Center for Grain and Animal Health Research

Research Kernels

Our Latest Research Results • February 2010

Chymotrypsin-like Peptidases from *Tribolium castaneum*: RNA Interference Reveals Physiological Functions in Molting

Authors: G. Broehan, Y. Arakane, R.W. Beeman, K.J. Kramer, S. Muthukrishnan, H. Merzendorfer

Submitted to: Insect Biochemistry and Molecular Biology

Digestion and exoskeleton are unique and sensitive aspects of insect physiology that could be exploited by appropriately-targeted biopesticides. Chymotrypsins are a small but important group of digestive enzymes that have been suspected to have an additional role in synthesis of the exoskeleton. In this work we confirmed for the first time that two chymotrypsins do indeed have vital and specific functions in insect exoskeleton and molting, and that disruption of these genes prevents the insect from shedding the old skin, resulting in death.

Studying the detailed functions of insect genes continues to reveal new weaknesses that may be exploited for insect control.

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Identification, mRNA Expression and Functional Analysis of Some of the Yellow Family Genes in *Tribolium castaneum*

Authors: Y. Arakane, N.T. Dittmer, K.J. Kramer, S. Muthukrishnan, R.W. Beeman, M.R. Kanost

Submitted to: Insect Biochemistry and Molecular Biology

The chemistry of insect exoskeleton is still only poorly understood, but represents a sensitive aspect of insect physiology that could be exploited by appropriately-targeted biopesticides. We identified fourteen new genes in the red flour beetle that seem to have some role in the maturation (hardening and darkening) of the insect cuticle (skin). Knocking out the function of some of these genes resulted in failure of the exoskeleton to either darken or ripen normally. In some cases such gene knockout prevented the affected insects from shedding the old skin, resulting in the death of the insect. A better understanding of insect exoskeleton could reveal new weaknesses that may be lead to new methods of insect control.

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Domain Organization, Phylogenetic Analysis and Expression of Gene Families in *Tribolium castaneum* Encoding Proteins with Peritrophin A-Type Chitin-Binding Domains

Authors: S. Jasrapuria, Y. Arakane, G. Osman, K.J. Kramer, R.W. Beeman, S. Muthukrishnan

Submitted to: Insect Biochemistry and Molecular Biology

Digestion and exoskeleton are unique and sensitive aspects of insect physiology that could be exploited by appropriately-targeted biopesticides. Peritrophins are a poorly-understood class of proteins that are believed to be the major structural proteins of the insect midgut digestive sac. We identified 29 peritrophin-like proteins in the red flour beetle, and showed that 11 of these appear to have unique and specific functions in digestion in the midgut. Surprisingly, the remaining 18 do not appear to have a digestive function. Instead, at least some of them are required for development of the exoskeleton or other tissues of similar composition. Studying the detailed functions of insect genes continues to reveal new weaknesses that may be exploited for insect control.

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A Near-Infrared Spectroscopic Method for the Identification of Fusarium Head Blight Damage and Prediction of Deoxynivalenol in Single Wheat Kernels

Authors: K.H.S. Peiris, M.O. Pumphrey, Y. Dong, E. Maghirang, W. Berzonsky, F.E. Dowell

Submitted to: Euphytica

Proportion of Fusarium damaged kernels (FDK) and deoxynivalenol (DON) content in grain samples are often assessed to evaluate resistance of wheat germplasm for Fusarium Head Blight (FHB) resistance. Visual sorting of kernels to determine FDK% are laborious and subjective while chemical analysis of DON content is destructive and expensive. Therefore, a rapid instrumental technique to evaluate FDK and DON levels objectively and non-destructively is highly beneficial for the enhancement of breeding programs. The objective of this study was to develop automated single kernel near-infrared (SKNIR) spectroscopic methods for identification of FDK and for estimating DON levels of single kernels. The techniques developed could classify visually sound and fusarium damaged kernels with an accuracy of 98.8% and 99.9%, respectively. Moreover, the fusarium damaged kernel fraction could be sorted into 2 - 3 sub fractions with low to high DON levels. It was also possible to estimate DON levels of FDK fairly accurately.

Compared to traditional methods, these techniques will allow analysis of grain samples for comprehensive evaluation of Fusarium resistance in breeding materials and therefore permit plant breeders and geneticists to evaluate many samples rapidly and cost effectively while retaining the seeds for generation advancement. Agronomists and plant pathologists may also use these techniques for analysis of grain samples in experiments designed for testing fungicides and/or other cultural control treatments for management of FHB disease and DON levels in wheat crops.

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A Computer Model for Simulating Population Development of the Indianmeal Moth (*Lepidoptera: Pyralidae*) in Stored Corn

Authors: J.E. Throne, R.T. Arbogast
Submitted to: Journal of Economic Entomology

The Indianmeal moth is a common pest of stored corn. We developed a computer model to simulate population development of the Indianmeal moth in stored corn. The model accurately simulated population development of Indianmeal moths in corn stored during fall and winter of three separate storage seasons in South Carolina. The model predicted that populations would increase after winter as grain temperatures rose, but observed populations in the grain bins never increased after winter. Despite this, the model should be useful from a management perspective because the corn is being sold off or used up after winter, and the observed Indianmeal moth populations never reached damaging levels after winter.

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Reproductive Parameters of the Parthenogenetic Psocid *Lepinotus reticulatus* (Psocoptera: Trogiidae) at Constant Temperatures

Authors: G.P. Opit, J.E. Throne, M.E. Payton
Submitted to: Environmental Entomology

Psocids, which are minute insects that are often called booklice, are pests in grain storages, grain processing facilities, and product warehouses in the United States and many other countries. A little studied psocid species, *Lepinotus reticulatus*, is a pest of stored commodities throughout the world. Development of an effective pest management program for *L. reticulatus* is dependent on having sound knowledge of its biology and population dynamics. We determined preoviposition period (number of days before adult females start laying eggs), oviposition period (number of days that adult females lay eggs), fecundity (number of eggs laid per female), postoviposition period (number of days after adult females stop laying eggs and before they die), and longevity (adult life span) of this psocid at temperatures from 72.5 to 95 degrees F. This information can be used in simulation models to predict *L. reticulatus* population dynamics and to improve pest management strategies.

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Sorghum Proteins: The Concentration, Isolation, Modification and Food Applications of Kafirins

Authors: N.O.I. DeMesa-Stonestreet, S. Alavi, S. Bean
Submitted to: Journal of Food Science

Celiac disease is a serious condition affecting millions of individuals. Those afflicted with this illness are resigned to a lifelong avoidance of products containing proteins found in the cereal grains wheat, rye and barley. Since many food products are based on these cereals, especially wheat, celiac patients have very limited food choices. Thus, a burgeoning need exists for developing nutritious, palatable and affordable foods, especially staples like bread and pasta, for these individuals and their families and friends who are accustomed to wheat based staples. Grain sorghum and its proteins are safe for celiac patients. However, the main sorghum proteins, kafirins, are resistant to digestion and also difficult to extract and modify with food-compatible chemicals, thus limiting its use in foods. This review describes studies on kafirin extraction or concentration and methods for modifying sorghum proteins for improved nutrition and functionality, as well as food applications.

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