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XVIII 26-04 IMPACT OF MILK PREACIDIFICATION WITH CO2 ON CHEDDAR CHEESE COMPOSITION AND YIELD

B. K. Nelson, J. M. Lynch and D. M. Barbano
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Preacidification of milk for cheese making may have a beneficial impact on increasing proteolysis during cheese aging. Unlike other acids, CO2 can easily be removed from whey. The objectives of this work were to determine the effect of milk preacidification on Cheddar cheese composition, the recovery of individual milk components, and yield. Carbon dioxide was injected inline after the cooling section of the pasteurizer. Cheeses with and without added CO2 were made simultaneously from the same batch of milk. This procedure was replicated 3 times. Carbon dioxide in the cheese milk was about 1600 ppm, which resulted in a milk pH of about 5.9 at 31°C. The starter culture and coagulant addition rates were the same for both the CO2 treatment and the control. The whey pH at draining of the CO2 treatment was lower than the control. Total make time was shorter for the CO2 treatment compared with the control. Cheese manufactured from milk acidified with CO2 retained less of the total calcium and fat than the control cheese. The higher fat loss was primarily in the whey at draining. Preacidification with CO2 did not alter the crude protein recovery in the cheese. The CO2 treatment resulted in a higher added salt recovery in the cheese and produced a cheese that contained too much salt. Considering the higher added salt retention, the salt application rate could be lowered to achieve a typical cheese salt content. Cheese yield efficiency of the CO2 treated milk was 4.4% lower than the control due to fat loss. Future work will focus on modifying the make procedure to achieve a normal fat loss into the whey when CO2 is added to milk.

XVIII 27-04 IMPACT OF MILK PREACIDIFICATION WITH CO2 ON THE AGING AND ROTEOLYSIS OF CHEDDAR CHEESE

B. K. Nelson, J. M. Lynch and D. M. Barbano
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To determine the influence of milk preacidification with CO2 on Cheddar cheese aging and proteolysis, cheese was manufactured from milk with and without added CO2. The experiment was replicated 3 times. Carbon dioxide (approximately 1600 ppm) was added to the cold milk, resulting in a milk pH of 5.9 at 31°C in the cheese vat. The starter and coagulant usage rates were equal for the control and CO_2 treatment cheeses. The calcium content of the CO_2 treatment cheese was lower, but no difference in moisture content was detected. The higher CO_2 content of the treatment cheeses (337 vs. 124 ppm) was maintained throughout 6 mo of aging. In spite of having almost one and a half times the salt-in-moisture, proteolysis as measured by pH 4.6 and 12% trichloroacetic acid soluble nitrogen expressed as percentages of total nitrogen, was higher in the CO_2 treatment cheeses throughout aging. The ratio of αs-casein (CN) to para-α-CN decreased faster in the CO_2 treatment cheeses than in the control cheeses, especially before refrigerated storage. No difference was detected in the ratio of ß-CN to para-α-CN between the control and CO_2 treatment cheeses. Intact αs- and ß-CN were found in the expressible serum (ES) from the CO_2 treatment cheese as well as αs1-I-CN, but they were not detected in the ES from the control cheese. No CN was detected in the ES from the curd before the salting of either the control or CO_2 treatment cheese. Higher proteolysis in the cheese made from milk preacidified with CO_2 may have been due to increased substrate availability in the water phase or increased chymosin activity or retention in the cheese.

XVIII 28-04 VATLESS MANUFACTURING OF LOW-MOISTURE PART-SKIM MOZZARELLA CHEESE FROM HIGHLY CONCENTRATED SKIM MILK MICROFILTRATION RETENTATES

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Low-moisture, part-skim (LMPS) Mozzarella cheeses were made from concentration factor (CF) 6, 7, 8, and 9, pH 6.0 skim milk microfiltration (MF) retentates using a vatless cheese-making process. The compositional and proteolytic effects of cheese made from 4 CF retentates were evaluated as well as their functional properties (meltability and stretchability). Pasteurized skim milk was microfiltered using a 0.1-µm ceramic membrane at 50°C to a retentate CF of 6, 7, 8, and 9. An appropriate amount of cream was added to achieve a constant casein:fat ratio in the 4 cheesemilks. The ratio of rennet to casein was also kept constant in the 4 cheesemilks. The compositional characteristics of the cheeses made from MF retentates did not vary with retentate CF and were within the legal range for LMPS Mozzarella cheese. The observed reduction in whey drained was greater than 90% in the cheese making from the 4 CF retentates studied. The development of proteolytic and functional characteristics was slower in the MF cheeses than in the commercial samples that were used for comparison due to the absence of starter culture, the lower level of rennet used, and the inhibition of cheese proteolysis due to the inhibitory effect of residual whey proteins retained in the MF retentates, particularly high molecular weight fractions.

XVIII 29-04 ISOLATION AND CHARACTERIZATION OF COPOLYMERS OF ß-LACTOGLOBULIN, α-LACTALBUMIN, κ-CASEIN, AND αS1-CASEIN GENERATED BY PRESSURIZATION AND THERMAL TREATMENT OF RAW MILK

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Raw skim milk was submitted to high pressure (300 to 600 MPa) and temperature (4 to 70°C) treatments for 2 or 5 min. The combined effects of pressure and temperature on milk proteins induced structural changes and polymer and copolymer formation characterized by anion-exchange and size-exclusion fast protein liquid chromatography and electrophoretic techniques. Approximately half of the ß-lactoglobulin formed polymers, and the other half formed large copolymers, mainly with α-casein, α-lactalbumin via intermolecular disulfide bond exchange, and αs1-casein via physicochemical interactions, in proportions of 1.0:0.7:0.3:0.1, respectively. Minor whey proteins (serum albumin, immunoglobulins, and lactoferrin) also participated in the formation of the copolymers but to a lesser extent. Two populations of the copolymers were found with apparent molecular masses ranging from 440 to 2000 kDa for the first and more than 2000 kDa for the second. On the contrary, for heated milks the aggregation kinetics obtained by combination of high pressure and thermal treatment were very fast, as no intermediates such as dimers and small size oligomers were observed after pressurization, whatever the temperature studied. Lactosylation of proteins as well as proteolysis were very limited. A ß-casein amino-terminal peptide of 22 kDa was specifically recovered in milk samples treated under the more drastic conditions (500 MPa/55°C per 5 min and 600 MPa/70°C per 5 min) and might have been generated by neutral proteases such as elastase released from somatic cells present in milk. No casein was released from the micelle whatever the combination of high pressure and temperature studied.

XVIII 30-04 COMPARISON OF EFFECT OF VACUUM-CONDENSED AND ULTRAFILTERED MILK ON CHEDDAR CHEESE

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The objective was to compare the effects of vacuum-condensed (CM) and ultrafiltered (UF) milk on some compositional and functional properties of Cheddar cheese. Five treatments were designed to have 2 levels of concentration (4.5 and 6.0% protein) from vacuum-condensed milk (CM1 and CM2) and ultrafiltered milk (UF1 and UF2) along with a 3.2% protein control. The samples were analyzed for fat, protein, ash, calcium, and salt contents at 1 wk. Moisture content, soluble protein, meltability, sodium dodecyl sulfate-PAGE, and counts of lactic acid bacteria and nonstarter lactic acid bacteria were performed on samples at 1, 18, and 30 wk. At 1 wk, the moisture content ranged from 39.2 (control) to 36.5% (UF2). Fat content ranged from 31.5 to 32.4% with no significant differences among treatments, and salt content ranged from 1.38 to 1.83% with significant differences. Calcium content was higher in UF cheeses than in CM cheeses followed by control, and it increased with protein content in cheese milk. Ultrafiltered milk produced cheese with higher protein content than CM milk. The soluble protein content of all cheeses increased during 30 wk of ripening. Condensed milk cheeses exhibited a higher level of proteolysis than UF cheeses. Sodium dodecyl sulfate-PAGE showed retarded proteolysis with increase in level of concentration. The breakdown of ás1- casein and ás1-I-casein fractions was highest in the control and decreased with increase in protein content of cheese milk, with UF2 being the lowest. There was no significant degradation of ß-casein. Overall increase in proteolytic products was the highest in control, and it decreased with increase in protein content of cheese milk. No significant differences in the counts of lactic starters or nonstarter lactic acid bacteria were observed. Extent as well as method of concentration influenced the melting characteristics of the cheeses. Melting was greatest in the control cheeses and least in cheese made from condensed milk and decreased with increasing level of milk protein concentration. Vacuum condensing and ultrafiltration resulted in Cheddar cheeses of distinctly different quality. Although both methods have their advantages and disadvantages, the selection of the right method would depend upon the objective of the manufacturer and intended use of the cheese.

XVIII 31-04 AROMA COMPOUNDS IN SWEET WHEY POWDER

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Aroma compounds in sweet whey powder were investigated in this study. Volatiles were isolated by solvent extraction followed by solvent-assisted flavor evaporation. Fractionation was used to separate acidic from nonacidic volatiles. Gas chromatography/mass spectrometry and gas chromatography/olfactometry were used for the identification of aroma compounds. Osme methodology was applied to assess the relative importance of each aroma compound. The most aroma-intense free fatty acids detected were acetic, propanoic, butanoic, hexanoic, heptanoic, octanoic, decanoic, dodecanoic, and 9-decenoic acids. The most aroma-intense nonacidic compounds detected were hexanal, heptanal, nonanal, phenylacetaldehyde, 1-octen-3-one, methional, 2,6-dimethylpyrazine, 2,5-dimethylpyrazine, 2,3-dimethylpyrazine, 2,3,5-trimethylpyrazine, furfuryl alcohol, p-cresol, 2-acetylpyrrole, maltol, furaneol, and several lactones. This study suggested that the aroma of whey powder could comprise compounds originating from milk, compounds generated by the starter culture during cheese making, and compounds formed during the manufacturing process of whey powder.

XVIII 32-04 EMULSIFYING PROPERTIES OF FRACTIONS PREPARED FROM COMMERCIAL BUTTERMILK BY MICROFILTRATION

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J. Dairy Sci. 87(12): 4080. 2004.

A novel method for the separation of milk-fat globule membrane (MFGM) isolate by microfiltration in the presence of citrate was applied to prepare a fraction to be used to stabilize oil-in-water emulsions. The emulsifying properties of this fraction, containing high amounts of MFGM, were compared with a buttermilk concentrate (BMC) prepared in a similar manner but still containing the original ratio of proteins (caseins, whey proteins, and MFGM). The objective of this work was to determine if the isolation procedure would result in an ingredient with different functionality when compared with BMC. These fractions were incorporated into oil-in-water emulsions at various isolate and oil concentrations. At low concentrations of isolate, MFGM emulsions showed better creaming stability and smaller oil droplet size distribution than whole buttermilk concentrate samples. The difference in stability was attributed to the compositional difference between the 2 ingredients prepared. A selective concentration of MFGM in buttermilk by microfiltration has the potential for the development of ingredients that differ substantially from the ingredients deriving from milk or whey.