Editorial: Quality dairying

Christopher H Knight

UK

Supplementation with antioxidants and phenolic compounds in ruminant feeding and its effect on dairy products: a systematic review

Azalia Avila-Nava, Isabel Medina-Vera, Hugo Toledo-Alvarado, Luis Corona and Claudia C Márquez-Mota

Mexico

Abstract

Milk and dairy products have great importance in human nutrition related to the presence of different nutrients, including protein, fatty acid profile and bioactive compounds. Dietary supplementation with foods containing these types of compounds may influence the chemical composition of milk and dairy products and hence, potentially, the consumer. Our objective was to summarize the evidence of the effect of supplementation with antioxidants and phenolic compounds in the diets of dairy animals and their effects on milk and dairy products. We conducted a systematic search in the MEDLINE/PubMed database for studies published up until July 2022 that reported on supplementation with antioxidants and phenolic compounds in diets that included plants, herbs, seeds, grains and isolated bioactive compounds of dairy animals such as cows, ewes and goats and their effects on milk and dairy products. Of the 94 studies identified in the search, only 15 met the inclusion criteria and were analyzed. The review revealed that supplementation with false flax cake, sweet grass, *Acacia farnesiana*, mushroom myceliated grains and sweet grass promoted an effect on the milk lipid profile, whereas supplementation with dried grape pomace and tannin extract promoted an effect on the milk and cheese lipid profiles. In six studies, the addition of *Acacia farnesiana*, hesperidin or naringin, durum wheat bran, mushroom myceliated grains, dried grape pomace and olive leaves increased the antioxidant activity of milk. In conclusion, supplementation with bioactive compounds had a positive impact which ranged from an increase in antioxidant capacity to a decrease oxidative biomarkers such as malondialdehyde.

The effect of slow-release milk replacer feeding on health and behaviour parameters in dairy breed calves

Lea Krump, Ríona G Sayers, Emer Kennedy, Jim O'Mahony and Gearóid P Sayers
Ireland

Abstract

The aim of this research paper was to evaluate the effect of a slow-release milk replacer on health and behaviour of neonatal dairy calves and its potential benefits during transport, where prolonged periods of hunger are commonplace. A total of 15 calves were randomly divided into three groups of 5, namely, a control group fed twice in 24h with 3 litres of a conventional milk replacer, a slow-release group fed once in 24h with 2 litres of conventional milk replacer and 1 litre of a specialised micro-encapsulated feed and an enriched-replacer group fed once in 24h with 3 litres of milk replacer enriched with micellar casein. Blood samples were taken before feeding and 6, 12, 18 and 24 hours after and analysed for acid-base parameters, electrolytes, glucose, haemoglobin, cortisol, insulin, cholecystokinin and adiponectin. Calf behaviour was recorded between 6 and 14 hours after feeding. There was a significant increase in blood pH 6 hours after feeding in all groups, but the glucose, HCO_3^- and base equivalent increased significantly in the slow-release group only, whereas sodium increased significantly in the enriched group only. Glucose levels remained significantly higher in the slow-release group, relative to the control, at 6, 12, and 18 hours after feeding. Insulin levels changed significantly over time in the enriched and control group but remained constant in the slow-release group. Insulin levels were significantly higher in the control group when compared to the slow-release group after feeding. Adiponectin changed significantly over time after feeding in the control group only, but no significant changes were observed between the feeding groups. Calves in the enriched group spent significantly less time lying and vocalised more, when compared to the other two groups. In conclusion, feeding of slow-release milk replacer demonstrated different metabolic patterns relative to conventional feeding and was comparable in terms of calf behaviour.

Milk coagulation properties are moderately heritable in dairy cows: A meta-analysis using the random-effects model

Navid Ghavi Hossein-Zadeh
Iran

Abstract

This study aimed to conduct a meta-analysis using the random-effects model to merge published genetic parameter estimates for milk coagulation properties (MCP: comprising rennet coagulation time (RCT), curd-firming time (k20), curd firmness 30 min after rennet addition (a30), titrable acidity (TA) and milk acidity or pH) in dairy cows. Overall, 80 heritability estimates and 157 genetic correlations from 23 papers published between 1999 and 2020

were used. The heritability estimates for RCT, a30, k20, TA, and pH were 0.273, 0.303, 0.278, 0.189 and 0.276, respectively. The genetic correlation estimates between RCT-a30, RCT-pH, and RCT-TA were 0.842, 0.549 and -0.565, respectively. Genetic correlation estimates between RCT and production traits were generally low and ranged from -0.142 (between RCT and casein content) to 0.094 (between RCT and somatic cell score). Moderate and significant genetic correlations were observed between a30-pH (-0.396) and a30-TA (0.662). Also, the genetic correlation estimates between a30 and production traits were low to moderate and varied from -0.165 (between a30 and milk yield) to 0.481 (between a30 and casein content). Genetic correlation estimates between pH and production traits were low and varied from -0.190 (between pH and milk protein percentage) to 0.254 (between pH and somatic cell score). The results of this meta-analysis indicated the existence of additive genetic variation for MCP that could be used in genetic selection programs for dairy cows. Because of the moderate heritability of MCP and small genetic correlations with production traits, it could be possible to improve MCP with negligible correlated effects on production traits.

Detection of two SNPs of the *LIPE* gene in Holstein-Friesian cows with divergent milk production

Seham El-Kassas, Haitham G Abo-Al-Ela, Esraa Abdulraouf, Mohamed Atef Helal, A M Sakr and Safaa E Abdo
Egypt

Abstract

The *LIPE* gene (*lipase E*, hormone sensitive type), also known as *hormone-sensitive lipase*, acts as a primary regulator of lipid metabolism during lactation in cows. We studied a total of two hundred Holstein-Friesian cows and performed sequencing analysis that revealed two synonymous nucleotide changes within the *LIPE* gene: a transition change, c.276T>C in exon 2 (g.50631651T>C; position 351 of GenBank: ON638900) and a transversion change, c.219C>A in exon 6 (g.50635369C>A; position 1070 of GenBank: ON638901). The observed genotypes were TC and CC for the c.276T>C SNP and CC and CA for the c.219C>A SNP. Notably, the heterozygous TC genotype of the T351C SNP exhibited a significant association with high milk yield. Furthermore, the T351C SNP displayed significant associations with various milk parameters, including temperature, freezing point, density and the percentages of fat, protein, lactose, solids and solids-not-fat, with the homozygous CC genotype showing higher values. The c.219C>A SNP also demonstrated a significant association with milk composition, with heterozygous genotypes (CA) exhibiting higher percentages of fat, protein, and lactose compared to homozygous genotypes (CC). This effect was consistent among both high and low milk producers for fat and lactose percentages, while high milk producers exhibited a higher protein percentage than low milk producers. These findings highlight the importance of considering the detected SNPs in marker-assisted selection and breeding programs for the identification of high milk-producing Holstein-Friesian cows and potentially other breeds.

Moreover, this study strongly supports the fundamental role of the *LIPE* gene in milk production and composition in lactating animals.

Do you see the pattern? Make the most of sensor data in dairy cows

Akke Kok, Emma Ternman and Vivi M. Thorup
The Netherlands, Norway and Denmark

Abstract

Sensors are increasingly being used to monitor animal behavior. Data handling methods have, however, lagged behind the continuous data stream to some extent, often being limited to summarizing data into daily averages at group level. This research reflection presents our opinion of the neglected application of 24-h pattern analysis. Recent studies of dairy cow behavior have demonstrated that additional ways of analyzing data improve our understanding of animal behavior and add value to data that were already retrieved. The terminology for the described 24-h patterns differs between these studies, making them difficult to compare. Thus, diurnal, circadian, daily, periodicity and 24-h pattern are all terms used to describe dairy cow activities over a 24-h period. Several studies have shown that the 24-h behavioral pattern at herd level is relatively consistent over time, and that with well-established management routines, a specific herd signature will be evident. However, within a herd, individual cows may have individual 24-h patterns with more or less variability. Recent studies suggest that deviations from herd and/or individual 24-h patterns can be used to describe cow robustness, as well as to predict disease. We strongly believe that individual and herd 24-h patterns provide a great deal of information about behavior and that these patterns offer opportunity for more precise and timely health management and welfare monitoring.

The relationship between feed efficiency and behaviour differs between lactating Holstein and Jersey cows

Vivi M Thorup, Lene Munksgaard, Marta Terré, Julie CS Henriksen, Martin R Weisbjerg and Peter Løvendahl
Denmark and Spain

Abstract

In dairy production, high feed efficiency (FE) is important to reduce feed costs and negative impacts of milk production on the climate and environment, yet little is known about the relationship between FE, eating behaviour and activity. This research communication describes how cows differing in FE, expressed as daily energy corrected milk production per unit of feed intake, differed in eating behaviour and activity. We used data from a study of 253 lactations obtained from 97 Holstein and 91 Jersey cows milked in an automatic milking

system. Automated feed troughs recorded feed intake behaviour and cows wore a sensor that recorded activity from 5 to 200 days in milk (DIM). We used a mixed linear model to estimate random solutions for individual cows for traits of steps, lying and eating behaviour and calculated their correlation with FE during four periods (5-35, 36-75, 76-120 and 121-200 DIM). Separate analyses were performed for each breed and period. We found that individual level correlations between FE and behaviour traits were stronger in Jersey than in Holstein cows. Eating rate correlated weakly negatively to FE in Holstein cows and more strongly so in Jersey cows, such that efficient Jerseys were slower eaters. The physical activity of Jersey cows was weakly and negatively correlated to FE, but this was not the case in Holstein cows. We conclude that eating rate was consistently negatively associated with FE throughout lactation for Jersey cows, but not for Holstein cows.

Association between dam and calf measurements with overall and fetopelvic dystocia in Holstein heifers.

Angeliki Tsaousioti, Anastasia Praxitelous, Akke Kok, Evangelos Kiossis, Constantinos Boscos and Georgios Tsousis
Greece and the Netherlands

Abstract
We investigated the relationship between dam's pelvic and calf's dimensions with dystocia due to fetopelvic disproportion in the Holstein breed and estimated risk factors and dystocia probability. For this purpose, external pelvic measurements were performed in 402 heifers $15 \pm 11 (1 - 38)$ days ante-partum and specific conformation measurements were obtained from their calves 1.7 ± 1.2 post-partum. Dystocia was defined as the inability of the heifer to complete parturition spontaneously within 120 minutes after the appearance of the amnion with normal presentation, position and posture or as having definite obstetrical obstacles within 60 min. Overall and fetopelvic disproportion dystocia incidence was 10.4% and 5.2%, respectively. Heifer measurements mainly influenced overall dystocia, whereas calf conformation was related solely with fetopelvic dystocia. Specifically, heifers with a small pelvis (hip width <49.95 cm, pelvic inlet area <333.2 cm^2, pelvic volume <7799.2 cm^3) had 2.8 to 3.5 times greater incidence of overall dystocia $(19.0 - 20.8\%)$ compared to heifers with a larger pelvis (incidence of $7.0 - 7.6\%$). Regarding calf factors, sex (male calves), body weight, chest circumference and fetlock joint circumference significantly increased the odds of experiencing dystocia due to fetopelvic disproportion compared with female, lighter or smaller calves. In a backward elimination model with independent variables treated as continuous, an area under the ROC curve of 0.66 regarding the prediction of overall dystocia based on heifer pelvic length, and of 0.64 for the prediction of fetopelvic dystocia based on fetlock joint circumference was found. The combination of the two variables in one model improved the ROC area to 0.71 regarding dystocia due to fetopelvic disproportion, reaching acceptable level of discrimination. Our findings indicate that dystocia due to fetopelvic

disproportion in heifers is mainly influenced by the fetal side. Additionally, the estimation of pelvic dimensions of the dam before parturition and specific conformation characteristics of the calf during parturition, especially fetlock joint circumference, could aid obstetricians and herdsmen regarding dystocia probability and parturition surveillance.

Skin carotenoid levels in lactating dairy cows as measured using multiple spatially resolved reflection spectroscopy

Martina Jakob, Joana Lima, Frederic Launay and Holly J Ferguson
Germany, France and UK

Abstract

This research communication describes a pilot study measuring skin carotenoid levels of lactating dairy cows. Carotenoids are natural antioxidants, involved in cell communication and immune function, protecting against oxidative stress. They are precursors of vitamin A, important for reproduction efficiency, growth and male fertility. Therefore, easy-to-use, inexpensive methods to measure carotenoids in cattle would provide interesting data for farmers to monitor the health and nutritional status of their herds. In this study, we used a commercially available sensor based on multiple spatially resolved reflection spectroscopy (MSRRS), intended for human use, to measure the carotenoid content in bovine skin in three research herds in France, Ireland and Scotland. Carotenoid levels were measured by applying the sensor to the teat barrel, avoiding pigmented areas of skin. Mean sensor values differed significantly between herds and between diets, with pasture-based animals showing significantly higher carotenoid levels. Our results suggest that MSRRS can be used to accurately to measure skin carotenoids in cows. However, further calibration in bovines is needed to improve of the accuracy of the MSRRS sensor in cattle.

Predicting dairy herd resilience on farms with conventional milking systems

Roxann SC Rikkers, Bart J. Ducro, Rianne van Binsbergen and Claudia Kamphuis
The Netherlands

Abstract

This research paper addresses the problem that, thus far, there is no method available to predict herd resilience for farms that do not use automated milking systems (AMS). Recently, a methodology was developed to estimate both individual cow as well as herd resilience using daily milk yield observations at individual cow level from farms with AMS. This AMS-based method, however, is not suitable on farms that use conventional milking systems (CMS) where such individual cow milk yield observations are lacking. Therefore, this research aimed at predicting herd resilience using herd performance data that is commonly available on CMS farms. To do so, data consisting of 585 Dutch AMS farms where herd resilience estimates using the AMS-based method were available was examined. To predict herd resilience with

herd performance data, only those data that are also commonly available on CMS farms were used in a 5-fold cross validation Random Forest model. These herd resilience estimates were subsequently compared with the AMS-based herd resilience estimates. Results showed that it is possible to predict with a 69.9% probability whether a herd performs with above or below average herd resilience using only variables available on CMS farms. Especially, the proportion of cows with an indication of rumen acidosis, proportion of cows with an elevated somatic cell count and the fluctuation in herd size over the years are good predictors of herd resilience. Since herd management decisions appear to affect herd resilience, a lower predictive herd resilience could be taken as a general indication that tactical or strategic management changes could be taken to improve the herd resilience.

Farm management and economic factors associated with bulk tank total bacterial count in Holstein dairy herds in Iran

Fatemeh Soleimani-Rahimabad, Ali Sadeghi-Sefidmazgi, Abbas Pakdel, Rabie Rahbar and Jeffrey M Bewley
Iran and USA

Abstract
The objectives of this research were (1) to study different factors affecting milk total bacterial count (TBC) and (2) to estimate the economic value associated with TBC in Holstein dairy herds in Iran. The relationships between bulk tank TBC and farm management and economic factors were examined on 56 randomly selected intensive dairy farms. Herd management factors associated with bulk tank TBC were determined using mixed linear models. The median bulk tank TBC for the sample herds was 299 (range 81 to 1,185) x 10^3 cfu/mL. The average economic premium opportunity from bulk tank TBC was US$ 1.32 per ton of milk ranging from US$ 0.02 per ton of milk for herds applying wet tissue procedures as teat cleaning material and washing the water troughs three times per day to US$ 5.20 per ton of milk for herds with dirty barns. Results showed that the following management factors were associated with low TBC and high economic value: frequency of cleaning water troughs, teat cleaning material, the frequency of milk delivery to the processor, bedding material, herd size, education level of workers, udder washing material, material of milking parlor wall, frequency of disinfection of the calving area, presence of veterinarian, water quality control, having a hospital pen and barn hygiene. In conclusion, our findings highlight the need to pay more attention to farm management issues, particularly farm hygiene practices to reduce milk TBC and so reduce the economic burden of TBC in dairy herds in Iran.

Detection of the β-lactoglobulin genotype in the zebu cattle (*Gangatiri*) milk using high-resolution accurate mass-spectroscopy

Manish Kumar Singh, Arvind Kumar, Ramadevi Nimmanapalli and Anand Kumar Pandey
India

Abstract

We studied the genetic polymorphism of beta-lactoglobulin (β-Lg) whey protein in Gangatiri zebu cows for this Research Communication. The polymorphic nature of milk protein fractions and their association with milk production traits, composition and quality has attracted several efforts in evaluating the allelic distribution of protein locus as a potential dairy trait marker. Genetic variants of β-Lg have highly significant effects on casein number (B > A) and protein recovery (B > A) and also determine the yield of cheese dry matter (B > A). Molecular techniques of polyacrylamide gel electrophoresis and high-resolution accurate mass-spectroscopy were applied to characterize the β-Lg protein obtained from the Gangatiri breed milk. Sequence analysis of β-Lg showed the presence of variant B having UniProt database accession number P02754, coded on the PAEP gene. Our study can provide reference and guidance for the selection of superior milk (having β-Lg^B) from this indigenous breed that could potentially give a good yield of β-Lg for industrial applications.

Effects of high hydrostatic pressure on antimicrobial protein stability and the rheological and shelf-life properties of donkey milk

Alperen Koker, Sebnem Ozturkoglu-Budak and Hami Alpas
Turkey

Abstract

The effects of high hydrostatic pressure (HHP) and heat treatments on antimicrobial protein stability and on the physico-chemical, microbiological, rheological and shelf-life properties of donkey milk were investigated. Although heat treatment at 75°C for 2 min resulted in 1.50 log CFU ml^{-1} microbial inactivation, losses in activities of lysozyme (58%) and lactoferrin (82%) were observed due to whey protein denaturation. By contrast, HHP application at 400 MPa caused lower enzyme activity losses (22 and 37% respectively) whilst maintaining a significant reduction of microbial load (1.80 log CFU ml^{-1}). Color analyses showed that the lightness values of all samples decreased during storage. Higher flow consistency (viscosity) and lower flow behavior indexes were observed in heat-treated samples compared to untreated and HHP-treated ones, which can be explained by advanced protein denaturation during heat-treatment. The results suggest that HHP is a more suitable process than heat treatment for preservation of donkey milk within the conditions studied.

The effect of homogenisation pressure on the microstructure of milk during evaporation and drying: particle size distribution, electronic scanning microscopy, water activity and isotherm

Thiago Medeiros Zacaron, Júlia d'Almeida Francisquini, Ítalo Tuler Perrone and Rodrigo Stephani
Brazil

Abstract

Homogenisation is a widely used technique in manufacturing powdered milk with a direct impact on product solubility, and the homogenisation pressure is a central attribute of this process. We aimed to understand the effect of increasing homogenisation pressures (0/0, 15/5, and 75/5 MPa, 1st/2nd stages) on particle size distribution during homogenised whole milk powder manufacture and rehydration of the final product. The fluid milk was thermally treated, homogenised, concentrated by rotary evaporation, and then dried using a spray dryer. Particle size (Dv90) was monitored at all stages of the manufacturing process. The final product (milk powder) was analysed using particle size distribution, electronic scanning microscopy, water activity, and isotherms. The results demonstrated that increasing the homogenisation pressure leads to milk powder with smaller particle size when rehydrated (Dv90 values: 6.08 µm, 1.48 µm and 0.64 µm for 0 MPa, 20 MPa and 80 MPa, respectively). Furthermore, the volume (%) of the particles in the "sub-micro" region (smaller than 1.0 µm) presented an inversely proportional profile to the homogenisation pressure (homogenised fluid milk: 86.1%, 29.3% and 2.4%; concentrated milk: 86.1 %, 26.5% and 5.7%, and reconstituted milk powder: 84.2%, 31.8% and 10.9%). Surprisingly, this pattern was not observed in the SPAN value (which corresponds to the width or range of the size distribution based on the volume). Additionally, the increase in the homogenisation pressure did not affect the sorption isotherm pattern. These results demonstrate that increasing the homogenisation pressure decreases the particle size of the reconstituted powdered milk, indicating the potential for future studies on how this phenomenon affects its physicochemical and final product properties.

The effect of high-temperature heat treatment and homogenization on the microstructure of set yogurt curd networks

Takefumi Ichimura, Mai Kusaka and Taku Nakamura
Japan

Abstract

Set yogurt's physical characteristics are greatly affected by the homogenization and heat treatment processes. In our previous study, set yogurt treated at 130℃ and with the fat particle size reduced to ≤0.6 µm had equivalent curd strength, less syneresis and smoother texture than yogurt treated at 95℃. When investigating the mechanisms underlying yogurt's

physical properties, it is important to evaluate the yogurt's microstructure. We conducted electron microscopy evaluations to investigate the mechanisms of changes in yogurt's physical properties caused by 130℃ heat treatment and by a reduction in the fat globule size. We prepared yogurt mixtures by combining heat treatment at 95℃ and 130℃ and homogenization pressure at 10+5 MPa and 35+5 MPa and then fermented the mixtures in a common yogurt starter. Scanning electron microscopy (SEM) and transmission electron microscopy (TEM) were used for the structural observations. Fine particles were observed on the surface of the casein micelles of the yogurt treated at 95℃, and the coalescence density between micelles was high. The surface of the yogurt treated at 130℃ had few fine particles, and the coalescence density between micelles was low. The yogurt treated at 130℃ with 35+5 MPa homogenization had low coalescence density between casein micelles, but smaller-particle-size fat globules increased the network density. Approximately 30% of the fat globules were estimated to be incorporated into the yogurt networks compared to the volume of casein micelles. We speculate that 130℃ heat treatment alters the structure of whey protein on the surface of casein micelles and interferes with network formation, but reducing the size of fat globules reinforces the network as a pseudoprotein.

Production of reuterin by *Lactobacillus coryniformis* and its antimicrobial activities

Harutoshi Tsuda
Japan

Abstract

Reuterin is a broad-spectrum antimicrobial substance produced by lactic acid bacteria, and most previous studies have reported that reuterin is only produced under anaerobic conditions. If there are lactic acid bacteria that also produce it under aerobic conditions, it could be applied to fermented foods. In this study, it was found that *Lactobacillus coryniformis* WBB05 showed optimal reuterin production (123 mM reuterin from 200 mM glycerol) when incubated aerobically at 20°C. Furthermore, the minimum inhibitory concentration (MIC) of reuterin was determined for starter lactic acid bacteria strains and cheese moulds. MIC toward *Penicillium camemberti* was 0.125 mM and the white mould starter was much more sensitive than other moulds.

Identification of lactic acid bacteria with anti-listeria activity. Characterization and application of a bacteriocinogenic strain in the control of *Listeria monocytogenes* in cheese

Fernanda Montanholi de Lira, Fernanda Yuri Rodrigues Tanaka, Edson Antônio Rios, Stael Málaga Carrilho, Samanta Stinghen de Abreu, Giulia Ferracin Ferreira, Natalia Gonzaga, Ulisses de Pádua Pereira, Ronaldo Tamanini, Vanerli Beloti and Raphael Fagnini
Brazil

Abstract

The purpose of the research paper was firstly to identify bacteriocin-producing lactic acid bacteria characterizing strains with anti-listeria activity and, secondly, to characterize bacteriocin evaluating its *in vitro* efficiency as a natural preservative and, thirdly, to evaluate the anti-listeria effect of the bacteriocinogenic strain of *Lactiplantibacillus plantarum* in cheeses and produce an edible film with anti-listerial effect. Of 355 lactic acid bacteria strains tested, two were able to produce bacteriocin against *Listeria monocytogenes* and were identified as *Lactiplantibacillus plantarum* and *Lactiplantibacillus pentosus*. A bactericidal effect of strain QS494 (*Lactiplantibacillus plantarum*) was observed in the first 8 hours, with a reduction of 1.7 log, using cell-free supernatant with *Listeria monocytogenes*, where viable cells were counted on listeria selective agar. Both strains showed good technological characteristics and were without production of virulence factors. Changes in the pH of the cell-free supernatant obtained from *Lactiplantibacillus plantarum* did not affect its antimicrobial activity, which remained stable after heat treatments for up to 15 min at 121°C. Inhibitory activity was also observed after 12 weeks of storage at -20°C. In the evaluation of the anti-listeria effect in cheeses, a 3 log reduction in the *Listeria monocytogenes* count was observed in 120 hours in cheeses produced with bacteriocinogenic lactic acid bacteria, while in cheeses produced with non-bacteriocinogenic culture, we observed a 2 log increase in the count. Edible films produced with the addition of precipitate from the cell free supernatant showed an antimicrobial effect against *Listeria monocytogenes*. Thus, the two strains studied have technological and biosafety potential.