KANSAS STATE UNIVERSITY | Department of Grain Science and Industry

Our Latest Published Research

RESEARCHUPDATE

July-December 2013, part I of II

Book:

Resistant Starch: Sources, Applications and Health Benefits. 2013.

Editors: **Yong-Cheng Shi**, C.C. Maningat.
Publisher: Wiley-Blackwell, ISBN:978-0-8138-0951-9.
The discovery of resistant starch is considered one of the major developments in our understanding of the importance of carbohydrates for health in the past twenty years. Resistant starch, which is resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine, is naturally present in foods. *Resistant Starch: Sources, Applications and Health Benefits* covers the intrinsic and extrinsic sources of resistant starch in foods, and compares different methods of measuring resistant starch and their strengths and limitations. Applications in different food categories are fully covered, with descriptions of how resistant starch performs in bakery, dairy, snack, breakfast cereals, pasta, noodles, confectionery, meat, processed food and beverage products.

Manuscripts:

Evaluation of pelleting as a pre-processing step for effective biomass deconstruction and fermentation. 2013.

Authors: **Yadhu Guragain, Jonathan Wilson**, Scott Staggenborg, Leland McKinney, Donghai Wang, **Praveen Vadlani**.
Published in: Biochemical Engineering Journal, 77(15):198-207
Densification of bulky forages by pelleting reduces their transportation, handling, and storage costs. Because of high shearing force and frictional heating during the pelleting process, it is hypothesized that pelleting of lignocellulosic biomass could also partially deconstruct its complex structure and facilitate bioethanol production. In this study, pelleted wheat straw, corn stover, big bluestem, and sorghum stalk were evaluated for sugars and ethanol production, and compared with those of unpelleted biomasses. Mass recovery after alkali pretreatment increased by 14%, 11%, 2%, and 5%, respectively, in unpelleted biomasses. Lignin content reduced significantly more in pelleted samples for all types of biomass, except sorghum stalk. Volumetric productivity of enzymatic hydrolysis was 23%, 21%, 20% and 12% higher, respectively, in pelleted samples; ethanol yield on the basis of released sugars did not differ significantly between pelleted and unpelleted samples. These results indicate that the pelleting process led to better enzymatic hydrolysis of pretreated biomasses without affecting the quality of sugars for fermentation. However, overall yield of ethanol from the raw biomass was not significantly higher in pelleted biomasses because of higher mass loss during pretreatment process. In our study, we propose a schematic for complete utilization of various byproducts for enhanced economic viability.
Contact: Dr. Praveen Vadlani (vadlani@ksu.edu)

Models to predict mortality of *Tribolium castaneum* first instars and adults exposed to elevated temperatures during structural heat treatments. 2013.

Authors: Fuji Jian, **Bhadriraju Subramanyam**, Digvir Jayas, Noel White.
Published in: Journal of Economic Entomology, 106(5):2247-2258.
Novel thermal death models were developed with certain assumptions, and these models were validated by using actual heat treatment data collected under laboratory conditions at constant temperatures over time and in commercial food-processing facilities where temperatures were dynamically changing over time. The predicted mortalities of both young larvae and adults of the red flour beetle, Tribolium castaneum (Herbst), were within 92–99% of actual measured insect mortalities. There was good concordance between predicted and observed mortalities of young larvae and adults of T. castaneum exposed to constant temperatures in laboratory growth chambers and at variable temperatures during structural heat treatments of commercial food-processing facilities. The models developed in this study can be used to determine effectiveness of structural heat treatments in killing young larvae and adults of T. castaneum and for characterizing insect thermotolerance.
Contact: Dr. Bhadriraju Subramanyam (sbhadrir@ksu.edu)

Reaction of octenylsuccinic anhydride with a mixture of granular starch and soluble maltodextrin. 2013.

Authors: **Yanjie Bai, Yong-Cheng Shi**.
Published in: Carbohydrate Polymers, 98(2):1599-1602.
The reaction of octenylsuccinic anhydride (OSA) with a mixture of granular waxy maize starch and soluble maltodextrin was investigated. OSA was reacted with a 1:1 (w/w) mixture of the granular starch and maltodextrin at OSA levels of 1.5, 3, 9, and 15% (wt% based on starch weight). After the first 0.5 h of the reaction, degree of substitution (DS) on maltodextrin reached 0.021, 0.030, 0.080, and 0.10 for 1.5, 3, 9, and 15% OSA, respectively, whereas DS for granular starch was only 0.0020, 0.0087, 0.014, and 0.016. At 2 h of the reaction, the bound OS ratio of maltodextrin to granular starch was 10.8 when OSA concentration was 1.5% and the ratio decreased to ca. 5 at higher OSA concentrations. OSA preferred to react with maltodextrin than semi-crystalline granular starch when both existed in the system. OSA reacted with maltodextrin at a much faster rate and to a greater extent than with granular starch, but a significant amount of OSA reacted with granular starch at 3–15% OSA concentrations.
Contact: Dr. Yong-Cheng Shi (ycshi@ksu.edu)

Efficacy of fixed bed ozonation treatment to control insects in stored bulk grain. 2013.

Authors: **Carlos Campabadal, Dirk Maier,** Linda Mason.
Published in: Applied Engineering in Agriculture, 29(5):693-704.
Scale-up demonstration trials were conducted at the pilot bin facility of the Purdue University Post-Harvest Education and Research Center in June 2005, August 2006, July 2007, and October 2008 with conventional yellow maize and at a popcorn storage facility in July 2005 and 2006. The primary objective of these trials was to determine the efficacy of ozonation to control insect pests without affecting end-use quality. The setup consisted of generating ozone at a constant rate with commercially available generators, introduction in the headspace, drawdown to the plenum with a fan with a minimum air velocity through the grain of 0.03 m/s, re-circulation back into the headspace or exhausting from the plenum into another bin. Ozonation was done to attain an ozone concentration of 50 ppm in the plenum to be maintained for a period of 72 h (3,600 ppm-h). When this concentration was not achieved, an ozone concentration-time product of 3,600 ppm-h was aimed for extending the time to expose the grain mass to the same treatment effect to achieve 100% insect mortality. The trials were performed using insect bioassays with adults of maize weevil (MW) and red flour beetle (RFB). Insect mortality was essentially 100% for both MW and RFB. The concept of two phases of ozonation and the airflow rates needed to achieve the required treatment levels of 3,600 ppm-h were investigated. The trials at the popcorn facility confirmed that end-use parameters of popcorn were not affected.
Contact: Dr. Carlos Campabadal (campa@ksu.edu)

High-soy, fishmeal-free diets support Florida pompano growth. 2013.

Authors: Melanie Rhodes, Terry Hanson, **Sajid Alavi**, D. Allen Davis.
Published in: Global Aquaculture Advocate, Sept-Oct 2013:100-103.
The authors have achieved good growth using a fishmeal-free diet for the carnivorous marine fish Florida pompano. In studies, they used pompano as a model marine species in a cost/benefit analysis of two extruded diets. Growth performance was similar for fish fed either fishmeal- or soy-based diets. The soy-based diet supplemented with taurine was a less-expensive feed formulation, and the overall cost per unit fish was less than when using the traditional diet containing fishmeal. Contact: Dr. Sajid Alavi (salavi@ksu.edu)

Utilization of sorghum lignin to improve adhesion strength of soy protein adhesives on wood veneer. 2013.

Authors: Zhigang Xiao, **Yonghui Li,** Xiaorong Wu, **Guangyan Qi,** Ningbo Li, Ke Zhang, Donghai Wang, **X. Susan Sun**.
Published in: Industrial Crops and Products, 50:501-509.
Features of sorghum lignin (SL) and extruded sorghum lignin (ESL) were examined. Adhesion properties of lignin (SL or ESL) blended soy protein adhesives (SPA) based on soy protein isolates (SPI) or modified soy protein (MSP) were also investigated, respectively. Both SL and ESL exhibited similar softening temperature at around 112 °C; however, the softening enthalpy of ESL was much larger than that of SL. The thermal stability of lignin was significantly improved through the extrusion process. The ratio of relative absorbance for free OH groups to the bands at 1510 cm^{-1} and 1600 cm^{-1} went from 0.55 and 0.54 in SL to 0.74 and 0.66 in ESL; carbonyl groups went from 0.81 and 0.80 in SL to 1.08 and 0.96 in ESL. Extrusion changed the microstructure of SL from large masses to small irregular particles. The shear strength and water resistance of lignin (SL or ESL)-blended SPAs (SPI based) on wood veneer joints were obviously improved.
Contact: Dr. X. Susan Sun (xss@ksu.edu)

Adhesion and physicochemical properties of soy protein modified by sodium bisulfite. 2013.

Authors: **Guangyan Qi,** Ningbo Li, Donghai Wang**, X. Susan Sun.**
Published in: Journal of American Oil Chemistry, 90(12): 1917-1926.
Soy protein adhesives with a high solid content (28–39 %) were extracted from soy flour slurry modified with sodium bisulfite ($NaHSO_3$) at different concentrations. 11S-dominated soy protein fractions (SP 5.4) and 7S-dominated soy protein fractions (SP 4.5) were precipitated at pH 5.4 and pH 4.5, respectively. The objective of this work was to study the effects of $NaHSO_3$ on adhesion and physicochemical properties of soy protein. The adhesion performance of $NaHSO_3$-modified SP 4.5 was better than SP 5.4; the wet strength of these two fractions was from 2.5 to 3.2 MPa compared with 1.6 MPa of control soy protein isolate. SDS-PAGE results revealed the reducing effects of $NaHSO_3$ on soy protein. The isoelectric pH of soy protein decreased as $NaHSO_3$ increased due to the induced extra negative charges ($RS\text{-}SO_3^-$) on the protein surface. The rheological properties of soy protein adhesives were improved significantly. Unmodified samples SP 5.4 and SP 4.5 had clay-like properties and extremely high viscosity, respectively; with 2–8 g/L $NaHSO_3$ modification, both SP 5.4 and SP 4.5 had a viscous cohesive phase with good flowability. Overall, $NaHSO_3$-modified soy protein adhesives in our study have many advantages over the traditional soy protein isolate adhesive such as better adhesion performance, higher solid content but with good flowability and longer shelf life.
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