

June 15, 2005

Volume XIX No. 2

**XIX 8-05      INHIBITION OF PENICILLIUM COMMUNE BY EDIBLE WHEY PROTEIN FILMS INCORPORATING LACTOFERRIN, LACTO-FERRIN HYDROLYSATE, AND LACTOPEROXIDASE SYSTEMS**

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J. Food Sci. 70(2): 87. 2005.

Effects of lactoferrin (LF), lactoferrin hydrolysate (LFH), and lactoperoxidase systems (LPOS), both directly and incorporated into edible whey protein isolate (WPI) films, on the inhibition of *Penicillium commune* were studied. Mechanical, oxygen-barrier, and color properties of WPI films with and without LPOS were also compared. Antimicrobial effects were examined by turbidity, disc diameter, surface spreading, and film surface inoculation tests. Film elastic modulus, tensile strength, percent elongation, oxygen permeability, and Hunter L, a, and b values were tested. LF and LFH at 10 mg/mL or higher inhibited *P. commune* in 1% peptone water but not in potato dextrose broth. WPI films incorporating LPOS inhibited growth of *P. commune*. The properties of WPI films were not significantly changed by incorporation of LPOS ( $P > 0.05$ ).

**XIX 9-05      MECHANICAL PROPERTIES OF HEAT-CURED WHEY PROTEIN-BASED EDIBLE FILMS COMPARED WITH COLLAGEN CASINGS UNDER SAUSAGE MANUFACTURING CONDITIONS.**

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J. Food Sci. 70(2):131. 2005.

Edible films were produced using whey protein isolate (WPI) (5%, w/v), glycerol (3.3%, w/v) and candelilla wax (0.8%, w/v). One set of films was heat cured at 90 °C for 12 h and another at 80 °C for 24 h. WPI-based films, together with collagen films, were put through a meat-processing scheme typical of Polish sausage manufacture. Meat-processing conditions were stage 1: 57 °C/60 min/36% RH; stage 2: 65 °C/90 min/60% RH; and stage 3: 77 °C/30 min/80% RH. Effects of meat-processing conditions on mechanical properties: tensile strength (TS), elongation (%E), and apparent modulus (AM) were determined. All films remained intact throughout the process. TS, %E, and AM of collagen films did not change during the multistage cooking process. The %E of heat-cured WPI films was similar to that of collagen films and also did not change during the cooking stages. The TS and AM of both heat-cured WPI-based films were initially lower than collagen films and continued to decline during the cooking stages. TS and AM of both films at the end of cooking were lower ( $P < 0.05$ ) than films that did not go through the

multistage cooking process.

**XIX 10-05    SENSORY TEXTURE AND MECHANICAL PROPERTIES OF STRANDED AND PARTICULATE WHEY PROTEIN EMULSION GELS**

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J. Food Sci. 69(9): 333. 2004.

The influence of gel structure type and amount of lipid on texture of whey protein isolate (WPI) gels was evaluated by descriptive sensory analysis and determination of fracture and water-holding properties. A series of 16 gels of varying structure (particulate or stranded) and lipid composition (0% to 20%) were developed at a constant protein concentration (12% w/v). Stranded gels had higher values for fracture strain, strain hardening, and held-water. Particulate and stranded gels were similar in fracture stress. Eighteen sensory texture attributes were used to evaluate gels throughout the mastication process that was separated by the following phases: prefracture, 1st bite, chew-down, and preswallowing. The 1st bite property of firmness and preswallowing properties of number of chews and time to swallow were the only sensory properties associated with lipid content. Fracture stress was correlated with these properties. The remaining 15 texture terms were primarily determined by gel structure type. It appears that gel structure type determines the primary texture properties of WPI emulsion gels. An increase in lipid content increases gel firmness and amount of chews required; however, it did not change the primary texture sensation.

**XIX 11-05    MELT ANALYSIS OF PROCESS CHEESE SPREAD OR PRODUCT USING A RAPID VISCO ANALYZER**

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J. of Dairy Sci. 88(4): 1277. 2005.

The objective of this study was to evaluate a rapid visco analyzer (RVA) method for measuring the melting characteristics of process cheese spread or product. The melt properties of 32 commercial process cheese spread and process cheese product samples from 4 manufacturers were analyzed with the RVA, tube melt test, texture profile analysis (TPA) hardness, and dynamic stress rheometry (DSR). For the RVA melt test, a 15-g disc of cheese was packed into the RVA canister and subjected to a heating, holding, and cooling profile during continuous mixing. During the test, the apparent viscosity was continuously measured and several data points (melt time, hot viscosity, time at 5000 cP during cooling, and solidification time) were collected from the viscosity vs. time curve. There was a high correlation ( $R^2 = 0.91$ ) between the DSR melt temperature and the tube melt test. There was also a high correlation between the RVA melt time and the DSR melt temperature or the tube melt test ( $R^2 = 0.84$  and  $0.74$ , respectively). The RVA hot viscosity had a low correlation ( $R^2 < 0.44$ ) with the DSR melt temperature and the tube melt test but had a high correlation ( $R^2 = 0.74$ ) with DSR  $G''$  at  $85^\circ\text{C}$ . The results of this study indicate that RVA melt analysis of process cheese spread/product is correlated with the results from other melt tests

and is capable of measuring the melt properties quantified by other methods. The RVA melt test may also provide additional information on the melt characteristics of process cheese spread/product not measured in other tests.

#### **XIX 12-05 RATE OF MAILLARD BROWNING IN SWEET WHEY POWDER**

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J. of Dairy Sci. 88(5): 1636. 2005.

The objective was to evaluate the rate of Maillard browning in 3 commercial sweet whey powders (WC1, WC2, and MW1), under accelerated shelf-life testing (ASLT) and under normal storage conditions (21°C and 35% RH). Rate of brown pigment formation (k) obtained from short-term ASLT of whey powder was compared with actual findings obtained from the long-term shelf-life testing under normal conditions. Deterioration by Maillard browning, measured by spectrophotometer, was compared with changes in color (Hunter Laboratory), free moisture, titratable acidity, and sensory attributes. Results suggest that estimated k (from ASLT) was comparable with the observed rate (obtained at ambient temperature) for 2 producers (WC1, MW1). The actual k values observed for samples WC1, WC2, and MW1, stored under normal conditions, were 0.0031, 0.0080, and 0.0148 color units/g of solid per mo, respectively. The estimated values of k for samples WC1, WC2, and MW1 were 1.12, 4.90, and 1.35 times more than the observed values, respectively. The Q10 values (increase in reaction rate for a 10°C temperature increase) ranged from 1.77 to 4.14, and the activation energies ranged from 15.9 to 28.4 kcal/mol. Hunter Laboratory values L\* and a\* appeared most sensitive to changes during storage. Free moisture content, and acidity increased significantly with storage. However, no significant changes were detected by the sensory panel in the attributes considered.

#### **XIX 13-05 STORAGE STABILITY OF LUTEIN DURING RIPENING OF CHEDDAR CHEESE**

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J. of Dairy Sci. 88(5): 1661. 2005.

Lutein (3,3'-dihydroxy- $\alpha$ -carotene) has been identified as a dietary factor that can delay the onset of age-related macular degeneration (AMD). However, available food sources of lutein contain only modest amounts of the carotenoid. Food fortification with lutein extract has been identified as a low-budget approach to prevent the onset or progression of AMD. The objectives of this study were to 1) incorporate various amounts of lutein into Cheddar cheese; 2) examine the color, pH, microbiological, and sensory characteristics of the Cheddar cheese during storage; and 3) analyze the stability of lutein during the cheese maturation process. Lutein extracted from corn was added to Cheddar cheese in quantities of 1, 3, and 6 mg per serving size. Measurements of the lutein stability were carried out by HPLC using a YMC C30 carotenoid column. Microbiological analyses of cheese samples included aerobic plate count, coliform, and yeast/mold counts. The color attributes a\* and b\* were significantly different between the treatment and control groups; however, no significant difference was observed in L\* value and pH. Significant differ-

ences among 1, 3, and 6 mg lutein-enriched cheeses were observed in the aerobic plate count and yeast/mold compared with the control. Cheese samples contained no detectable levels of coliforms (<10 cfu/g). The HPLC data showed quantitative recovery of lutein during the storage period, and no lutein degradation products were identified. These results indicate that lutein, a functional additive with purported ability to prevent or reduce the onset of AMD, can be incorporated into cheese adding value to this product.

**XIX 14-05    A MICROFILTRATION PROCESS TO MAXIMIZE REMOVAL OF SERUM PROTEINS FROM SKIM MILK BEFORE CHEESE MAKING**

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J. of Dairy Sci. 88(5): 1661. 2005.

Microfiltration (MF) is a membrane process that can separate casein micelles from milk serum proteins (SP), mainly  $\beta$ -lactoglobulin and  $\alpha$ -lactalbumin. Our objective was to develop a multistage MF process to remove a high percentage of SP from skim milk while producing a low concentration factor retentate from microfiltration (RMF) with concentrations of soluble minerals, nonprotein nitrogen (NPN), and lactose similar to the original skim milk. The RMF could be blended with cream to standardize milk for traditional Cheddar cheese making. Permeate from ultrafiltration (PUF) obtained from the ultrafiltration (UF) of permeate from MF (PMF) of skim milk was successfully used as a diafiltrant to remove SP from skim milk before cheese making, while maintaining the concentration of lactose, NPN, and nonmicellar calcium. About 95% of the SP originally in skim milk was removed by combining one 3x MF stage and two 3x PUF diafiltration stages. The final 3x RMF can be diluted with PUF to the desired concentration of casein for traditional cheese making. The PMF from the skim milk was concentrated in a UF system to yield an SP concentrate with protein content similar to a whey protein concentrate, but without residuals from cheese making (i.e., rennet, culture, color, and lactic acid) that can produce undesirable functional and sensory characteristics in whey products. Additional processing steps to this 3-stage MF process for SP removal are discussed to produce an MF skim retentate for a continuous cottage cheese manufacturing process.