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Grain Marketing and Production Research Center

Research Kernels

Our Latest Research Results • May 2008

Structure and functional properties of sorghum starches differing in amylose content

Starch was isolated and studied from a waxy, heterowaxy, and normal sorghum to determine their chemical properties. The properties of starch greatly influence their functionality and nutritional properties and therefore waxy and heterowaxy sorghum starch may have unique functionality. Cooked waxy starch was found to behave like a visco-elastic liquid, which differed from that of cooked normal and heterowaxy starch. Heterowaxy starch was found to have less amylopectin chains with a degree of polymerization in the range of 6-15 than did normal starch. Functionally, heterowaxy starch had a higher gelatinization temperature and contained lower amounts of rapidly digestible starch and higher levels of resistant starch than waxy starch.

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Movement behavior in response to landscape structure: the role of functional grain

The ability of the red flour beetle, *Tribolium castaneum*, to find and colonize small patches of food is a major contributor to its pest status in food processing and storage facilities such as flour mills, but this process is not well understood. Amount of food material and its pattern of distribution can influence beetle movement patterns and provide insight into how they perceive the structure of their environment. Model landscapes were created with different levels of total flour abundance and individual flour patch size, and beetle movement behavior on these landscapes was recorded and analyzed. As landscape structure changed, beetles were demonstrated to modify their movement behavior, indicating that they perceived some of the changes in the landscape and changed their search strategy. This study serves as an important first step in identifying behavioral rules of movement that may ultimately lead to more accurate predictions of how beetles use the environment and how the landscape pattern can be manipulated to reduce its suitability for this pest.

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A unique approach to micronization

Resonance destruction occurs when the vibration of a certain material exceeds its natural resonance frequency, such as when the Tacoma Narrows Bridge failed in 1940. This research reports the use of this resonance destruction phenomenon to process grain. In cooperation with Dr. Jeff Gwirtz, KSU, we used a Pulsewave™ Technology machine with a capacity range of 500-8,000 pounds per hour to reduce wheat grain to flour. The Pulsewave™ Technology has the ability to reduce a very high percentage of clean endosperm into flour in a single pass and thus potentially uses significantly less energy than a conventional mill. This technology causes grain to break into fractions differently than a conventional mill, and thus produces flour with different, possibly superior, quality traits.

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Detection of genes encoding antimicrobial peptides in Mexican strains of *Trichoplusia ni* (Hubner) exposed to *Bacillus thuringiensis*

Resistance to the insecticide bacterium *Bacillus thuringiensis* (Bt) is being studied in one of the primary target pests in Mexico, the cabbage looper, to prevent the development of resistance to sprays in the field. The role of insect immune protective mechanisms to evade Bt infection is unknown. Therefore, we compared the expression of genes encoding antibacterial peptides in strains of the cabbage looper with varying susceptibility to Bt protoxins and toxins. Our findings suggest that the expression of antibacterial peptides correlates with previous exposure to Bt, although a definitive link to resistance has yet to be determined.

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Differential responses of wheat inhibitor-like genes to Hessian fly (*Mayetiola destructor*) attacks during compatible and incompatible interactions

The Hessian fly (*Mayetiola destructor*) is one of the most destructive insects of wheat. The insect is currently controlled by host plant resistance. The challenge for the host plant resistance strategy is that resistance conferred by resistance genes is short lived, often lasting for about 6 to 8 years. Therefore, new strategies for durability should be explored. This paper characterized a group of inhibitor-like genes that were strongly suppressed in susceptible plants and were induced in resistant plants. This observation suggests that the inhibitor-like genes may help the wheat to fight Hessian fly damage. Further research may lead to durable resistant cultivars that can effectively control this insect pest.

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Genome filtering using methylation-sensitive restriction enzymes with six-base pain recognition sites

Genome sequencing is a means of finding all of the genes in an organism. Rice and Arabidopsis are two plant examples that have had all of their DNA sequenced. Unfortunately, some species have huge amounts of DNA. Wheat has 16 billion bases of DNA while rice only has 400 million, making wheat sequencing very expensive. Most of the wheat DNA, approximately 90%, consists of repeated sequences that do not code for genes. Sequencing the complete genome will be expensive not only in cost, but most of the sequence will not be informative. This manuscript is about a new technique that removes most of the repetitive DNA and enriches for gene-containing sequence. The technique uses enzymes that cut DNA, but only regions that have not been modified with a methyl molecule. The data presented shows that the technique is very efficient in wheat. It reduced the amount of repetitive DNA sequenced to as low as 16.2%. Other techniques can only reduce the repetitive DNA to just 30%. The technique was also effective in both corn and tobacco, which also have large genomes. By reducing the level of repeat DNA, it will be more cost effective to find the gene regions when doing genome sequencing.

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Impact of nighttime temperature on physiology and growth of spring wheat

Climate models predict greater increases in nighttime temperature in future climates. The effects of high nighttime temperature on wheat (*Triticum aestivum* L.) are not well understood and are needed to better understand impacts of climate change. Two spring wheat cultivars (Pavon-76 and Seri-82) were grown in controlled environments chambers at optimum temperatures (day/night, 24/14°C; day/night photoperiod, 16/8 h) from sowing to booting and thereafter plants were exposed to four different nighttime temperatures (14ºC, 17ºC, 20ºC, 23ºC) until maturity. The daytime temperature was similar at 24ºC across all treatments. High night temperature (>14ºC) decreased photosynthesis after 14 d of stress. Grain yields linearly decreased with increasing nighttime temperatures. High nighttime temperature (=20ºC) decreased spikelet fertility and grains per spike, and grain-size. When compared to control (14ºC) grain filling duration was decreased by 3 and 7 d, respectively, at night temperatures of 20°C and 23ºC. High nighttime temperatures increased the expression of chloroplast protein EF-Tu in both cultivars suggesting possible involvement of this protein in wheat response to nighttime temperature stress. This study highlights the importance of high nighttime temperatures in determining the responses of wheat and possibly other crops to climate change.

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