



Journal of Dairy Research

Volume 85 (3) August 2018

Collected Abstracts

Effects of new n-3 fatty acid sources on milk fatty acid profile and milk fat properties in dairy cows

Elise Vanbergue, Jean-Louis Peyraud and Catherine Hurtaud

France

Summary

Feeding livestock with n-3 fatty acid (FA) sources (linseed, for example) is a common strategy to improve lipid quality of meat and milk products. However, in monogastric animals, linseed tegument decreases digestibility and alpha-linolenic acid (ALA) uptake, while the whole linseed is well used by ruminants. In a context of increasing sustainability of feeding systems, providing monogastric animals and ruminants with linseed products adapted to their digestive systems is an important issue. This research paper addresses the hypotheses: i) seamed/sift extruded linseed (SEL) specific for ruminants is as or more effective than standard extruded linseed ii) microalgae DHA Gold[®] is an interesting source of docosahexaenoic acid (DHA) in feedstuff and iii) the effects of SEL and microalgae on milk characteristics are complementary and additive. Thirty-two cows were divided into 4 groups with different dietary n-3 fatty acid sources using a continuous design. All the diets were fed as mixed rations based on maize silage, energy concentrate and soybean meal. The first group received a control diet (CTRL) with no additional fat. The 3 other groups received SEL, microalgae DHA Gold[®] (ALG) and a mixture of microalgae DHA Gold[®] and SEL (SEL/ALG). Milk was collected from morning milkings for six weeks. In SEL and SEL/ALG, ALA increased (+ 0.32 and + 0.26 percent unit, respectively), and DHA increased in ALG and SEL/ALG (+ 0.43 and + 0.15 percent unit, respectively) compared to CTRL, as a consequence of the initial composition of the n-3 FA sources. In SEL, milk yield, fat and protein contents, milk fat globule size and spontaneous lipolysis (measured to evaluate suitability for milk processing) were not different compared with CTRL. In ALG and SEL/ALG, milk yield decreased (- 2.8 and - 6.0 kg/d, respectively), fat content was halved, and fat globule size was reduced (- 1.46 and - 1.31 μm , respectively) compared to CTRL. Spontaneous lipolysis increased in ALG (+ 0.12 mEq/kg of milk) compared to CTRL. Protected microalgae and the doses of microalgae in the diet need further investigation to prevent FA

Nutritional depletion of total mixed rations by red-winged blackbirds and projected impacts on dairy cow performance

James C Carlson, Randal S Stahl, John J. Wagner, Terry E Engle, Shelagh T DeLiberto, Dustin A Reid and Scott J Werner

USA

Summary

This Research Communication describes an investigation of the nutritional depletion of total mixed rations (TMR) by pest birds. We hypothesized that species-specific bird depredation of TMR can alter the nutritional composition of the ration and that these changes can negatively impact the performance of dairy cows. Blackbirds selected the high energy fraction of the TMR (i.e., flaked corn) and reduced starch, crude fat and total digestible nutrients during controlled feeding experiments. For Holsteins producing 37.1 kg of milk/d, dairy production modeling illustrated that total required net energy intake (NE_i) was 35.8 Mcal/d. For the reference TMR unexposed to blackbirds and the blackbird-consumed TMR, NE_i supplied was 41.2 and 37.8 Mcal/d, and the resulting energy balance was 5.4 and 2.0 Mcal/d, respectively. Thus, Holsteins fed the reference and blackbird-consumed TMR were estimated to gain one body condition score in 96 and 254 d, and experience daily weight change due to reserves of 1.1 and 0.4 kg/d, respectively. We discuss these results in context of an integrated pest management program for mitigating the depredation caused by pest birds at commercial dairies.

Early weaning and high feeding level in post-weaning period did not impact milk production in Alpine dairy goats

Clémence Panzuti, Gaëlle Mandrile, Christine Duvaux-Ponter and Frédéric Dessauge

France

Summary

The experiment reported in this Research Communication aimed to determine the combined effects of early weaning and post-weaning feeding level on growth, reproductive parameters and milk yield in Alpine goats. Sixty-four Alpine goat kids were weaned abruptly at either 12.2 (± 1.40) kg (40 d of age, E) or 17.7 (± 2.30) kg (60 d of age, No). After weaning, E and No goats were subjected to 2 feeding strategies (n=16): *ad libitum* concentrate until 130 d of age and then 620 g DM/d/goat until 200 d of age (EC and NoC) or *ad libitum* concentrate until 200 d of age (EAL and NoAL). Goats were weighed twice a month until 200 d of age. Pregnancy rate and litter size were recorded. Daily milk yield was measured by milk meter during the first lactation. Up to 60 d of age, average daily gain (ADG) of E kids was significantly lower than No kids. From 60 to 130 d of age, ADG of the four treatments were not different. After 130 d of age, EC and NoC kids had lower ADG than EAL and NoAL kids. Pregnancy rates of EAL and NoAL goats were lower than those of EC and NoC. Milk yield was not modified by weaning weight or feeding management. Milk quality was not affected by any treatment.

To conclude, the age at weaning as well as the feeding level after weaning did not negatively impact growth and milk yield. We hypothesize that the establishment of the lactation function is not impacted by rearing management. Hence, decreasing the age at weaning could be an interesting way to reduce the cost of the rearing period in goat kids.

A two-step immunomagnetic separation of somatic cell subpopulations for a gene expression profile study in bovine milk

Sara Divari, Laura Starvaggi Cucuzza, Fulvio Riondato, Paola Pregel, Paola Sacchi, Roberto Rasero, Bartolomeo Biolatti and Francesca Tiziana Cannizzo

Italy

Summary

The objective of this study was to demonstrate the usefulness of an immunomagnetic method to purify subpopulations of milk somatic cells. The experiment was conducted on milk samples collected from healthy cows (n=17) and from cows with clinical mastitis (n=24) due to a *Staphylococcus aureus* natural infection. A two-step immunomagnetic purification was applied to simultaneously separate three somatic cell subpopulations from the same milk sample. Total RNA was extracted and qPCR was performed to determine mRNA levels of innate immunity target genes in purified somatic cell subpopulations. Good quality and quantity of RNA allowed the reference gene analysis in each cell subpopulation. An up-regulation of the main genes involved in innate immune defense was detected in separated polymorphonuclear neutrophilic leucocytes-monocytes and lymphocytes of mastitic milk. These results and flow cytometric analysis suggest that the immunomagnetic purification is an efficient method for the isolation of the three populations from milk, allowing the cells to be studied separately.

Evaluation of xanthosine treatment on gene expression of mammary glands in early lactating goats

Ratan K Choudhary, Shanti Choudhary, Devendra Pathak, Rahul Udehiya, Ramneek Verma, Sandeep Kaswan, Arpan Sharma, Dhiraj Gupta, Mrigank Honparkhe and Anthony V Capuco

India and USA

Summary

This study examined the hypothesis that xanthosine (XS) treatment would promote mammary-specific gene expression and stem cell transcripts and have a positive influence on milk yield of dairy goats. Seven primiparous Beetal goats were assigned to the study. Five d after kidding, one gland (either left or right) was infused with XS (TRT) twice daily for 3 d and the other gland with no XS infusion served as a control (CON). Mammary biopsies were collected at 10 d and RNA was isolated. Gene expression analysis of milk synthesis genes, mammary stem/progenitor cell markers, cell proliferation and differentiation markers were performed using real time quantitative PCR (RT-qPCR). Results showed that the transcripts of milk synthesis genes (*BLG4*, *CSN2*, *LALBA*, *FABP3*, *CD36*) and mammary stem/progenitor cell markers (*ALDH1* and *NR5A2*) were increased in as a result of XS treatment. Average milk yield in TRT glands was increased marginally (approximately ~2% $P=0.05$, paired t-test) per gland relative to CON gland until 7 wk. After 7 wk, milk yield of TRT and CON glands did not differ. Analysis of milk composition revealed that protein, lactose, fat and solids-not-fat percentages remained the same in TRT and CON glands. These results suggest that XS increases expression of milk synthesis genes, mammary stem/progenitor cells and has a small effect on milk yield.

Peroxisome proliferator-activated receptor β/δ does not regulate glucose uptake and lactose synthesis in bovine mammary epithelial cells cultivated *in vitro*

Jayant Lohakare, Johan S. Osorio and Massimo Bionaz

USA

Summary

The hypothesis of the study was that inhibition of PPAR β/δ increases glucose uptake and lactose synthesis in bovine mammary epithelial cells by reducing the expression of the glucose transporter mRNA destabilizer calreticulin. Three experiments were conducted to test the hypothesis using immortalized bovine mammary alveolar (MACT) and primary bovine mammary (PBMC) cells. In Experiment 1 the most effective dose to inhibit PPAR β/δ activity among two synthetic antagonists (GSK-3787 and PT-s58) was assessed using a gene reporter assay. In Experiment 2 the effect on glucose uptake and lactose synthesis was evaluated by measuring glucose and lactose in the media and expression of related key genes upon modulation of PPAR β/δ using GSK-3787, the synthetic PPAR β/δ agonist GW-501516, or a combination of the two in cells cultivated in plastic. In Experiment 3 the same treatments were applied to cells cultivated in Matrigel and glucose and lactose in media were measured. In Experiment 1 it was determined that a significant inhibition of PPAR β/δ in the presence or absence of fetal bovine serum was achieved with ≥ 1000 nM GSK-3787 but no significant inhibition was observed with PT-s58. In Experiment 2 inhibition of PPAR β/δ had no effect on glucose uptake and lactose synthesis but they were both increased by GW-501516 in PBMC. The mRNA abundance of PPAR β/δ target gene pyruvate dehydrogenase kinase 4 was increased but transcription of calreticulin was decreased (only in MACT cells) by GW-501516. Treatment with GSK-3787 did not affect the transcription of measured genes. No effects on glucose uptake or lactose synthesis were detected by modulation of PPAR β/δ activity on cells cultivated in Matrigel. The above data do not provide support for the original hypothesis and suggest that PPAR β/δ does not play a major role in glucose uptake and lactose synthesis in bovine mammary epithelial cells.

Associations of teat morphometric parameters and subclinical mastitis in riverine buffaloes

Kaur Gagandeep, Baljinder Kumar Bansal, Raj Sukhbir Singh, Neeraj Kashyap and Shukriti Sharma

India

Summary

The possible association between teat morphometric traits and subclinical mastitis (SCM) in dairy buffaloes was studied. Teat morphometric parameters, i.e. teat shape (bottle, conical, cylindrical, and others), teat-end shape (flat, round, and pointed), teat length (TL), teat diameter (TD), and teat-end to floor distance were measured before milking, but after proper milk let-down, in clinically healthy buffaloes (47 Murrah and 34 Nili-Ravi breeds). Subclinical mastitis was defined on the basis of bacteriology and somatic cell count (SCC) of quarter foremilk samples. A high proportion of cylindrical teats (40%) and pointed teat-ends (64.4%) was observed. Hind teats were longer and thicker than fore teats ($P<0.05$). A significant breed effect was found with respect to teat shape, length and diameter ($P<0.05$). Teats were mostly cylindrical (43.3 vs. 35.4%) and conical (34.2 vs. 30.8%) shaped, smaller (mean 8.2 vs. 9.5 cm) and thinner (mean 3.3 vs. 3.6 cm) in the Murrah breed compared with the Nili-Ravi breed. Teats that had 'other' shapes and were longer, wider, and placed closer to the floor were more associated with SCM ($P<0.05$). Mean SCC was significantly higher ($P<0.05$) in Nili-Ravi buffaloes, teat shapes classified as 'others', and quarters with SCM. Teat morphometric traits seem to be associated with indicators of udder health in buffaloes, thus, their inclusion in breeding programmes for selection against undesirable dairy type traits may be of value in reducing susceptibility to intramammary infections in Indian buffaloes.

Associations of the first occurrence of pathogen-specific clinical mastitis with milk yield and milk composition in dairy cows

Mitsunori Kayano, Megumi Itoh, Nobuyuki Kusaba, Osamu Hayashiguchi, Katsuya Kida, Yoshiharu Tanaka, Keiko Kawamoto, and Yrjö T Gröhn

Japan and USA

Summary

The aim of this study was to estimate the associations of the first occurrence of pathogen-specific clinical mastitis (CM) with milk yield and milk composition (somatic cell count (SCC), lactose, fat, protein content in milk and milk urea nitrogen (MUN)). We studied 3149 dairy cows in 31 Hokkaido dairy farms in Japan. Five pathogen groups were studied: *Streptococcus* spp.; *Staphylococcus aureus* (*S. aureus*); coagulase-negative staphylococci (CNS); coliforms; and fungi. Test-day milk data and clinical records were collected from June 2011 until February 2014. Mixed models with an autoregressive correlation structure were fitted to quantify the effects of CM and several other control variables (herd, calving season, parity, week of lactation, and other diseases). Primipara (first lactation) and multipara (second and later lactations) were analysed separately. All pathogens, particularly *S. aureus* and fungi, were associated with significant milk losses in multipara. In this study, *S. aureus* and CNS infections were not associated with significant milk loss in primipara. All pathogens, in particular *S. aureus* and fungi, significantly increased SCC in both parity groups. All pathogens, especially CNS (in primipara) and *S. aureus* (in multipara), decreased lactose content. All pathogen groups except for fungi were associated with significant changes in fat, protein and MUN. Some pathogens such as *Streptococcus* spp. and coliforms seemed to be associated with long-term fat, protein and MUN changes. These findings provide estimates that could be used to calculate precise costs of CM, and also provide better indicators of pathogen-specific mastitis.

Association of subclinical mastitis prevalence with sheep breeds in Greece

Natalia GC Vasileiou, Dimitris A Gougoulis, Valentino Riggio, Katerina S Ioannidi, Dimitris C Chatzopoulos, Vasia S Mavrogianni, Efthimia Petinaki and George C Fthenakis

Greece and UK

Summary

The objective of the research described in this Research Communication was to describe potential associations of subclinical mastitis with sheep breeds in Greece. A countrywide survey (2,198 ewes in 111 farms) was performed. Prevalence of subclinical mastitis was 0.260. Results did not indicate any difference in the prevalence of subclinical mastitis between farms with pure-bred and farms with cross-bred animals, nor any difference in prevalence between farms with Greek pure-bred animals and farms with imported pure-bred animals. Results indicated that prevalence of subclinical mastitis was smaller in farms with Assaf-breed (0.100) and higher in farms with Frisarta-breed (0.625) ($P<0.02$). Prevalence of mastitis was smaller in farms with Greek traditional indigenous breeds (0.221) ($P=0.007$). In a model that included sheep breed and management system in farm, breed emerged as a significant factor for prevalence of subclinical mastitis ($P=0.003$).

Detection of tetracycline and other antimicrobial residues in milk from cows with clinical mastitis treated by combination therapy

Aleksandar Siljanoski, Renata Ciglarič, Tomaž Pezdir, Petra R Lainšček, Jožica Dolenc, Jože Starič and Ksenija Šinigoj-Gačnik

Slovenia

Summary

The purpose of this study was to determine tetracycline and other antimicrobial residues in milk from dairy cows treated for clinical mastitis. Data on cow health and drugs used were obtained from the farm veterinarians. A milk sample from each affected udder quarter of each cow was taken for bacterial identification before treatment. All 35 cows in the study were treated with an intramammary product containing tetracycline, neomycin, bacitracin, and prednisolone (tetracycline injector) and also simultaneously with other drugs via the intramammary or parenteral route. The withhold period of the "tetracycline product" was eight milkings but, in all cases, longer withhold periods were prescribed due to off-label application of additional combinations of drugs. Milk samples from treated udder quarters, taken two milkings before and two after the prescribed withhold period, were analysed for antimicrobial residues. Additionally, milk samples were taken from untreated healthy udder quarters to check if any crossover of drugs had occurred. Three screening tests were used for antimicrobial detection. In 15 (42.9%) cows the milk samples from the treated infected quarters contained tetracycline residues above the maximum residue limit (MRL) after the prescribed withhold period and, in two cases (5.7%) the same was true for neomycin and cefquinome residues. Cephalexin above the MRL was detected in only one case (2.9%). Beta-lactams did not exceed the MRL after the prescribed withhold period. Antimicrobial residues were not detected in milk samples from untreated quarters. Cow condition including parity, decreased milk production and severity of mastitis significantly influenced the excretion of antimicrobials in milk ($P\leq 0.05$). No significant differences were found between the tetracycline positive and tetracycline negative cows regarding the bacteria involved, combination antimicrobial therapy, or treatment interval and duration.

Technological attempts at producing cheese from donkey milk

Michele Faccia, Giuseppe Gambacorta, Giovanni Martemucci, Giuseppe Natrella and Angela G D'Alessandro
Italy

SUMMARY

The work described in this Research Communication addressed the hypothesis that it is possible to produce cheese from donkey milk by appropriate adjusting of the cheesemaking parameters. A series of coagulation trials were performed on donkey milk, alone or fortified with goat milk (85/15 and 70/30, v/v), using calf rennet under different technological conditions. The parameters that changed were pH and concentration of soluble calcium, amount of rennet added and temperature of coagulation. Donkey milk gave rise to sufficiently firm curd only at "extreme" technological conditions and, as expected, addition of goat milk improved coagulation. A cheesemaking protocol was developed for producing fresh cheese prototypes, which were checked for microbiological safety, chemical composition and sensory characteristics. Pure donkey milk gave 5.9 % yield, cheese having 6.12 pH, 32.4 % dry matter, 2.1 % fat and 18.5 % protein. The electrophoretic analysis ascertained that β -casein was the most abundant compound in donkey cheese, but whey proteins were also present in non-negligible amounts. Finally, the sensory evaluation demonstrated that all cheeses were acceptable and provided detailed description of their flavour characteristics.

Early blowing in raw goats' milk cheese: gas production capacity of *Enterobacteriaceae* species present during manufacturing and ripening

Rafael Tabla, Antonia Gómez, Alfredo Simancas, José Emilio Rebollo, Felipe Molina and Isidro Roa
Spain

Summary

The aim of this study was to identify the main *Enterobacteriaceae* species responsible for early gas blowing during curdling and the first week of ripening in raw goats' milk cheese. Two batches of raw goats' milk cheese were selected. One of them showed early blowing within the first 24 h of cheese ripening while the other showed no alteration. Although initial levels of *Enterobacteriaceae* were similar in defective and non-defective cheese, their dynamics (growth and disappearance rates of the species detected) were different. *Klebsiella oxytoca* and *Enterobacter cloacae* were the main species in the defective curd, whereas *Buttiauxella spp.* was predominant in normal curd. *Hafnia alvei* was the prevailing isolated species for both normal and defective cheese throughout the ripening process. The highest gas production was rendered by *K. oxytoca* and *H. alvei*, mainly isolated from curd and cheese. However, other species relevant in milk or curd, like *Pantoea ssp.* or *Buttiauxella spp.* were considered as low gas producers. The analysis of digitalized images of cheese showed that most of the cheese eyes were formed before the first week of ripening, although this process continued during maturation.

According to the species found in the defective and non-defective cheese, their proportions at different ripening stages, their ability to produce gas and eye formation, *K. oxytoca* might be considered the most likely responsible for early blowing in raw goats' milk cheeses; while *H. alvei* increased the eyes number in the later stages of the ripening period.

Artificial neuronal networks (ANN) to model the hydrolysis of goat milk protein by subtilisin and trypsin

F Javier Espejo-Carpio, Raúl Pérez-Gálvez*, Antonio Guadix and Emilia M Guadix

Spain

Summary

The enzymatic hydrolysis of milk proteins yield final products with improved properties and reduced allergenicity. The degree of hydrolysis (DH) influences both technological (e.g., solubility, water binding capacity) and biological (e.g., Angiotensin-converting enzyme (ACE) inhibition, antioxidation) properties of the resulting hydrolysate. Phenomenological models are unable to reproduce the complexity of enzymatic reactions in dairy systems. However, empirical approaches offer high predictability and can be easily transposed to different substrates and enzymes. In this work, the DH of goat milk protein by subtilisin and trypsin was modelled by feedforward artificial neural networks (ANN). To this end, we produced a set of protein hydrolysates, employing various reaction temperatures and enzyme/substrate ratios, based on an experimental design

The time evolution of the DH was monitored and processed to generate the ANN models. Extensive hydrolysis is desirable because a high DH enhances some bioactivities in the final hydrolysate, such as antioxidant or antihypertensive. The optimisation of both ANN models led to a maximal DH of 23.47% at 56.4°C and enzyme-substrate ratio of 5% for subtilisin, while hydrolysis with trypsin reached a maximum of 21.3% at 35°C and an enzyme-substrate ratio of 4%.

Screening of cell surface properties of potential probiotic lactobacilli isolated from human milk

Namita Rokana, Brij Pal Singh, Nishchal Thakur, Chetan Sharma, Rohini Devidas Gulhane and Harsh Panwar

India

Summary

Evaluation of eleven candidate probiotic *Lactobacillus* strains isolated from human milk showed that some of the strains were well endowed with desirable cell surface and attachment attributes. The cell surface properties (hydrophobicity, auto-aggregation, attachment to collagen and HT-29 monolayer) of probiotic *Lactobacillus* species of human milk origin were compared with reference probiotic/ non-probiotic species and pathogenic strains. The bacterial adhesion to hydrocarbons (BATH) was determined using three aliphatic (Chloroform, n-Hexane and n-Octane) and two aromatic (Toluene and Xylene) solvents. Maximum affinity of *Lactobacillus* strains towards chloroform and toluene indicated the presence of low electron acceptor/ acidic surface components on cell surface of most of the strains. The highest value of percent hydrophobicity was recorded with chloroform in HM1 (*L. casei*) (97.10±3.35%) and LGG (98.92±1.24%). A moderate auto-aggregation attribute was observed in all of our *Lactobacillus* isolates. Only HM10, HM12 and HM13 exhibited comparatively enhanced precipitation rate after 7 hours of incubation period. The adhesion potential to collagen matrix was highest in LGG (26.94±5.83%), followed by HM1 (11.07±3.54%) and HM9 (10.85±1.74%) whereas, on HT-29 cells, HM8 (14.99±3.61%), HM3 (13.73±1.14%) and HM1 (11.21±3.18%) could adhere effectively. In this manner, we noticed that although the cell surface properties and adhesion prospective of probiotic bacteria were strain dependent, five of our isolates viz. HM1, HM3, HM8, HM9 and HM10 exhibited promising cell surface properties, which could be further targeted as indigenous probiotic.

Lack of evidence of IgE allergic sensitization from working with lactic acid bacteria in the dairy foods industry.

Coralie Barrera, Gabriel Reboux, Audrey Laboissière, Laurence Millon and Anne Oppliger
France and Switzerland

Summary

This research communication aimed to evaluate the level of immunoglobulin E from lactic acid bacteria (LAB) that are used in dairy industries. Previous studies have demonstrated that workers report symptoms of irritation and are frequently IgG-sensitized to LAB. Workers (n=44) from a probiotic production unit and the control lab were seen by a medical practitioner and responded to an occupational questionnaire. Specific IgE by the DELFIA® technique against 6 strains of LAB were measured on 44 exposed workers and 31 controls sera. Levels of specific IgE were low and no difference was observed between the two groups. This lack of IgE response could be explained by a healthy worker effect, an efficient implementation of personal protective equipment or by an absence of allergic mechanisms to account for the self-reported irritative symptoms. Despite the high concentrations of LAB, preventive measures are effective enough to guarantee no allergic effect and to prevent other adverse health effects. The implementation of preventive measures to avoid or reduce exposure to dust of LAB, and more generally to milk powder, is recommended in all dairy industry.

Immune reactivity against a variety of mammalian milks and plant-based milk substitutes

Aristo Vojdani, Chris Turnpaugh and Elroy Vojdani
USA

Summary

The research reported here seeks to evaluate the allergenicity and antigenicity of different mammalian and plant-based milks/milk substitutes in healthy subjects. We used ELISA to measure IgE and IgG antibodies against cow, goat, sheep, camel, human milks, and soy, almond, and coconut plant-based milk substitutes, as well as IgA antibodies against all these apart from human milk, in 500 individuals in order to find the percentage of antibody elevation. IgG and IgE positivity showed that human milk was the least antigenic and allergenic, followed by camel milk. Cow's milk showed the highest percentage of elevation or reactivity. Among plant-based milk substitutes, the almond-based substitute was the most allergenic with the highest IgE reactivity, while the coconut milk substitute was lowest. For IgG and IgA immuno-reactivity, soy was first, with coconut again the lowest. We found IgE and IgG immune reactivity against coconut, almond and soymilks in some individuals who were non-reactive to mammalian milk, therefore, we should not assume that consumption of these milks is automatically without risk of allergenic response. We selected 24 samples out of the original 500 for the measurement of IgE antibodies against five different types of cow's milk, from non-organic to organic, A1 and A2. Statistical variance analysis detected no significant difference in IgE, IgG and IgA immune reactivities of the five different cow milks. Our results showed that if an individual is immuno-reactive to cow's milk, organic or not, the probability of reacting to goat and sheep milk is very high. Overall, the results presented here showed that for individuals allergic to cow's milk, the least allergenic alternatives in descending order are human, camel, sheep, and goat milks. Before choosing an alternative for cow's milk, one must go through accurate and quantitative blood testing for determination of IgE, IgG and IgA antibodies against different mammalian and plant-based milks/milk substitutes.

DairyWater: Striving for sustainability within the dairy processing industry in the Republic of Ireland

William Finnegan, Eoghan Clifford, Jamie Goggins, Niall O’Leary, Alan Dobson, Neil Rowan, Liwen Xiao, Song Miao, Kelly Fitzhenry, Peter Leonard, Emma Tarpey, Beatriz Gil-Pulido, Fei Gao and Xinmin Zhan

Ireland

Summary

This Review describes the objectives and methodology of the DairyWater project as it aims to aid the Irish dairy processing industry in achieving sustainability as it expands. With the abolition of European milk quotas in March 2015, the Republic of Ireland saw a surge in milk production. The DairyWater project was established in anticipation of this expansion of the Irish dairy sector in order to develop innovative solutions for the efficient management of water consumption, wastewater treatment and the resulting energy use within the country’s dairy processing industry. Therefore, the project can be divided into three main thematic areas: dairy wastewater treatment technologies and microbial analysis, water re-use and rainwater harvesting and environmental assessment. In order to ensure the project remains as relevant as possible to the industry, a project advisory board containing key industry stakeholders has been established. To date, a number of large scale studies, using data obtained directly from the Irish dairy industry, have been performed. Additionally, pilot-scale wastewater treatment (intermittently aerated sequencing batch reactor) and tertiary treatment (flow-through pulsed ultraviolet system) technologies have been demonstrated within the project. Further details on selected aspects of the project are discussed in greater detail in the subsequent cluster of research communications.

Potential of using synthesized nano-zeolite for ammonium and phosphate immobilisation in dairy wastewater

Fei Gao, Liwen Xiao and Hongzhou Zhang

Ireland

Summary

The studies described in the Research Communication aimed to describe the feasibility of using coal fly ash to synthesize nano-zeolite, and the ammonium and phosphate adsorption efficiencies of the nanomaterial in dairy wastewater. Chemical treatment of coal fly ash was conducted and changes observed. Samples treated with NaOH had an increased cation exchange capacity and P sorption index compared to the initial fly ash, due to particle modification from smooth surface to plate- and rod-shape crystals, referred to as nano-zeolite. Batch experiments were conducted by mixing coal fly ash and nano-zeolite with synthesized wastewater to study the effect of sorption time, pH values and dosage of nano-zeolite on ammonium and phosphate removal efficiency. The adsorption process reached equilibrium in a very short time (less than 60min), which suggests a potential for fast immobilisation of pollutants. The concentration of ammonium decreased from 118 to 35 mg/L (71% removal) while the concentration of phosphate decreased from 52 to 45 mg/L. The removal efficiency of ammonium was 36.6, 51.8 and 70.9% at pH 3, 7 and 10, respectively whilst that of phosphate increased dramatically with decreased slurry pH (92.1, 47.3 and 12.3% at pH 3, 7 and 10, respectively). Nano-zeolite could be a potential absorbent for fast immobilisation of ammonium but not phosphate. Surface modification of nano-zeolite could be introduced in order to enhance the pollutants removal efficiency.

Efficient treatment of dairy processing wastewater in a laboratory scale Intermittently Aerated Sequencing Batch Reactor (IASBR)

Peter Leonard, Emma Tarpey, William Finnegan and Xinmin Zhan
Ireland

Summary

This Research Communication describes an investigation into the viability of an Intermittently Aerated Sequencing Batch Reactor (IASBR) for the treatment of dairy processing wastewater at laboratory-scale. A number of operational parameters have been varied and the effect has been monitored in order to determine optimal conditions for maximising removal efficiencies. These operational parameters include Hydraulic Retention Time (HRT), Solids Retention Time (SRT), aeration rate and cycle length. Real dairy processing wastewater and synthetic wastewater have been treated using three laboratory-scale IASBR units in a temperature controlled room. When the operational conditions were established the units were seeded using sludge from a municipal wastewater treatment plant for the first experiment and sludge from a dairy processing factory for the second and third experiment. In experiment three, the reactors were fed on real wastewater from the wastewater treatment plant at this dairy processing factory. These laboratory-scale systems will be used to demonstrate over time that the IASBR system is a consistent, viable option for treatment of dairy processing wastewater in this sector. In this study, the capacity of a biological system to remove both nitrogen and phosphorus within one reactor will be demonstrated. The initial operational parameters for a pilot-scale IASBR system will be derived from the results of the study.

Efficient treatment of dairy processing wastewater in a pilot scale Intermittently Aerated Sequencing Batch Reactor (IASBR)

Peter Leonard, William Finnegan, Maria Barrett and Xinmin Zhan
Ireland

Summary

This Research Communication describes the initial operation of a pilot-scale intermittently aerated sequencing batch reactor system, which is located at an Irish dairy processing factory. Laboratory-scale research has facilitated the design specifications and operational parameters necessary for the construction and running of a pilot-scale. Laboratory scale research was necessary prior to the pilot scale system to ensure high quality treatment and nutrient removal efficiencies. The pilot system operates with a hydraulic retention time of 4 days, a solids retention time of 16 days and a cycle length of 12-hours. There are 4 non-aeration and aeration phases within the system's react phase. This system has a 3000 litre working volume, treating 375 litres of wastewater per cycle, 750 litres daily. The system was seeded from an aeration tank at the dairy processing factory where the unit is located. The system is operating with the goal to remove both nitrogen and phosphorus from the wastewater biologically, reducing the need for chemical treatment. Currently, the system is performing with high efficiency, treating the wastewater to an acceptable level according to the Irish Environmental Protection Agency for discharge into surrounding water bodies. Therefore, the initial removal results demonstrate this technology's suitability for the treatment of high strength dairy wastewaters.

Dominance of the genus *Polaromonas* in the microbial ecology of an Intermittently Aerated Sequencing Batch Reactor (IASBR) treating dairy processing wastewater under varying aeration rates.

Beatriz Gil-Pulido, Emma Tarpey, William Finnegan, Xinmin Zhan, Alan DW Dobson and Niall O' Leary
Ireland

Summary

In this Research Communication we investigate potential correlations between key bacterial groups and nutrient removal efficiency in an Intermittently Aerated Sequencing Batch Reactor (IASBR) treating synthetic dairy processing wastewater. Reactor aeration rates of 0.6 and 0.4 litre per minute (LPM) were applied to an 8 litre laboratory scale system and the relative impacts on IASBR microbial community structure and orthophosphate (PO₄-P) and ammonium (NH₄-N) removal efficiencies compared. Aeration at 0.6 LPM over several sludge retention times (SRTs) resulted in approximately 92% removal efficiencies for both PO₄-P and NH₄-N. Biomass samples subjected to next generation sequencing (NGS), 16S rRNA profiling revealed a concomitant enrichment of *Polaromonas* under 0.6 LPM conditions, up to ~50% relative abundance within the reactor biomass. The subsequent shift in reactor aeration to 0.4 LPM, over a period of 3 SRTs, resulted in markedly reduced nutrient removal efficiencies for PO₄-P (50%) and NH₄-N (45%). An 85.7% reduction in the genus level relative abundance of *Polaromonas* was observed under 0.4 LPM aeration conditions over the same period.

Microbiological characterisation and impact of suspended solids on pathogen removal from wastewaters in dairy processing factories

Kelly Fitzhenry, Neil Rowan, William Finnegan, Xinmin Zhan and Eoghan Clifford
Ireland

Summary

In this Research Communication we investigate the microbiological profile of 12 dairy wastewater streams from three contrasting Irish dairy processing factories to determine whether faecal indicators/pathogens were present and in turn, whether disinfection may be required for potential water reuse within the factory. Subsequently, the impact of suspended solids on the inactivation efficiency of *E.coli* via two means of ultraviolet (UV) disinfection; flow-through pulsed UV (PUV) and continuous low pressure UV (LPUV) disinfection was analysed. Faecal indicators of total coliforms and *E.coli* were detected in 10 out of the 12 samples collected at the dairy processing factories while pathogenic bacteria *Listeria monocytogenes* was detected in all samples collected at 2 out of the 3 factories. *Salmonella spp.* was undetected in all samples. The results also indicated that organic dairy wastewater solids had an impact on the performance efficiency of the PUV system and, to a lesser extent, the LPUV system. The findings indicate that the targeting of key pathogens would be required to enable wastewater reuse (and indeed effluent discharges if regulation continues to become more stringent) and that LPUV may offer a more robust disinfection method as it appears to be less susceptible to the presence of suspended solids.

Assessing the environmental impact of the dairy processing industry in the Republic of Ireland

William Finnegan, Jamie Goggins and Xinmin Zhan

Ireland

Summary

This Research Communication describes the methodology used and the subsequent results obtained for an assessment of the environmental impact associated with the manufacture of dairy products in the Republic of Ireland. As the Irish dairy industry changes and grows, it is necessary to have a benchmark of the environmental performance of the sector if it is to remain sustainable in the future. In order to estimate the environmental impact, life cycle assessment has been implemented, which has been structured in accordance with the International Organisation for Standardisation guidelines. In this study, the environmental impact categories assessed are terrestrial acidification potential, cumulative energy demand, freshwater eutrophication potential, global warming potential, marine eutrophication potential and water depletion. The main Irish dairy products have been compared across these environmental impact categories in order to derive meaningful results. It is identified that packaging materials, particularly for infant formula, and energy usage, across each of the life cycle stages, should be targeted as these are the most significant contributors to the overall environmental impact.