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Grain Marketing and Production Research Center

Research Kernels

Our Latest Research Results • July 2008

Detecting counterfeit antimalarial tablets by near-infrared spectroscopy

There are about 300 million cases of malaria each year and 3 million deaths. However, malaria can usually be cured if treated correctly. Counterfeit antimalarial drugs are found in as many as 50% of tablets in some developing countries. However, it is difficult to differentiate between genuine and fakes due to their increasing sophistication. We tested the application of near-infrared spectroscopy for discriminating between single counterfeit and genuine artesunate antimalarial tablets. This is an extension of technology developed to detect characteristics of single grain kernels. Using this rapid technique we found that antimalarial tablets could be identified as genuine or counterfeit with 100% accuracy. This NIR technique can be field-portable and requires little training after calibrations are developed, thus showing great promise for rapid and accurate detection of fake tablets.

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Small-scale mashing procedure for predicting ethanol yield of sorghum grain

A small-scale mashing (SSM) procedure requiring only 300 mg of sample was investigated as a possible method of predicting ethanol yield of sorghum grain. This procedure had the advantage of requiring only a small quantity of sorghum, use of common industrial enzymes, high repeatability, high efficiency and low cost of per-sample analysis. The 18 sorghum samples tested showed strong, linear correlations between completely hydrolyzed starch from the SSM and ethanol yields from both traditional (R squared = 0.86) and simultaneous saccharification and fermentation procedures (R squared = 0.93). CHS proved a reliable indicator for ethanol yield. Thus this methodology can be used to rapidly and inexpensively screen breeders samples and be used by the ethanol industry to screen samples for fermentation performance.

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Gas cell stability in bread making. II. Mechanism of stability of the gluten-starch matrix

It is the unique properties of the gluten proteins of wheat that allow bakery products such as breads, pizza, and tortillas to be made. This research project examined the role of gluten and starch in stabilizing gas cells in bread, which are important in determining product quality. Fractions of gluten proteins with different molecular weight distributions were prepared and added back to flour, then strain hardening and mixing parameters measured. Doughs with higher strain hardening index were sufficiently extensible to respond to gas pressure but also had sufficient strength to resist collapse. The phenomenon of strain hardening appeared to depend on the balance between strength and extensibility of the entangled network of polymeric proteins of wheat flour. The optimum balance seemed to exist when the relative proportions of polymerice proteins greater and smaller than the optimum molecular weight were roughly 60:40. A shift in the balance to either side was related to a decrease in loaf volume. The smaller polymers (less than the optimum molecular weight) may decrease the stability of the gluten-starch matrix. On the other hand, an increase in strength conferring polymeric proteins may prevent sufficient expansion of the gluten-starch matrix required to increase loaf volume.

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Quantitative trait loci for aluminum resistance in Chinese wheat landrace FSW

Aluminum (Al) toxicity is a major problem for wheat production in acid soils. Chinese landrace FSW shows a high level of Al resistance. Quantitative trait loci (QTLs) controlling Al resistance were identified in FSW through evaluating net root growth (NRG) in a nutrient solution culture containing Al3+ and hematoxylin staining score (HSS) of roots after Al stress. Molecular marker analysis identified three QTLs to control Al resistance in FSW. They were located on chromosomes, 4DL, 3BL and 2A, respectively. Together, the three QTLs accounted for up to 81.9% of the variation for HSS and 78.3% of the variation for NRG. The QTL on 3BS is a novel QTL with a large effect on Al resistance discovered in this study. The two major QTLs on 4DL and 3BL demonstrated an additive effect. The SSR markers closely linked to the QTLs have potential to be used for marker-assisted selection to improve Al resistance of wheat cultivars in breeding programs.

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A major QTL controlling seed dormancy and pre-harvest sprouting resistance on chromosome 4A in a Chinese wheat landrace

Germination of wheat kernels in a ripe wheat head before harvesting due to a long period of wet weather is called pre-harvest sprouting (PHS). PHS can cause significant reduction in wheat yield and grain quality worldwide. Wheat resistance to PHS can effectively reduce the PHS losses. Some Chinese wheat has been reported to be resistant to PHS. A gene from Chinese wheat Tutoumai A was identified through analysis of molecular markers. Twelve molecular markers were associated with the gene for PHS resistance and long seed dormancy. This gene was located on the long arm of chromosome 4A. Two molecular markers were close to the gene, and explained 30.6% of PHS resistance in Tutoumai A. Therefore, this gene is most likely the major gene for PHS resistance. The linked markers to the gene can be used for marker-assisted breeding for PHS-resistant white wheat cultivars.

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Evaluation and characterization of forage sorghum as feedstock for fermentable sugar production

Successful use of biomass for biofuel production depends on not only pretreatment methods and efficient processing conditions but also physical and chemical properties of the biomass. In this study, four varieties of forage sorghum (stems and leaves) were characterized and evaluated as feedstock for fermentable sugar production. Fourier transform infrared spectroscopy and X-ray diffraction were used to determine changes in structure and chemical composition of forage sorghum before and after pretreatment and the enzymatic hydrolysis process. Up to 72% of hexose yield and 94% of pentose yield were obtained using “modified” steam explosion with 2% sulfuric acid at 140°C for 30 min and enzymatic hydrolysis with
ellulase (15 FPU/g. cellulose) and ß-glucosidase (50 CBU/g. cellulose).

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Genomic analysis of a 1 Mb region near the telomere of Hessian fly chromosome X2 and avirulence gene vH13

The Hessian fly [*Mayetiola destructor* (Say)] is one of the most destructive pests of wheat. Host plant resistance is the most effective and cost-efficient way to control the damage caused by this pest. The challenge for the host plant resistance strategy is that resistance conferred by specific genes are short lived, effective for only 6 to 8 years. To develop more durable resistance cultivars, we need to understand how the insect can overcome host plant resistance so quickly. This goal of research is to isolate an avirulence gene that will help to understand how the Hessian fly overcomes host plant resistance.

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Vasopressin-like peptide and its receptor function in an indirect diuretic signaling pathway in the red flour beetle

Maintenance of proper hydration and prevention of desiccation is an important function of the insect kidney, especially for insects in dry environments such as stored grain and cereal products. Until recently, very little has been known about the genes and proteins that are needed for the proper functioning of this vital organ in pest insects. We identified two important osmoregulatory proteins in the red flour beetle and showed that they have very potent, indirect effects on production of insect urine. There must be a still-undiscovered component of this system, which acts directly on the osmoregulatory organ. Each of these newly-discovered genes can become a target in screening assays for new biopesticides that disrupt maintenance of hydration and related physiological processes.

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