Bioethics: Ethical and Social Issues in Animal Biotechnology

431 Ethics and animal biotechnology: A re-evaluation in light of the Bush Administration Science Policy. P. Thompson*, *Michigan State University*, *East Lansing*.

In previous studies, this author has advocated a procedural approach not unlike the one that is used in IACUCs to address ethical issues for animal biotechnology. Although there is no evidence that the Bush administration is contemplating action with respect to animal biotechnology, the accumulation of indicators in how key individuals within the administration approach science policy suggest that earlier recommendations emphasizing production goals and animal welfare needs to be re-evaluated. Three key indicators are reviewed in this process: policies on stem cell research, the published position of Leon Kass, Chair of the Bioethics Advisory Committee, and published statements by Mathew Scully, an occasional speechwriter for the President. These three indicators in combination provide the basis for thinking that it will be important to take a range of perspectives formerly associated exclusively with European attitudes into account in conceptualizing the ethical issues associated with animal biotechnology. This will, in turn, lead to a considerably expanded universe of issues that need to be addressed in any procedural approach to the ethics of animal biotechnology.

Key Words: Animal welfare, Cloning, Gene transfer

432 Animal biotechnology: Interfacing ethics with scientific advancement. R. Anthony*, *University of Alaska*, *Anchorage*.

One of the important tools and processes by which scientists determine the ethical merits of a particular research effort has been Russell and Burch's (1959) Principles of the Three R's, namely Replacement, Reduction and Refinement. Animal ethics review committees, i.e., Institutional Animal Care and Use Committees (often made up of mostly scientists), employ these principles to guide policies and scientific behavior as one way to assuage tensions between the social benefits of the research and the interests of the animal research subjects. Thus, committees wrestle with ways to replace the use of live-animal experiments with viable alternatives, reduce the number of animals used and the degree of their exposure to aversive experimental conditions, and refine techniques that may cause animals to suffer. The principles of the three R's have governed much of how laboratory science that employs animals is conducted in the United States. They reflect a utilitarian reformist attitude that supports piecemeal changes to increase animal well-being, finding the most favorable balance of benefits and harms for all the sentient beings affected by human action. This presentation explores the extent to which recent advances in contemporary animal biotechnology challenges the ethical guiding prowess of the Three Rs. Recent cultural views regarding the dignity or integrity of individuals animals and concern for natural living will be discussed as a way to highlight opportunities to expand how we should consider animal research in this particular case but also more broadly. I consider other ethical notions like need, reciprocity, and care responsibilities with an eye to expanding discussions on governance issues related to research involving animals in North America.

Key Words: Animal biotechnology, Animal ethics, Institutional Animal Care and Use Committees

433 Genetically engineered animals and the ethics of food labeling. R. Streiffer* and A. Rubel, *University of Wisconsin*, *Madison*.

The current debate about labeling genetically engineered (GE) food focuses on food derived from GE crops, neglecting food derived from GE animals. This is not surprising, as GE animal products have not yet reached the market. Participants in the debate may also be assuming that conclusions about GE crops automatically extend to GE animals. But (i) there is already an interest in selling surplus GE farm animals used in research for use in the food supply, (ii) there are two GE animals, the Enviropig and the AquAdvantage Bred salmon, that are approaching the market, (iii) animals raise more ethical issues than plants, and (iv) U.S. regulations treat animal products differently from crops. Whether there are legally mandated labels may well impact the commercial viability of GE animal products: if labels enable consumers to make a choice at the point of sale as to whether to purchase GE animal products, consumers might well choose not to. This is therefore an important gap to fill in the existing literature. This presentation examines the specific question of whether there should be mandatory labeling on all food products derived from GE animals, including an examination of the likely regulatory pathways, salient differences between GE animals and GE crops, and relevant social science research on consumers' attitudes.

Key Words: Ethics, Labeling, Genetically engineered animals

Dairy Foods: Products and Processing

434 Aggregation of casein micelles and κ-carrageenan in reconstituted skim milk. S. Ji, H. D. Goff*, and M. Corredig, *University of Guelph*, *Guelph, Ontario, Canada*.

It is well known that 0.025% κ-carrageenan can gel skim milk. However, when the system is sheared while cooling from 60°C to 25°C, aggregates of 10-100 μm can be formed and the system shows fluid like behavior. Effects of shear (200, 400, 800 s^{-1}) and concentrations of κ-carrageenan (0.025%, 0.05%, 0.075%) on the formation of micellar casein/κ-carrageenan aggregates were studied with a controlled stress rheometer. Particle size of casein/κ-carrageenan aggregates decreased with increasing shear rate (200, 400 and 800 s^{-1}) but increased with carrageenan concentration (0.025%, 0.05% and 0.075%). The microstructure of casein/κ-carrageenan aggregates was studied with Cryo-SEM, field emission-SEM and TEM. Interaction between casein micelles and κ-carrageenan was significantly affected by the total solid content of solution. It was shown that the aggregation of casein micelles and κ-carrageenan decreased with increasing total solid content of solution and was completely inhibited at 21% of total solid content. Effects of casein/κ-carrageenan ratio on casein/κ-carrageenan interaction at different total solid contents (13%, 16%, 18% and 21%) were studied. It was shown that although the concentration of κ-carrageenan had great effects on particle size distribution of aggregates, at higher level of total solid content, increasing κ-carrageenan concentration did not significantly enhance casein/carrageenan interaction. Effects of K^+ and Ca^{2+} on the formation of casein/κ-

carrageenan aggregates at different total solid contents (13%, 16%, 18% and 21%) were studied. It was shown that addition of K^+ did not affect the formation of aggregates but addition of Ca^{2+} did. However, casein aggregation rather than casein/κ-carrageenan interactions may be involved in Ca^{2+} supplemented systems. By removing ions from skim milk powder solution, the interactions between casein micelles and κ-carrageenan were enhanced and less κ-carrageenan was needed to form aggregates with casein micelles.

Key Words: Protein-polysaccharide interaction, Casein micelles, κ-carrageenan

435 Comparison of the fatty acid distributions among different vegetable oil blends toward infant milk formulation. C. O. Maduko*[1], C. Akoh[1], and Y. W. Park[2], [1]*University of Georgia*, *Athens*, [2]*Fort Valley State University*, *Fort Valley, GA*.

The absorption efficiency of human milk fat is reportedly higher than caprine or bovine milks due to the differences in fatty acid arrangements of the milk fats. Unlike milk of ruminants and most other mammals, human milk contains predominantly saturated, monounsaturated (MUFA) and polyunsaturated fatty acids (PUFA) ranging from C10 to C22. Caprine milk has been recommended as a substitute for those who suffer from allergies to cow milk. Cow milk allergy is a frequent disease in infants, but its etiologic mechanisms are not clear. There is need to develop milk products more homologous as well as less allergenic to human milk fat by using vegetable oil blends rich in saturated long chain acids, MUFA and PUFA. The purpose of this study was to determine the best ratio combination of different vegetable oils to simulate the fatty acid composition of human milk for infant feeding. Five different vegetable fat blends using coconut, safflower and soybean oils were incorporated into skim goat milk at several different formulation ratios to make 4.4g fat/100 ml milk. Fat content of each vegetable oil was determined before blending, and the blended milks were lyophilized. Fatty acid profiles of skim goat milk, whole goat milk and reconstituted formulated lyophilisates were determined by a gas chromatography. Fatty acid profiles of the blended samples were compared to those of human milk for compositions of long chain saturated acids, MUFA and PUFA. The formulated caprine milk containing 2.5, 1.1 and 0.8g blend of coconut, safflower and soybean oils, respectively, had the best simulation to the fatty acid composition of human milk. This product contained 12.5%, 9.2%, 11.8%, 9.2%, and 1% of C14:0, C16:0, C18:1, C18:2 and C18:3, respectively, and concluded that it is closer to human milk for infant feeding than those of whole goat milk and other preparations.

Key Words: Fatty acids, Distribution, Infant milk formulation

436 Milk quality improvement in Iran. R. Noorbakhsh*[1] and A. Heravi Moussavi[2], [1]*Institute of Standards and Industrial Research*, *Mashhad, Iran*, [2]*Center of Excellence and Department of Animal Science, Ferdowsi University*, *Mashhad, Iran*.

The dairy industry in Iran has changed dramatically in the last decade. Milk production has increased from 620,000 tons a year after the revolution, to 6.7 million tons in 2003. The government will aim at increasing total annual milk production to 12.5 million tons. Raw milk is mainly processed into sterilised or pasteurised milk, cheese, butter, yoghurt, and ice cream. Along with increase in milk production, the quality also has been improved. Many factors have caused this improvement. Defined regulatory requirements for sanitation, machine milking, pipeline systems, better cleaning and sanitation materials, more rapid cooling of milk, improved milk quality testing methods, better farm management to prevent mastitis, and reporting of milk quality test results to producers are some of them. However, a very important and encouraging factor in improving milk quality was the initiation of premium payments to producers with higher milk quality. According to the raw milk standard provided by Iranian Institute of Standards and Industrial Research (ISIRI) producer must meet following criteria to qualify: bacteria count: less than 100,000/mL, antibiotic: negative, freezing point: between -0.507 and -0.545°C, somatic cells: less than 500,000/mL. As the most quality problems originate at the farm cannot be erased by further processing, some dairy farms are complying with a HACCP-compatible program for quality control. On the other hand, the processing plants especially the milk powder factories pay more for their products. The trend towards improvement in the milk quality in Iran has resulted in a huge decrease in somatic cell counts from over millions to less than 500,000 in modern farms during the recent years. Results from this study demonstrate that establishing the mandatory national standard by ISIRI containing the new criteria for somatic cell counts along with using better technology and methods in dairy farms and the premium payments support the improvement in raw milk quality.

Key Words: Milk quality, Iran dairy, Somatic cell counts

437 Functional behavior of liquid virgin whey protein concentrate. P. Marcelo* and S. S. H. Rizvi, *Institute of Food Science, Cornell University*, *Ithaca, NY*.

The compositional variability and fractional protein denaturation in commercial whey proteins (WP) products give rise to varied levels of aggregation during heat and shear applications. In food products, this often results in uncontrolled structure development and impedes attainment of the desired texture. The liquid virgin whey protein concentrate (LVWPC) is a novel ingredient rich in native WP. Harvested before cheesemaking and concentrated by membrane technology alone, LVWPC offers unique physicochemical properties not shown by commercial products. The objective of this study was to elucidate LVWPC's behavior, microstructure formation and texture development under heat and shear applications and compare them with those of commercial products. Thermal properties of LVWPC and commercial whey protein products were determined by differential scanning calorimetry. Textural changes during shear applications at 70 °C were quantified by rheological measurements. Structure development was elucidated using scanning electron microscopy (SEM) and confocal laser scanning microscopy (CLSM). While the denaturation temperature was similar to those of commercial products, LVWPC's onset and enthalpy of denaturation were higher, indicating higher thermal stability. The apparent viscosity at pH 6.1 of 8 wt.% LVWPC at 70 °C and 245 s^{-1} shear rate was constant for a period of time before increasing at a steady rate of 0.18 mPa-s per minute to 27 mPa-s. On the other hand, those of commercial products increased rapidly at 0.25 mPa-s per minute shortly after the start of the test. SEM images showed that the sheared and heat-treated LVWPC formed a continuous structure, giving smooth texture, while the commercial products gave either fractured or flaky texture due to extensive aggregation that led to phase separation. CLSM results indicated well-controlled structure development of LVWPC upon heating. WP products continue to be important food ingredients due to incessant demand for products of specific texture and nutritive value. Our results suggest that LVWPC is ideal for imparting fine-tuned texture in foods compared with existing commercial WP products.

Key Words: Virgin whey, Functional behavior, Texture

438 Pressure-induced interactions of milk proteins: Are they different from heat-induced interactions? H. A. Patel*[1,2], H. Singh[3], and L. K. Creamer[2], [1]*Institute of Food, Nutrition and Human Health, Massey University*, *Palmerston North, New Zealand*, [2]*Fonterra Research Centre*, *Palmerston North, New Zealand*, [3]*Riddet Centre, Massey University*, *Palmerston North, New Zealand*.

Almost all dairy products are subjected to some form of heating, either directly or by virtue of being made from heated milk. Heating has direct effects on the structure and functionality of milk proteins. Therefore, heat-induced interactions of the milk proteins have considerable importance in the manufacture of dairy products (e.g. yogurt, heat-stable milk powder, evaporated milk, etc.). As a result, this subject has been investigated extensively and ample literature is available. During the past few years, growing consumer demand for minimally processed, high quality, and safe foods has led to increasing interest in non-thermal processes for food preservation; among them, high hydrostatic pressure processing (HPP) is currently a major focus of investigation. As HPP is being considered for the processing of dairy products, an understanding of the modification of the protein structure and the functional properties as a result of HPP is particularly important for its application to dairy products. The changes in the heat and pressure treated samples were studied using various analytical techniques (viz. polyacrylamide gel electrophoresis, size exclusion chromatography, transmission electron microscopy and rheology). A comparison of the HPP-induced and heat-induced interactions of milk proteins using selected commercial pressure treatments and heat treatments showed that HPP has many useful effects on milk proteins. Each of the major whey proteins responded differently to pressure and heat treatments, showing quite different denaturation and aggregation patterns in the pressure- and heat-treated samples. The cysteine-containing caseins (αs_2- and κ-casein) and whey proteins (notably β-lactoglobulin, α-lactalbumin, and bovine serum albumin) interacted differently under pressure, compared with under heat. The implications of such effects on the functionality of pressure-treated products may be profound.

Key Words: Milk proteins, Heat treatment, Protein interactions

439 Microbial and somatic cells removal from raw skim milk by cold microfiltration: Quality and shelf life effects. J. A. Fritsch* and C. I. Moraru, *Cornell University*, *Ithaca, NY*.

The removal of microorganisms from milk using microfiltration (MF) has the potential to significantly improve the safety, quality and shelf life of dairy products. Maximum benefits can be achieved if the process takes place in the early stages of milk processing, preferably in the raw milk stage. Technical challenges of applying MF to raw milk arise from the fact that for regulatory reasons such a process must occur at temperatures < 45F (7C), which are conducive of low permeate fluxes. The objective of this work was to investigate the factors that influence the separation efficiency in cold milk MF and to develop technical solutions for maximizing both the flux, as well as the shelf life and quality benefits of such a process. An experimental setup including a ceramic MF membrane of 1.4um pore size was used to MF raw skim milk at t<7C. The microbiological quality of the milk was evaluated by standard plating and counting, protein composition by the Kjeldhal method and particle size distribution by laser light scattering. Membrane fouling was assessed by scanning electron microscopy. High cross-flow velocities (v), which lead to turbulence and destabilization of the fouling layer, and low transmembrane pressures (TMP) were conducive of high permeate fluxes. An average permeate flux of about 52 L/(m^2h) was obtained after 45min of microfiltering skim milk at v=7m/s and TMP=10psi, as compared to 17.5 L/(m^2h) after 45min at 7m/s and 19psi. The protein composition of the MF milk obtained under optimal process conditions was nearly identical to that of the raw skim milk. Significant flux enhancement and reduced flux decay were achieved by employing a CO2 surging technique. The cold MF process led to about 5 log reduction in bacteria and near complete removal of spores and somatic cells, which resulted in a significantly longer shelf life of the MF milk as compared to the unfiltered milk. Additional shelf life extension for the MF milk stored under CO2 pressures >0.68bar was found. Optimum process parameters coupled with the developed CO2 technique have the potential to make raw milk MF an economically attractive process.

Key Words: Microfiltration, Shelf life, CO2

440 Process analysis for liquid virgin whey protein concentrate production using membrane technology. P. Marcelo* and S. S. H. Rizvi, *Institute of Food Science, Cornell University*, *Ithaca, NY*.

Native whey proteins (WP) possess high conformational potentials that give rise to superior functional properties compared with denatured WP. In harvesting and concentrating these valuable proteins, care must be taken to minimize denaturation. The objective of this study was to analyze relevant process parameters in the production of the native WP-rich liquid virgin whey protein concentrate (LVWPC) using membrane technology. Virgin whey, containing 0.5 wt.% WP and 5.3 wt.% total solids (%TS) harvested from slightly acidified skim milk (pH 6.0) prior to cheesemaking, was concentrated by two-stage ultrafiltration (UF) with diafiltration (DF) at 45 °C. First-stage UF was done in a 10,000-molecular weight cut-off (MWCO) polysulphone spiral wound membrane (SWM) with filtration area of 5.9 m^2. It was operated at -ΔP of 275 kPa until the concentration factor (CF) was 13 and DF ensued using four diavolumes of phosphate buffer in the SWM. The second-stage UF was done using 10,000-MWCO polysulphone hollow fiber membrane (HFM) with 2.9 m^2 filtration area, operated at -ΔP of 130 kPa until CF reached 5. In the SWM, 42.9 kg/hr-m^2 average permeate flux was initially observed before declining exponentially with time to 34.6 kg/hr-m^2 as CF reached 1.12. The flux then became approximately constant at 30 kg/hr-m^2 as the retentate %TS went up to 8.94 and the viscosity increased by 34% as CF reached 13. The relatively low cross-flow velocity of 0.5 m/s generated a moderate shear stress of 90 Pa at the membrane wall and may have been sufficient to balance particle erosion and deposition rates on the membrane to give quasi steady-state permeation. There was an exponential flux decay with time in the second-stage UF as %TS increased to 26% (91% WP) and viscosity increased six times to 11.7 mPa-s. The results suggest that because of the high purity and the native state of the WP, instead of protein-protein interactions, changes in bulk transport properties due to increasing protein concentration contributed significantly to flux decline in the UF.

Key Words: Whey proteins, Ultrafiltration, Virgin whey