DAIRY FOODS: **TECHNICAL ORAL SESSION: CHEESE/YOGURT/ICE CREAM**

0238 Microbial production of conjugated linoleic acid: Development of functional dairy products-an overview. S. Abd El Ghani* and W. K. Bahgaat, *National Research Centre, Giza, Cairo, Egypt.*

Conjugated linoleic acid (CLA) is a generic name for a group of positional and geometric isomers of linoleic acid (LA), *cis*-9, *cis*-12, octadecadienoic acid) in which the double bonds are conjugated instead of the methylene interrupted configuration of LA. Of these isomers, *cis*-9, *trans*-11 and *trans*-10, *cis*-12 octadecadienoic acid (C 18: 2) has been reported as the most biologically active fatty acids that confer beneficial health effects on human. CLA isomers are found mostly in milk, dairy products and meat of ruminant animals. Interest in the beneficial health effects of CLA was reported over the years since the 1990s. Such benefits are: increased metabolic rate, decreased abdominal fat, enhanced muscle growth, lower cholesterol and triglycerides, lower insulin resistance, reduced risk of vascular diseases and anticarcinogenic effect. Microbiological production of CLA has recently attracted considerable research studies. The capability of several bacterial genera to convert linoleic acid in the forage of ruminants into CLA has been highlighted in many studies. The major CLA producing bacteria are lactic acid bacteria (LAB), bifidobacteria, and propionibacteria. Lactic acid bacteria (LAB) comprised 13 genera namely,*Carnobacterium*,*Enterococcus*, *Lactobacillus*, *Lactococcus*, *Lactosphaera*, *Leuconostoc*, *Melissococcus*, *Oenococcus*, *Pediococcus*, *Streptococcus*, *Tetragenococcus*, *Vagococcus* and *Weissella*among phylum Firmicutes. LAB were isolated from milk, fermented milk, cheese and other plant sources. They inhabit human and animal intestinal tracts and positively affect the health of the host. LAB are regarded as a unique group of bacteria having probiotic effect due to their capability to produce bioactive compounds such as peptides including antimicrobials, fatty acids, vitamins, and antioxidants. Probiotics refer to a live microbial feed or food supplement that beneficially affects the host by improving its intestinal microbial balance. LAB metabolites play a significant role in metabolism and detoxification of foreign substances and free radical entering the body of the host. Recently, manufacture of functional dairy products such as cheese and yogurt rich in CLA, using unique adjunct probiotics as vehicles to provide adequate dietary CLA for human consumption, has received considerable interest by dairy processors. The aim of the present overview was to highlight some aspects in the production of functional dairy products to satisfy modern consumer interest looking for their life betterment through increased tendency toward functional food consumption.

Key Words: microbial CLA, probiotic bacteria, functional foods, LAB

0239 Chemical and organoleptic characteristics of cheese from dairy cows supplemented with soya and partially hydrogenated vegetable oils. E. Vargas-Bello-Pérez*[1], G. Iñiguez-González[1], K. Fehrmann-Cartes[1], and P. C. Garnsworthy[2], *[1]Pontificia Universidad Católica de Chile, Santiago, Chile, [2]The University of Nottingham, Loughborough, United Kingdom.*

Lipid supplements have been used to improve the fatty acid profile of dairy products; however, little information is available concerning the effect of dietary vegetable oils on the sensorial properties of cow's milk cheese. The objective of the present study was to examine the effects of soya (SO) and partially hydrogenated vegetable (PHVO) oils supplementation in dairy cow diets on the chemical composition of milk and cheese and organoleptic characteristics of cheese. Nine multiparous Holstein cows averaging 169 ± 24 DIM (average ± SD) at the beginning of the study were used in a replicated (n = 3) 3 × 3 Latin square design that included three periods of 21 d. All cows received a basal diet formulated with a 56:44 forage:concentrate ratio. Dietary treatments consisted of the basal diet (C; no fat supplement), and fat-supplemented diets containing SO (unrefined oil; 500 g/d/cow) and PHVO (manufactured from palm oil; 500 g/d/cow). Individual milk samples were taken at 0700 h on Day 20 of each period. Milk collected on Day 21 from the same treatment and period across Latin squares was pooled and made into cheese. Three cheeses per treatment per period were allowed to mature for 14 d and analyzed for moisture, ash, fat and total protein contents. Sensory evaluation of cheeses was performed in relation to 16 attributes: appearance (color homogeneity and holes), odor (overall odor, ripe cheese odor and cow milk odor), flavor (salty, acid, bitter, overall flavor and ripe cheese flavor), and texture (sharpness, toughness, graininess, screeching, moisture and greasiness). Except for ash, milk composition was not affected by treatments. Cheese chemical composition was not affected by dietary treatments. Sensory attributes were not affected by treatments, however four principal components explained around 0.64 of the overall variance in the data. The outcome of this study showed that supplementing dairy cow diets with SO or PHVO do not have detrimental effect on the chemical composition of milk and cheese and the organoleptic characteristics of cheese. *This study was sponsored by a research grant from FONDECYT 11121142 (Fondo Nacional de Desarrollo Científico y Tecnológico, Chile).*

Key Words: cheese, milk, organoleptic characteristics

0240 Comparison of the effect of Holstein-Friesian and Jersey milk on Cheddar cheese production. J. H. Bland*, C. C. Fagan, and A. S. Grandison, *University of Reading, Reading, United Kingdom.*

The objective of this study was to compare the effect of using Holstein-Friesian or Jersey milk on the Cheddar cheese mak-

ing process, cheese composition and sensory quality. Cheddar cheese was produced using Jersey and Holstein Friesian milk and various blends ($n = 11$) in the University pilot plant (100L vat) each month over a year to take into account seasonal variation. A significant difference in actual yield and moisture adjusted yield (37% moisture) was found between the two breeds with Jersey milk yielding 34.6% and 40.9% more respectively ($P < 0.001$). The yield of whey for Jersey milk was significantly lower (−3.7%, $P < 0.001$), as was the yield of protein in whey (−13.5%, $P = 0.014$). However, concentrations of lactose and solids in whey for Jersey milk were higher (+3.6% and +3.8% respectively, $P < 0.001$) and no difference was detected in the yield of fat in whey. The recovery of both fat and protein in cheese was higher for Jersey by 22.9% ($P < 0.001$) and 11.9% ($P = 0.026$), respectively, compared to Holstein-Friesian. Cheese making time for Jersey milk was significantly higher (+13.1%, $P = 0.008$) even though coagulation time was significantly shorter (−44.5%, $P = 0.002$). The longer cheese making time was due to the increase in time required for acidity development, which has not been observed previously. In terms of cheese composition, Jersey milk produced cheese with higher levels of fat (+15.5%) and lower moisture content (−7.54%, $P < 0.001$). No differences in protein, pH and salt were observed. Jersey milk showed a higher suitability for cheese making with higher recovery of component and higher yield. The influence of seasonality on yield was studied and neither the actual yield nor moisture adjusted yield were significantly affected by season. Fat in whey was lowest in summer (−23.8%), while protein in whey was lowest in winter (−18.1%, $P < 0.05$). These changes in recoveries had, however, no significant effect on cheese composition. Results to date suggest that using Jersey milk to produce Cheddar cheese may be more efficient than using Holstein-Friesian. Differences in the fat and moisture content of the cheese could impact on the sensory quality of the cheese. Sensory analyses are still in progress and will include texture, color and standardized grading tests.

Key Words: Cheddar cheese, cheese yield, breed

0241 Adding citrate to ice cream mix for enhanced protein functionality.

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High-pressure processing has been shown to greatly improve the structure and texture of ice cream by modifying casein micelles, the net effect of which is to enhance protein functionality through increased air adsorption and enhanced protein-protein interactions in the aqueous phase. The addition of citrate to milk also modifies casein micelles, enhancing soluble casein levels through the chelation of calcium from within the micelle. This has been shown to enhance foamability in skim milk. It has been documented that citrate will decrease fat partial coalescence in ice cream mix, through enhanced soluble protein adsorption to the fat globule. Given these established relationships, the effect of citrate addition to ice cream mix was re-examined to determine if advantage could be gained from enhanced soluble proteins at air interfaces or within the serum phase, to either provide enhanced structure and air bubble stability and/or enhanced mouthfeel and texture. In this study, citrate triphosphate/citric acid was added to a typical ice cream mix at 0.1M/kg milk solids-not-fat (SNF) or 0.2M/kg SNF, balanced to keep the pH at 6.8, in the presence of either 0.15% saturated or unsaturated monoglyceride. Ice cream mix was batch pasteurized and batch frozen. Analyses included fat droplet size, soluble protein and protein adsorption to fat droplets in the mix; and structural collapse during melting, fat destabilization and structural analyses by transmission electron microscopy in the ice cream. Results indicated that serum proteins were enhanced in the mix due to citrate addition. However structural collapse during melting was enhanced by citrate in the presence of either surfactant, due to reduced fat partial coalescence. Adsorbed protein levels to the fat droplet were reduced by the addition of citrate, but TEM analyses indicated that the proteins were more homogeneously distributed around the fat droplets in the mix and emulsifiers were less able to displace these proteins than they were native casein micelles. Thus the soluble caseins over-stabilized the emulsion by creating a more continuous thin layer around the fat globules, which prevented the formation of a partially coalesced fat globule network necessary for air stabilization in ice cream. Consequently, while the citrate did successfully modify the casein micelles by increasing soluble casein, it did not result in enhanced foamability or protein structure in the aqueous phase.

Key Words: casein, citrate

0242 The nutritional value of kishk: dried wheat fermented milk Egyptian native dairy food.

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Kishk is dried wheat fermented milk mixture originated during Pharonic period since 3200 B.C. in Upper Egypt and continued until nowadays. It is considered a good source of carbohydrates, proteins, vitamins and minerals. Egyptian farmers prepared kishk as a home made product mainly for their consumption. However, considerable amounts of the product may be marketed to gain additional profit. The aim of this proposal was to evaluate the nutrition value of kishk. Therefore, gross composition and minerals content were determined. Quality and quantity of fatty acids as parameters of functionality were also analyzed. Forty kishk samples were procured from four provinces encoded as A, B, F, and G located in Upper Egypt (10 samples from each). Gross composition and minerals were examined according to (APHA, 2004). Moreover, quality and quantity of FAs methyl ester were pursued using

Agilent Technologies 6890 N GC/MS equipped with a flame ionization detector (FID) and a HP-5% Phenyl Methyl Silixane capillary column. Helium was used as a carrier gas. The oven temperature was 70°C with a 2 min. hold. Injector and detector temperatures were 250° and 280°C, respectively. FAMEs were identified by comparing its retention times with those of standard FAMEs mixture (Sigma, USA). Mean gross compositions were: moisture, 6.82, 7.24, 7.02 & 7.23; total solids, 93.18, 92.69, 92.98 & 92.77; and total carbohydrates, 65.43, 69.83, 73.09 & 69.43 g/100-g sample for A, B, F, and G kishk, respectively. Mean protein and fat contents were 18.84, 11.60, 11.87, 11.43; and 4.85, 3.21, 3.51 & 3.43 g/100 g dry matter in the same order, respectively. Po, K, Ca, Mg, Na, Fe, Mn, Zn and Cu were determined in varying concentrations. FA profile includes saturated, monounsaturated and polyunsaturated fatty acids from C10 to C21. Octadecadieonic and octadecatrienoic acids were detected in all kishk samples examined. However, Kishk A contained conjugated linoleic acid 10*t*,12*c*CLA. Perhaps this was the first report to document presence of beneficial CLA isomer in kishk. In conclusion, kishk is a very nutritive functional food containing carbohydrates, protein, fat and minerals. Moreover, occurrence of essential PUFA and CLA ensure its functionality for human health.

Key Words: kishk, CLA, functional food

0243 Bacterial community shifts in geriatric subjects in response to probiotic intervention revealed by high throughput DNA sequencing. G. H. Meletharayil[1], S. Senan[*2], P. Jashbhai[2], and C. G. Joshi[3], *[1]South Dakota State University, Brookings, [2]SMC College of Dairy Science, Anand Agricultural University, Anand, India, [3]Faculty of Veterinary Science, Anand Agricultural University, Anand, India*

Evidences on the association between bacterial shifts in human gut microbiota and disorders such as inflammatory bowel disease, diabetes and obesity are mounting. A comprehensive catalogue of gut microbiota is thus essential for personalized microbiome focused treatments. The microbiota of older people displays greater inter-individual variation than that of younger adults. Gastrointestinal disorders are a major cause of morbidity in the geriatric population. Probiotic interventions are known to have been shown to inñuence the composition of the intestinal microbiota in the geriatric. As most of the bacteria present in the gut are non culturable, we attempted to study the bacterial community structure of the geriatric gut using Ion torrent 16s rRNA sequencing. There remains considerable variability in response to probiotic intervention among subjects, hence we hypothesized that a signature gut metagenome could be the deciding biomarker for a successfully probiotic therapy. Among the 72 geriatric subjects who participated in the trial, we could identify 10 respondents who showed positive results in the primary outcome of cholesterol reduction and 10 who showed an increase in cholesterol with a decreasing lactobacilli population indicating non response to probiotic therapy. DNA from the fecal samples of these 20 respondents during baseline and end of feeding was analyzed. Amplicons from the hypervarialbe region of the 16S rRNA gene were generated and sequenced each on a 316 chip. Sequencing reads were clustered into operational taxonomic units described by community metrics and taxonomically classified. Reads per sample were clustered and studied for diversity and richness using MG-RAST. All the community members in our samples were from the domain bacteria. The most prevalent phyla in all samples were: *Firmicutes*, *Proeobacteria*, *Actinobacteria* and *Bacteroidetes,* with *Firmicutes* dominating in all samples. All the samples taken before treatment showed an abundance in *Blautia, Bifidobacterium, clostridium, Escherichia, Eubacterium, Fecalibacterium, Lactobacillus, Prevotella, Roseburia, Ruminococcus* and *Shigella*. It was strikingly evident that the non respondents harbored more *Shigella, Escherichia* and less *Runinococcus and Clostridium* (compared to positive respondents). *Lactobacilli and Prevotella* showed an increase in abundance values after probiotic treatment with a decrease in *Shigella, Ruminococcus, Bacillus* and *Bifidobacterium*. Such metagenomic analysis gives new insights into differences in response towards the same probiotic intervention due to host community profiles. Modulation of the community structure using probiotics can prove beneficial for geriatric intestinal well-being and cholesterol reduction.

Key Words: metagenome, probiotic, gut, geriatric

0244 Microbial population dynamics during aging of Cheddar cheese. B. Ganesan*, C. Brothersen, and D. J. McMahon, *Western Dairy Center, Utah State University, Logan.*

The dynamics of bacterial microflora changes in Cheddar cheese during ageing are largely unknown. Normally, the unwanted bacteria may die out and not survive through 60 d of storage of hard and semi-hard cheeses. However, the beneficial flavor producers such as starter and adjunct LAB may survive longer, as may some unwanted bacteria that have a competitive advantage due to shorter growth times and fewer nutritional requirements. Traditional estimates of bacterial populations depended on the ability to grow bacteria from cheese on specific media. While this is possible for the dominant bacterial species, it still does not define the breadth of the bacterial diversity adequately. A slightly broader picture of bacterial classes can be obtained by culture-independent techniques such as quantitative PCR analysis (qPCR) or phylogenetic microarrays, which are based on the levels of a gene of a particular organism estimated from DNA extracted from cheese. Challenges for DNA extraction such as interference from dairy components such as milk fat and protein in not allowing DNA separation and inability to lyse bacteria inside solid matrices have been tackled. We recently demonstrated that probiotic bacteria survive up to 6 mo of aging without

population reduction by measuring their levels using qPCR. However, the high number of simultaneous assays needed to define the diversity of bacteria and the necessity for prior knowledge of bacteria that may exist in cheese are both limitations for qPCR's or microarrays' applicability to cheese. Currently, the bacterial ecology research arena largely depends on sequencing of amplified 16s ribosomal gene segments at a very high throughput to characterize the populations in diverse extreme environments. This approach surmounts some of the drawbacks of array-based technologies where we only target short (11 probes that are each 20-25 bases long), discontinuous portions of the gene sequences, whereas with sequencing, we seek to identify bacteria based on 200 base-long continuous DNA sequences. Our objective was to study the changes in bacterial populations in cheese during manufacture and aging using the 16s pyrosequencing approach. While lactococci and lactobacilli were the dominant microbial species ($P < 0.05$) as expected, the presence of hitherto unknown species was also identified. This demonstrates that 16s DNA sequencing is a nonrestrictive approach towards surveying both known bacterial types and relatively unknown or previously unexpected cheese microflora members.

Key Words: Cheddar cheese, mciroflora, lactococcus, lactobacillus

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0245 The influence of protein content of milk protein concentrates on the rheological properties of Greek style acid skim milk gels. G. H. Meletharayil[*1], H. A. Patel[2], and T. Huppertz[1], [1]*South Dakota State University, Brookings,* [2]*Dairy Science Department, South Dakota State University, Brookings.*

Greek-style yogurt (GSY) derives its popularity from combining nutritionally desired high protein content with a rich smooth texture. The straining process traditionally applied in GSY manufacture leads to large amounts of acid whey, which is an industrial concern in terms of further processing or disposal. An alternative process, preventing the creation of acid whey, is producing GSY from suitable milk protein ingredients for attaining the desired protein concentration. The aim of this study was to evaluate the rheological properties of Greek-style acid milk gels prepared from milk protein concentrates (MPCs) of varying protein content. MPC powders containing 50% (MPC50) to 85% (MPC85) protein were prepared by ultrafiltration and spray-drying from the same lot of milk. Solution (7.5% protein and 15% total solids) were prepared with these MPCs and lactose and pH was adjusted to pH 6.7 before preheating at 90°C for 10 min. Acid gels were prepared using glucono-δ-lactone to obtain final pH 4.6 after 4h of incubation at 30°C. Small amplitude oscillatory rheology (SAOR) measurements at 1% strain and a frequency of 1 Hz were performed for rheological characterization. pH was also monitored continuously during acidification. The pH of gelation (pH_G) and time of gelation were taken as the point where elastic modulus (G') was > 1 Pa. Statistical significance ($P < 0.05$) of effects observed was tested by ANOVA. The SAOR measurements showed a significant differences ($P < 0.05$) in G' of acid milk gels prepared from MPC60–MPC85 compared to gels prepared with MPC50. This was also reflected in a significant increase ($P < 0.005$) in the gelation pH and decrease in gelation time of acid gels. Such differences in the rheological properties, gelation time and gelation pH could be attributed to increased diafiltration during the preparation of MPC powders with higher protein contents, thereby reducing serum calcium and phosphate, increasing calcium ion activity and increasing the amount of denatured whey proteins associated with the casein micelles after heating. From these studies, it can be concluded that the use of MPC60−MPC85 in the manufacturing of GSY has a positive influence on G', gelation pH and gelation time. There was no significant differences in the rheological properties of gels manufactured with MPCs with > 60% protein. Hence, opportunities exist to produce GSY without acid whey as a by-product using MPC like MPC60 or MPC70, which are not prone to excessive solubility loss during storage.

Key Words: Greek style yogurt, milk protein concentrate. rheology

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0246 Investigating the refrigerated performance shelf-life of high pressure treated, reduced sodium, low moisture part skim Mozzarella cheese. M. Ozturk[*1], S. Govindasamy-Lucey[2], Y. Lu[2], J. J. Jaeggi[2], M. E. Johnson[2], and J. A. Lucey[1,2], [1]*University of Wisconsin, Madison,* [2]*Wisconsin Center for Dairy Research, Madison.*

Physical, or performance, properties of low moisture part skim (LMPS) Mozzarella cheese are acceptable for only a relatively short time period (e.g., 4−6 wk) when stored under refrigeration conditions (4°C). During longer term storage (such as for exporting), cheese becomes soft and pasty due to physicochemical changes in para-casein matrix and ongoing protein breakdown, which results in poor shredding properties for unmelted cheese. We proposed that the performance and sensory properties of reduced Na LMPS-Mozzarella cheese could be extended by decreasing microbial and enzymatic activity with the application of high hydrostatic pressure (HHP). Camel chymosin was also used as a coagulant to help reduce cheese proteolysis. Average composition of reduced Na (1.0 ± 0.1% NaCl) LMPS-Mozzarella cheeses were 48.6 ± 0.7% moisture, 22.6 ± 0.4% fat, and 24.4 ± 0.7% protein. Cheeses were divided into three groups randomly after manufacture and stored at ~4°C. One group was non-pressurized and kept as control. Two wk after manufacture, the two groups of cheese samples were HHP-treated at 500 or 600 MPa for 3 min. Analysis was performed at 2, 4, 6, 8, 12, 16, and 20 wk after cheese manufacture. Texture profile analysis (TPA) and dynamic low-amplitude oscillatory rheology was used to

monitor cheese functionality during ripening. Quantitative descriptive analysis was conducted with 9 trained panelists to evaluate texture and flavor attributes using a 15 point scale. Pressure treatments at 500 and 600 MPa resulted in ~1 and ~2 log reduction in starter culture numbers at 2 wk of ripening, respectively, compared to control cheese. High pressure treatment of LMPS-Mozzarella cheese resulted in an initial (at 2 wk of ripening) increase ($P < 0.05$) in pH values; however, by 4 wk of ripening we did not observe any statistical difference in pH values between control and HHP-treated samples. At 2 wk of ripening, pressure treatment significantly ($P < 0.05$) decreased cheese hardness; however, by 16 wk the 600 MPa HHP-treated cheeses exhibited significantly ($P < 0.05$) higher TPA hardness values compared to control. Sensory panels also indicated that by 16 wk of age, the 600 MPa HHP-treated sample was significantly ($P < 0.05$) firmer than the control. Pizza panels indicated that 600 MPa HHP-treated cheese was significantly ($P < 0.05$) chewier and exhibited lower blister quantity and higher strand thickness compared to control. Pressures of 600 MPa produced LMPS-Mozzarella cheese with acceptable performance on pizza for a greatly extended refrigerated storage period.

Key Words: high pressure, reduced sodium, camel chymosin

0247 Impact of potassium substitution for sodium on pH, proteolysis, organic acids, and microbial populations during storage of Cheddar cheese.

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Sodium reduction in cheese can assist in reducing dietary Na intake, yet saltiness is an important aspect of cheese flavor. Our objective was to evaluate impact of substitution of KCl for NaCl on cheese pH, organic acid content, extent of proteolysis as water soluble nitrogen (WSN) and protein profiles using urea-PAGE in Cheddar cheese in relation to changes in starter lactic acid bacteria (LAB) and nonstarter LAB (NSLAB) during 9 mo storage. Cheddar cheeses with molar salt contents equivalent to 1.7% salt and Na replacement of 0% (control), 10%, 25%, 50% and 75% were manufactured as well as a low-salt (0.7% NaCl) negative control cheese. The 1.7%-salt cheeses had mean composition of 352 g/kg moisture, 259 g/kg protein, 17.5 g/kg salt (measured as Cl^-) and 50% fat on a dry basis. After salting there was a faster initial drop in pH in the 0.7%-salt cheese and cheeses with high levels of K substitution, and the pH remained lower throughout storage. No difference in intact casein levels or %WSN levels between the various cheeses was observed with %WSN increasing from 5% at d 1 to 25% after 9 mo. There was a greater decrease in intact α_{s1}-casein than β-casein, and a linear relationship was observed between the ratio of α_{s1}-casein (f121–199) to α_{s1}-casein and storage time suggesting this ratio could be used as an index of cheese ripening. Lactic acid content increased with K substitution and throughout storage. Propionic acid concentration in the cheese increased earlier in the control cheese than in cheeses with $\geq$ 25% K substitution or cheese with only 0.7% salt. This increase corresponded to the time after NSLAB numbers in the cheeses became dominant. There were few other obvious trends in organic acid concentration observed as a function of Na or K content. Typical changes in bacteria microflora occurred during storage with lactococci gradually decreasing and NSLAB increasing. Lowering the Na content, even with K replacement, extended crossover time when NSLAB became the dominant microflora from 4.5 mo to 5.2, 6.0, 6.1 and 6.2 mo for cheeses with 10%, 25%, 50% and 75% K substitution. This was, however, still shorter than the 7.3 mo for the low-salt cheese. By 9 mo, NSLAB levels in all cheeses had increased from initial levels of $\leq 10^2$ to ~10^6 CFU/g. Lactococci remained at 10^6CFU/g in the low-salt cheese even after 9 mo storage.

Key Words: cheese, sodium, potassium