Preparation and structure of Octenyl succinic anhydride modified waxy maize starch, microporous starch and maltodextrin

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Abstract: Octenyl succinic anhydride (OSA) modified starch is widely used in emulsion and encapsulation applications. The functionality of OS starch depends on its molecular structure. A systematic study was performed to investigate the reaction of OSA with granular waxy maize (WM) starch, microporous WM starch and soluble maltodextrin. OS starches were prepared in an aqueous slurry system, and the degree of substitution (DS) of OS starches was determined by titration and [superscript]1H-NMR spectroscopy. For both 3% and 50% OSA treatment, OS maltodextrin had higher DS and reaction efficiency (RE) than OSA modified WM starch and microporous WM starch. The maximum DS of OSA modified granular WM starch was 0.14 and the highest DS of OS maltodextrin was 0.27. For the 3% OSA treatment, the RE for WM starch and maltodextrin was ~80% and ~100%, respectively. The structure of OSA modified WM starch and the locations of OS groups on anhydroglucose units (AGUs) were studied by [superscript]1H-NMR and [superscript]13C-NMR. As increasing OS substitution, [superscript]13C - signal at C-1 shifted to upper field. In addition, the [superscript]13C - signal at C-6 shifted to downfield when DS reached 0.073. The results suggested that OS groups were predominantly substituted at the O-2 position and started being substituted at O-6 position when DS was 0.073. FT-IR microspectroscopy was used to detect the heterogeneity OS starch products. Native WM starch, OSA modified WM starches (DS=0.019 and 0.073) and a starch blend with native starch to OSA modified WM starch (DS=0.073) ratio of 7:3 were examined. More than one hundred starch granules of each sample were analyzed one by one by FT-IR microspectroscopy. For the OS starch (DS=0.019), 7% starch granules showed carbonyl absorption. For the OS starch (DS=0.073), 99% starch granules showed carbonyl absorption but the intensity varied, indicating that OSA reacted with most starch granules when DS was 0.073. However, the OS contents of individual granules varied. For the starch blend,
only 30% starch granules had carbonyl absorption. FT-IR microspectroscopy is a useful tool to detect heterogeneity of OS starch blends containing native starch.

Physicochemical, morphological, and adhesion properties of sodium bisulfite modified soy protein components

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Abstract: Soybean protein modified with sodium bisulfite behaves like latex adhesives, with adhesive strength comparable to formaldehyde-based adhesives. β-conglycinin and glycinin are two major protein components of the adhesive system. The objective of this research was to investigate the effect of sodium bisulfite on the physicochemical, morphological, and adhesion properties of glycinin and β-conglycinin in order to better understand the function of glycinin and β-conglycinin in the formation of the soy latex adhesive. Sodium bisulfite broke the disulfide bonds that linked acidic and basic polypeptides of glycinin, and the reducing effect was enhanced with increasing sodium bisulfite concentration. Although cleavage of disulfide bonds was expected to destabilize proteins, the thermal stability of glycinin increased as the sodium bisulfite concentration increased. Sodium bisulfite modified glycinin had higher surface hydrophobicity, which facilitated hydrophobic interactions between molecules and aggregation of glycinin. The balance between hydrophobic interactions and electrostatic forces makes glycinin form unique chain-like structures. Adhesive performance of glycinin dropped significantly at lower sodium bisulfite concentration and then increased as sodium bisulfite concentration increased up to 24 g/L. Excess sodium bisulfite was detrimental to adhesive strength and water resistance. High-molecular-weight aggregates were observed in unmodified β-conglycinin, but these aggregates were dissociated by sodium bisulfite treatment. Similar to glycinin, the thermal stability of β-conglycinin was improved by the modification. However, the denaturation enthalpy of β-conglycinin decreased significantly at
high level of sodium bisulfite (36 g/L). The turbidity at pH 4.8 also dropped extensively at the concentration of 36 g/L. The contact angle of β-conglycinin reached its minimum at 6 g/L sodium bisulfite on cherry wood and 24 g/L on glass. Morphology study proved that sodium bisulfite modification made the β-conglycinin solution more dispersed. At pH 9.5, water resistance of β-conglycinin was improved to a small extent by 6 g/L sodium bisulfite. At pH 4.8, adhesive performance was enhanced by 3 g/L and 6 g/L sodium bisulfite. High level of sodium bisulfite at 36 g/L reduced the adhesive performance of β-conglycinin drastically.

Wet-milling of waxy wheat flours and characteristics of waxy wheat starch

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Abstract: Waxy wheat starch contains almost all amylopectin and is relatively new. Currently, advanced lines of hard winter waxy wheats are being bred through genetic elimination of waxy proteins. To realize the full potential of waxy wheat, the wet-milling of waxy wheat flour to produce gluten and waxy wheat starch was investigated. Flours of six advanced lines of waxy hard wheats and two normal hard wheats cultivars, Karl '92 and Trego, were fractioned by the dough-washing method. Doughs prepared from the waxy flours were found to be weaker than those of from normal wheats. All the waxy wheat and normal wheat flours were wet-milled by the dough-washing (Martin) process and the yield and recovery of starch and gluten were compared. One waxy wheat flour, NWX02Y2459, was sticky during the early stages of dough washing, and it gave relatively poor gluten and starch recoveries with low purity. By mixing the dough with 2% NaCl solution or by adding hemicellulase, the stickiness of the dough subsided during the washing step, and thereby recoveries of the gluten and starch fractions were improved. Waxy wheat starch offers unique functional properties. Waxy wheat starches gelatinize and cook at a relatively low temperature compared to maize starches, and their pastes retrograde more slowly and to a lower extent than
waxy maize starch. Pasting curves showed that waxy wheat starch generated a much higher viscosity at a lower temperature, and a lower setback viscosity than normal wheat starch and waxy maize starch. Changes in the morphology of waxy and normal wheat starch granules were determined by using a hot-stage microscope, and those changes were related to their pasting properties. After waxy wheat starch was cross-linked in an aqueous slurry at about 37% starch solids with 0.01% phosphoryl chloride (starch basis), visco-amylograms showed that viscosity breakdown was eliminated and that the cooked paste became non-cohesive (less "stringy"). Increasing levels of phosphoryl chloride at 0.03% and 0.06% caused a steady decline in the peak and final paste consistencies of cross-linked waxy wheat starch, whereas the consistencies of waxy maize starch proceeded through an optimum. Waxy maize starch cross-linked with 0.03% phosphoryl chloride had a higher peak and final consistency at 7% solids than when cross-linked with 0.01% and 0.06% phosphoryl chloride.

In vitro digestibility of starch in sorghum differing in endosperm hardness and flour particle size

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Abstract: In vitro digestibility of starch in sorghum grains differing in endosperm hardness and flour particle size was assayed by an Englyst resistant starch (RS) method. The starch digestibility increased as the particle size of flour decreased, but no significant difference in starch digestibility was observed among sorghum flours milled from grains with different hardness. To further understand the digestion of starch in sorghum, the effects of protein on starch digestion and amylose content in starch were determined. pH value was a factor affecting protein digestion since protein digestibility was higher at pH 2.0 than that at pH 1.3. Protein hydrolysis increased with time of pepsin treatment, leading to an increased starch digestion. RS content was 10.61-29.54% in native sorghum flours and 8.47-26.28% in isolated sorghum starch. The amounts of [Gamma]-kafirins extracted increased with time of pepsin treatment while [Alpha]- and [Beta]-kafirins decreased. The starch in sorghum flour with median
hardness had a higher amyllose content (23.9%) than the starch in hard and soft flours (~21%), which gave lower starch digestibility. Protein digestibility decreased after cooking while starch digestibility increased. Sulfhydryl groups decreased after cooking, indicating that disulfide bonds formed between protein molecules and may have formed a barrier for enzymes to access and digest starch. Confocal laser scanning microscopy (CLSM) showed that the protein matrix was less evident after pepsin treatment. As a result, starch digestion increased after protein matrix was removed.

The effects of DDGS inclusion on pellet quality and pelleting performance

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Abstract: Three experiments were conducted to evaluate the effects of distillers dried grains with solubles (DDGS) on pellet quality and pellet mill performance in pelleted swine diets. The experiments were completed at the Feed Processing Research Center in the Department of Grain Science at Kansas State University. In all experiments, pellet durability index (PDI), electrical energy consumption, production rate, and bulk density served as the response criteria. In Exp. 1, DDGS were substituted on an equal weight basis for corn, with substitution levels of 10%, 20%, 30%, and 40%. The diet was not adjusted to maintain equal nutrient levels across the treatments. There were no observed significant differences in pellet quality across all levels of DDGS substitution. Both production rate and bulk density were significantly lowered as DDGS level increased. In Exp. 2, diets were formulated to contain the same levels of DDGS, but all ingredients were allowed to vary to retain nutritionally similar diets. In this case energy consumption showed no significant differences among treatments, while pellet quality, throughput, and bulk density were all negatively affected by increasing levels of DDGS. In Exp. 3, the effect of incorporating pelleted and reground DDGS was evaluated. The levels of DDGS evaluated were 10%, 20%, and 30%, using the same diets as Exp. 2. These diets were then pelleted and compared to a control diet with no added DDGS and to diets with unprocessed DDGS added at the
same levels. At levels above 10% the diets containing unprocessed DDGS had significantly lower pellet quality than the control, while the diets containing pelleted and reground DDGS showed no significant difference from the control at any level. Significant effects were also observed for production rate, energy consumption, and bulk density. In conclusion, the use of standard DDGS in pelleted feeds is feasible, and although pellet quality may be significantly lower for feeds containing DDGS, the practical value is likely not affected. Furthermore, the data demonstrates some benefits of using DDGS that have been pelleted and reground.

The effect of tracers’ physical properties on retention time measurements inside the conditioner of a pellet mill

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Abstract: The effect of tracer particle size on the accuracy of measuring retention time inside the conditioner of a pellet mill was studied. Three experiments were conducted using tracers with different particle sizes. The control retention time was calculated using the hold-up capacity method, while retention times for treatments were calculated using the pulse-input method. In addition to the previously prepared tracers, crystalline salt and powder color dye were used as tracers in this study to represent small particle tracers. In experiment one, large, medium, and small tracers were used. The treatment with large particle size was closer to the control with differences around 1.5%. Conversely, using the tracer with small particle size resulted in larger differences, approximately 18%. Two tracers were used in experiment two, resulted in 33% difference between treatment and control using a small particle size tracer, and a 10% difference using a tracer with similar particle size to the main materials. A tracer similar in particle size to the materials flowing inside the conditioner was used in the third experiment in addition to the salt and dye. Statistical analyses for this experiment indicated that particle size affects the accuracy of retention time measurements. There was a significant difference (P<0.05) in the comparison between salt and red color dye in
treatment two, while there was no significant difference ($P > 0.05$) between them in treatment one (same particle size). Moreover, in another comparison of the differences between treatments and their related controls, there was significant difference ($P < 0.05$). However, the $P$-value for the red dye comparison (0.0126) was higher than that of salt (0.0026), which adds density as another influential factor that affects retention time measurement.

Susceptibility of Lasioderma serricorne (F.) life stages exposed to elevated temperatures

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Abstract: Heat treatment of food-processing facilities involves using elevated temperatures (46 to 60°C for 24 h) for management of stored-product insects. Heat treatment is a viable alternative to the fumigant methyl bromide, which is phased out in the United States as of 2005 because of its adverse effects on the stratospheric ozone. However, very little is known about responses of the cigarette beetle, Lasioderma serricorne (F.), a pest associated with food-processing facilities, to elevated temperatures. The main objective of my research was to evaluate stage-specific susceptibility of L. serricorne to elevated temperatures to identify the most heat tolerant stage. In the laboratory, I found L. serricorne was able to develop on ground, pelleted feed at 28°C and 65% RH; however, there is no data on the biology of this species on this diet. Therefore, several life history parameters of L. serricorne were studied on ground, pelleted feed at 28°C and 65% RH, to facilitate harvesting stages of specific ages in large numbers for assays with elevated temperatures. The mean duration for eggs was 8.1 d, and the mean egg survivorship was 92.0%. There were four discrete instars, and the mean durations of first, second, third, and fourth instars were 4.7, 4.5, 4.7, 11.8 d, respectively. The survivorship of first through third instars was about 99%, whereas that of fourth instars was 85%. The mean pupal duration was 4.6 d, and pupal survivorship was 98%. Newly eclosed unmated female adults lived 5 d longer than unmated males (29 d), whereas, mated males lived 6 d longer than mated females (17 d). Mated females started laying eggs on the third day after emergence and continued
this activity for an additional six to eight days. Females, on average, laid 105 eggs with a mean daily output of 12 eggs. The data reported here provide new information on the biology of *L. serricorne* on ground, pelleted feed, which appears to be an optimal diet for mass rearing this species. Exposure of eggs, young larvae (3 to 4- July 2007 did not clearly show which of the life stages was heat-tolerant. However, exposure of all life stages to fixed times at 46, 50 and 54°C and 25% RH in the laboratory indicated eggs to be the most heat-tolerant stage. Time-mortality responses, at each of these three old), old larvae (20 to 21-old), and adults during heat treatment of a food-processing facility in 20-22 temperatures, showed that the time for 99% mortality (LT99) based on egg hatchability and egg-to-adult emergence was not significantly different at each temperature. The LT99 based on egg hatchability at 46°C was 605 min and it decreased to 190 min at 50°C and 39 min at 54°C. Therefore, during structural heat treatments eggs should be used in bioassays for gauging heat treatment effectiveness, because treatments aimed at controlling the egg stage should control all other life stages of *L. serricorne*.

Evaluating flushing procedures to prevent drug carryover during medicated feed manufacturing

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**Abstract:** Carryover of medicated feed additives between batches of feed can potentially result in harmful drug residues in the edible tissues of food-animals. Flushing the equipment with an ingredient, such as ground grain, is one method used to remove any residual medicated feed from the system. It is generally recommended that the quantity of flush used be between 5 and 10% of the mixer's capacity. However, there is little data that supports this recommendation. Therefore, two experiments were conducted to 1.) determine which manufacturing equipment is the major source of carryover, 2.) evaluate which flush size adequately prevents drug carryover, and 3.) quantify the interrelationship between flush size and drug concentration. In Experiment 1, feed medicated with nicarbazin (Nicarb 25%®; 0.0125%) was manufactured and conveyed from the mixer, through a drag conveyor and bucket elevator, and then into a finished product bin. The system was then flushed using ground corn in the amount of 2.5, 5, 10, 15, or
20% of the mixer’s capacity (454.5 kg). Subsequently, a non-
medicated diet was conveyed through the system and samples
were collected and analyzed for nicarbazin. No significant (P >
0.05) differences were detected among the flush treatments, and
all treatments were effective in preventing nicarbazin carryover to
the non-medicated diet. In Experiment 2, feed medicated with
three levels of monensin (Rumensin® 80; 100, 600, and 1,200
g/ton) was manufactured and handled in the same manner as in
Experiment 1. The flushing treatments examined were: 1, 2.5, and
5% of the mixer’s capacity. Samples of the non-medicated diet for
each treatment were collected and analyzed for monensin. There
was significant interaction (P < 0.05) between drug level and
sampling location between treatments. As the drug level in the
medicated diet increased, higher concentrations of monensin were
detected in the non-medicated diet. Collectively, these studies
demonstrate that a 2.5%, even a 1% flush size, is effective in
preventing carryover of medicated feed additives. It was also
demonstrated that the bucket elevator and finished product bin
were the major sources of drug carryover in this particular feed
manufacturing system.

Variation in single kernel
hardness within the wheat
spike

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Abstract: Variation in wheat kernel hardness is influenced by several factors
including genetic expression and environmental conditions. However,
these factors explain only a portion of the observed variation. Thus,
there are unknown contributors to this important physical property. The
following experiments investigated growing locations between farms and
within the spike as a source of variation. Four commercial varieties of
Hard Red Winter (HRW) wheat were chosen for evaluation; Jagger,
Jagalene, Overley, and 2137. In total, 374 wheat spikes were collected
from three farms participating in the Kansas State University Research
and Extension-2007 Crop Performance Tests (KSCPT). For analyses,
each kernel was removed and cataloged by spikelet and floret position.
A total of 10,240 kernels were uniquely identified by variety, farm, plot,
spike, spikelet, and floret position. Using the single kernel
characterization system (SKCS), kernels were crushed to determine the
hardness, diameter, weight, and moisture content. The variability of
each measured attribute was greatest between spikes of a given variety. Measured attributes exist in gradients along the spike, with the top and bottom portions being most variable. This research broadens our knowledge of wheat kernel variation, and results from this experiment may contribute to improved methods for single kernel analysis.