagy (Moore 1969). They may also consume disintegrated cuticle along with rotting wood, as cuticle of dead arthropods is brittle and breaks apart easily (Tasch 1973). Chitinase is present in the digestive tract of insects with a chitinous diet (Fukamizo et al. 1985), with increased activity at the time chitinous foods are eaten (Merzendorfer & Zimoch 2003).

For the current study, high cellulase specific activity compared with that of chitinase could be anticipated, because wood cellulose is the major food of *R. virginicus*. However measurable chitinase activity showed that additional food resources besides wood are available, which provide all components necessary for the insect to live, i.e., carbohydrate for glycolysis and fat production, and nitrogen for protein synthesis. Some areas for future study include determination of sites where termite gut chitinase is synthesized, and whether chitinase activity varies between species of Rhinotermitidae as well as between colonies of the same species.

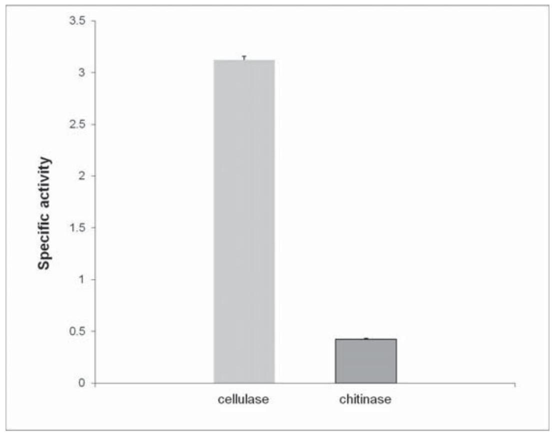

Fig. 1. Cellulase and chitinase specific activity from 3 groups of 50 *Reticulitermes virginicus* workers + SEM. Specific activity is defined as the amount of enzyme at pH 5.0 that released one nmol reducing sugar as glucose (celluase assay) or N-acetylglucosamine (chitinase assay) per min per mg protein.

SUMMARY

Chitinase activity was measured from nonmolting workers of a subterranean termite, *Reticulitermes virginicus* Banks. The specific activity of cellulase was 6-fold greater than that of chitinase. An ability of *R. virginicus* to digest chitin would allow utilization of additional food resources that contain dietary nitrogen lacking in wood.

Key Words: cellulose, chitin, dietary nitrogen, nonmolting workers, specific activity

RESUMEN

Se midió la actividad de la quitinasa de trabajadores que no mudan de la termita subterránea

Reticulitermes virginicus. La actividad específica de celulosa fue 6 veces mayor que la de quitinasa. La capacidad de *R. virginicus* para digerir quitina permitiría recursos alimenticios adicionales que contienen nitrógeno dietético que esta ausente en la madera.

Palabras Clave: celulosa, quitina, nitrógeno dietético, trabajadores que no mudan, actividad

Acknowledgments

We thank Nathan Little, Mississippi State University, for assistance in collecting and processing termites for this study. This manuscript was approved for publication as Journal Article No. 12245 of the Mississippi Agricultural and Forestry Experiment Station, Mississippi State University.

References Cited

Arquette, T. 2011. Study of food digestion and morphology of subterranean termites from Mississippi. Doctoral thesis, Mississippi State University. http://www.biochemistry.msstate.edu/thesis.asp. Accessed 12 May 2013.

Bowman, S. M., and Free, S. J. 2006. The structure and synthesis of the fungal cell wall. Bioassays 28: 799-808.

Fukamizo, T., Speirs, R., and Kramer, K. 1985. Comparative biochemistry of mycophagous and non-mycophagous grain beetles: chitinolytic activities of foreign and sawtoothed grain beetles. Comp. Biochem. Physiol. B 81: 207-209.

Kramer, K. J., and Muthukrishnan, S. 2009. Chitin metabolism in insects, pp. 497-530 *In* L. I. Gilbert [ed.] Insect Development: Morphogenesis, Molting and Metamorphosis. Academic Press, San Diego. 730 pp.

Laine, L. V., and Wright, D. J. 2003. The life cycle of *Reticulitermes* spp. (Isoptera: Rhinotermitidae): what do we know? Bull. Entomol. Res. 93: 267-278.

Merzendorfer, H., and Zimoch, L. 2003. Chitin metabolism in insects: structure, function and regulation of chitin synthases and chitinases. J. Exp. Biol. 206: 4393-4712.

Mishra, S. C., and Sen-Sarma, P. K. 1981. Chitinase activity in the digestive tract of termites (Isoptera). Material und Organismen 16: 157-160.

Moore, B. P. 1969. Biochemical studies in termites, pp. 407-432 *In* K. Krishna and F. M. Weesner [eds.], Biology of Termites, vol. 1. Academic Press, NY. 598 pp.

Noirot, C., and Noirot-Timothee, C. 1969. The digestive system, pp. 49-88 *In* K. Krishna and F. M. Weesner [eds.], Biology of Termites, vol. 1. Academic Press, NY. 598 pp.

Tasch, P. 1973. Paleobiology of the Invertebrates. John Wiley and Sons, NY. 946 pp.

Waller, D. A., and La Fage, J. P. 1987. Nutritional ecology of termites, pp. 487-532 *In* F. Slansky and J. G. Rodriguez [eds.], Nutritional Ecology of Insects, Mites, and Spiders, and Related Invertebrates. John Wiley and Sons, NY. 1016 pp.