**553 Development and application of an image analysis method to measure and characterize calcium lactate crystals on uncolored Cheddar cheese.** P. Rajbhandari* and P. S. Kindstedt, *University of Vermont*, *Burlington*.

Previous research demonstrated that image analysis can accurately and precisely measure the area occupied by calcium lactate crystals on the surface of smoked Cheddar cheese. Naturally smoked cheese is well suited for image analysis because the dark discolored smoked surface contrasts sharply with white calcium lactate crystals. Uncolored cheese is more problematical because of insufficient contrast between crystal and background. The objective of this study was to modify the previous image analysis method to measure calcium lactate crystals on uncolored Cheddar. Combinations of image contrast and sharpening settings of the digital camera and light options were systematically evaluated to identify settings that optimized the contrast between white crystals and the straw colored cheese background. Five replicate analyses of an uncolored cheese surface containing crystals were performed using the modified settings. The area occupied by crystals was determined to be 4.85 ± 0.16% of total surface area. The coefficient of variation of 3.26% was comparable to repeatability measurements previously reported for smoked Cheddar. The thresholding error (error of underestimation) for the 5 replicate measurements was 0.05%, which was less than that previously reported with smoked Cheddar. Thus, the efficacy of the revised image analysis method was comparable to that of the original method. The revised method was used to evaluate crystal growth on a smoked surface and a non-smoked (uncolored) surface, respectively, from the same Cheddar cheese sample that was stored for 10 wk under conditions chosen to accelerate crystal growth (1°C , loose packaging). The percentage of total surface area occupied by crystals increased in a non-linear manner from 0 to ca. 4.5% for both smoked and non-smoked surfaces. The pattern of area increase for both smoked and non-smoked surfaces conformed most closely to a second order polynomial relationship ($R^2$=0.97-0.98). Thus, crystal growth on uncolored cheese was effectively quantified using the revised image analysis method.

**554 Computer vision analysis to monitor syneresis of cheese curd in a cheese vat.** C. D. Everard*[1], C. P. O′Donnell[2], C. C. Fagan[2], D. J. O′Callaghan[1], M. Castillo[3], and F. A. Payne[3], [1]*Teagasc, Moorepark Food Research Centre*, *Fermoy, Co. Cork, Ireland*, [2]*University College Dublin*, *Dublin , Ireland*, [3]*University of Kentucky*, *Lexington*.

Syneresis, which follows the cutting of milk coagulum into cubes and is promoted by stirring, is the main phase separation process in cheese making. The extent of syneresis influences cheese quality as a result of its effect on moisture, mineral and lactose content of curd. The kinetics of curd syneresis is complex and there are no technologies currently available for monitoring it. The objective of this study was to investigate image analysis techniques for monitoring syneresis as a means of improving the control of curd moisture content in cheese making. The visual effect of syneresis during the curd agitation phase was monitored in a ten-litre cheese vat using a computer vision system in which curd and whey were distinguished by means of colour differences. The proposed monitoring system was evaluated within a wide range of curd syneresis kinetics using a completely randomized factorial design combining two levels of milk pH and two curd agitation speeds. Whey was found to have a filtering effect on light reflectance. As syneresis progressed, the reflected light became increasingly yellow in hue for circa 20 min., after cutting the gel. The changes leveled off after circa 30 min. Colour differences were found to be in proportion to percentage of whey expressed from the curd ($R^2$ = 0.99, $P < 0.001$). The results obtained show that a computer vision system could be used for monitoring syneresis. The proposed method would allow improving the control of the curd moisture content before ripening, which would decrease the production of down-graded ripened cheese.

**Key Words:** Computer vision analysis, Image analysis, Syneresis

## International Animal Agriculture: Alternatives to Antibiotics if Feeding Ruminants for Optimal Production and Health

**555 Differing objectives and key target microbes for manipulation of ruminal fermentation.** R. J. Wallace*, *Rowett Research Institute*, *Bucksburn, Aberdeen, United Kingdom*.

The main objectives of manipulating ruminal fermentation have changed with time, and are different in different parts of the world. In North America, the emphasis remains on production efficiency, so avoidance of high-input problems like acidosis and high protein breakdown have greatest priority. In Europe, health issues, both in animals and man, which are associated with animal production have in recent years taken precedence over production efficiency. In Australasia, the environmental consequences of ruminant production, particularly methane formation, have received much recent attention. And in the developing world, priority is inevitably on making the most of scarce resources of low nutritive value. Paradoxically, the objectives of the different systems often have similar microorganisms as their target. For example, if methane formation were to be inhibited, not only would the emission of a greenhouse gas be decreased, but production efficiency would be increased. Thus, targetting methanogenic archaea may have both environmental and efficiency benefits in both low- and high-input systems. Decreasing the bacteriolytic activity of ciliate protozoa would improve nitrogen retention in low-input systems scarce in N as well as enabling lower protein inputs into high-production systems that release environmentally damaging amounts of N to the environment. In terms of human health, minimising the biohydrogenation of unsaturated fatty acids to stearate by controlling key Butyrivibrio-related bacteria will, it is hoped, lead to ruminant products with a healthier fatty acid profile. Control of Escherichia coli is a high priority in all production systems. The means available to achieve the desired manipulations also vary geographically. Ionophores and antibiotics can still be used in North America but they are not permitted in Europe and are beyond the means of farmers in the developing world. Thus, natural products, including plants and their extracts, are increasingly being investigated throughout the world as potentially cheap, environmentally friendly means of manipulating ruminal fermentation.

**Key Words:** Manipulation, Rumen, Fermentation

**556 The use of yeast-based probiotics to meet new challenges in ruminant production.** C. Newbold* and A. Olvera-Ramirez, *Institute of Rural Science, University of Wales*, *Aberystwyth, Wales, UK*.

The importance of rumen fermentation in governing the response of productive ruminants to dietary changes is well accepted and considerable efforts have been made to understand and ultimately manipulate the rumen microbial population to improve animal productivity. However, the targets for manipulation are changing and no longer can the productivity of the animal be considered in isolation. There is a growing awareness of the health, safety and environmental issues associated with animal agriculture. Thus while numerous studies have investigated the use of yeast cultures based on Saccharomyces cerevisiae to stimulate ruminant production in both growing and lactating animals, our recent studies have investigated the role of S. cerevisiae in limiting pathogen passage through the rumen and linking this to microbial changes therein. Some, but not all, strains of yeast inhibited the growth and survival of Escherichia coli H0157 and Listeria monocytogenes in both batch cultures and rumen simulating fermentors. In sheep supplemented with S. cerevisiae the flow of pathogens from the rumen decreased by up to 50%. This decreased flow of pathogens was associated with a more than doubling in the total bacterial population and an even greater increase in the numbers of cellulolytic bacteria that could be recovered from the rumen. There is increasing agreement that the ability of yeast to remove oxygen from the rumen is at least partially responsible for the stimulation in bacterial numbers when yeast is fed. We have shown in vitro that some bacteria such as Selenomonas ruminantium, Megasphaera elsdenii and Fibrobacter succinogenes are both the most sensitive to oxygen and are stimulated by yeast addition while others such as Streptococcus bovis are neither oxygen sensitive nor stimulated by yeast. When the bacterial population in the sheep used above was examined by molecular profiling it was clear that while yeast causes a shift in the type of bacteria within the rumen the exact response varied between animals. We are currently investigating this shift in bacteria diversity and its relationship to pathogen survival in more depth.

**Key Words:** Yeast, Probiotic, Rumen

**557 Use of essential oils and other plant extracts to modify rumen fermentation.** S. Calsamiglia*, M. Busquet, L. Castillejos, P. W. Cardozo, and A. Ferret, *Universitat Autonoma de Barcelona*, *Bellaterra, Spain*.

Ionophore antibiotics have been very effective in improving the efficiency of energy and N utilization in ruminants. However, the use of in-feed antibiotics in the EU has been banned. Some plant secondary metabolites (which include saponins, tannins, and essential oils) are able to modulate microbial activity, but scientific evidence of their effects and mechanisms of action on rumen microbial fermentation is limited. Saponins have been shown to have antiprotozoal effects resulting in reduced ammonia N concentration and increased flow of microbial protein. Results indicated that garlic oil, cinnamaldehyde (main active component of cinnamon oil), thymol (active component in thyme and oregano oils), eugenol (main active component of clove buds), capsaicin (active component of hot peppers) and anise oil, among others, may improve the efficiency of energy (by increasing total VFA or propionate, and(or) reducing acetate or methane production) and protein utilization (by modifying proteolysis, peptidolysis and(or) deamination) in the rumen. However, the effects of some of these essential oils are pH and diet dependent, and its use may only be beneficial under specific conditions and production systems: for example, while eugenol may improve energy and protein utilization in the rumen of lactating animals (high fiber diets, high pH), the fermentation profile does not support its use for beef cattle diets (high concentrate, low pH). In contrast, capsaicin appears to have little benefit for dairy cattle, while changes observed in beef cattle may improve the efficiency of energy and protein utilization. Because plant extracts may act at different levels in energy and protein metabolism, their careful selection and combination may provide a useful tool to effectively manipulate rumen microbial fermentation. However, data on their effects on animal performance is limited or non-existing. Scientific evidence for their effect on rumen microbial fermentation, the potential synergism and animal performance will be discussed.

**Key Words:** Plant extracts, Rumen fermentation

**558 Immunisation to manage fermentative acidosis and methane production.** J. B. Rowe*, *Australian Sheep Industry Cooperative Research Centre*, *Armidale, NSW, Australia*.

Increasing concern about the use of antibiotics and chemicals in animal production makes use of the immune system to help manage fermentation in the digestive tract an attractive option. This paper describes progress in use of the immune system to address two problems of modern animal production. Methane from ruminant animals is regarded as a major contributor to greenhouse gases and its reduction is an important goal. Acidosis from fermentation of starch and soluble plant carbohydrates poses a serious risk to animal health in ruminant production systems based on use of grain and/or rapidly growing pastures. Immunisation with methane or lactic acid producing organisms have been shown to change patterns of fermentation in the rumen and colon. Immunisation against key methanogens has induced levels of antibodies capable of inhibiting methane production under in vitro fermentation. Sustained in vivo inhibition of methanogenesis is the subject of on-going research. Rumen protozoa harbor methanogens and immunisation against these organisms is also a target in the quest to reduce methane production. Streptococcus bovis and Selenomonas ruminantium appear to play a critical role in the transition from stable volatile fatty acid (VFA) production and neutral pH (6.5 to 7.0) on roughage diets to production of lactic acid and low pH with introduction of grain. Immunisation against these bacteria has been shown to reduce lactic acid production and maintain higher pH in sheep and cattle subjected to carbohydrate overload. The model of carbohydrate overload is important in testing efficacy. Extreme carbohydrate overload, suitable for study of the pathophysiology of fermentative acidosis, does not appear to involve S. bovis or S. ruminantium and such challenges are not effectively controlled by immunisation. In experimental models based on natural intake of grain, or administration of a single dose, immunisation has been shown to reduce lactic acid accumulation, maintain higher pH and higher levels of feed intake. Long term effects of immunisation are suited to protection against sporadic risk and management of life-time production.

**Key Words:** Immunisation, Acidosis, Methane