

Herbivore nutrition supporting sustainable intensification and agro-ecological approaches

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Herbivores play a crucial role in food security, poverty alleviation and the sustainable development of developing economies. The International Symposium on the Nutrition of Herbivores provided a unique opportunity to discuss the role of herbivore nutrition in addressing the current challenges of producing higher quality livestock products more efficiently, with smaller impacts on the environment and animal welfare. Scientists from 46 countries had the opportunity to focus on issues of herbivore nutrition, and the challenges they face in a globalised and changing world. Along with 22 invited keynotes, 422 original communications were presented and are published in *Advances in Animal Biosciences* (Baumont *et al.*, 2018).

As guest editors, we are pleased to publish the 22 full papers corresponding to the keynotes delivered at the Symposium across 11 sessions in this Supplement Issue of *animal*. The papers are authored by scientists from different countries to share an experienced vision on the various topics covered by the Symposium.

Session 1 focussed on herbivore nutrition in a globalised world. Mottet *et al.* (2018) emphasised the significant contribution of domestic herbivores to food security. They discussed the perspectives and the challenges for the sustainable development of the sector, including the development of adequate policies. Ayantunde *et al.* (2018) highlighted the role of herbivores in mixed farming systems and in supporting the livelihoods of much of the rural population in sub-Saharan Africa. They identified the gaps to enhance agricultural sustainability in this area. Dumont *et al.* (2018) have reviewed the potentials of sustainable intensification and agroecology. They proposed that both approaches promote ways to reconcile natural resource management and food production in the long term, and perhaps could converge to shape the future of ruminant production.

Session 2 centred on rumen microbial ecosystems. Mizrahi and Jami (2018) examined the natural variations in the rumen microbiome, its potential impact on productivity of

the host and the environment, and discussed the hurdles to modulations of the microbiome. Denman *et al.* (2018) addressed the application of meta-omics to rumen microbiota function and the potential benefit from the knowledge gained for manipulation of the microbiota towards a desired state.

Session 3 concentrated on the development of enhanced precision in herbivore nutrition. González *et al.* (2018) reviewed sensor and information technologies that allow monitoring of nutritional processes in individual animals, and discussed the challenges to integrate the increasing amount of data and computation of simulation models. Shalloo *et al.* (2018) argued for a user need-driven development of precision technologies. They reviewed the opportunities and challenges to implement precision technologies for an improved economical return in grass-based dairy systems.

Session 4 focussed on nutrition to improve the quality of herbivore products. Toral *et al.* (2018) compiled studies on nutritional strategies to manipulate ruminal lipid metabolism and to raise beneficial fatty acids in meat and milk. Among topics with significant prospects for the future are the manipulation of ruminal biohydrogenation, evaluation of alternative feed resources including by-products rich in active compounds, and advances in microalgae production. Ladeira *et al.* (2018) appraised studies on nutrigenomics of marbling. They showed how nutrition affects expression of genes involved in adipogenesis, lipogenesis and fatty acid profile of muscle, and how this knowledge will permit nutritionists to modulate ruminant meat quality during the prenatal or postnatal life.

Session 5 centred on feed resources and sustainable diets. Halmemies-Beauchet-Filleau *et al.* (2018) gave an overview of the current knowledge on alternative and novel feeds for ruminant systems both in temperate and tropical environments. They highlighted the potential of various novel and unexploited feeds to replace or supplement traditional crops used in ruminant rations. van Lingen *et al.* (2018) appraised the relationships between dairy cattle feed resources, animal characteristics, methane (CH₄) emissions and excreta (digestible volatile solids and nitrogen) through the use of

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univariate and multivariate mixed-effects models. The analysis revealed potential trade-offs between enteric CH₄ emissions and excretion of volatile solids and nitrogen (N) and identifies knowledge gaps related to impact of dairy nutrition and management interventions.

Following this, Session 6 addressed two areas in relation to feed conversion efficiency and reduction of excreta. Cantalapiedra-Hijar *et al.* (2018) integrated the knowledge on the biological determinants and molecular pathways of between-animal variation in feed efficiency in growing beef cattle. They suggested that the role of feeding and digestive-related mechanisms in feed efficiency could be minor, and emphasised the contribution of metabolic pathways and non-productive functions to efficiency. Løvendahl *et al.* (2018) discussed how CH₄ emissions and feed efficiency traits are related to each other, and the many interacting biological factors that may influence both trait groups. Understanding the underlying mechanisms remains a challenge and may improve the ability to select dairy cattle for improved feed efficiency and reduced CH₄ emissions.

Session 7 was dedicated to the interactions between nutrition, genetics and environment. Roche *et al.* (2018) discussed the influence of genotype × environment interactions on the robustness of dairy cows for grazing systems. The authors suggested that in the future there will be an increased emphasis on the evaluation of important traits for the quality of life of the animal and the reduction of the environmental footprint. Chavatte-Palmer *et al.* (2018) reviewed the effects of nutrition epigenetic marks in mammalian herbivores, and highlighted the need for research on nutritional strategies to modulate the epigenetic machinery and developmental programming.

Session 8 was dedicated to wild herbivores. Gordon (2018) highlighted that livestock production increasingly influences wildlife across the globe, mainly through ancillary activities. Land sparing, land-sharing between livestock production and wildlife, and win-win strategies are key issues that need to be addressed further. Improving the efficiency of livestock production will be key to successful strategies to maintain wildlife. Forbey *et al.* (2018) described a physiological model to help identify key physiological mechanisms that underlie diet-based ecological adaptations. The model is based on how both toxic and nutritional food constituents are metabolically processed, and provides a mechanistic link between foraging decisions in vertebrate herbivores and population consequences.

Session 9 focussed on nutritional management of health and welfare. Plaizier *et al.* (2018) argued that efficacy of nutritional strategies to prevent gastrointestinal health disorders in dairy cows may be improved. The mechanisms through which nutrition and feed supplements or additives enhance gastrointestinal health have to be unravelled. Neave *et al.* (2018) outlined evidence that individual variability in feeding behaviour of domesticated ruminants is associated with the personality of the individual. This highlights that an understanding of personality can help to adapt the management of animals to the needs of the individual in order to improve animal welfare and productivity.

Session 10 centred on adaptation of herbivores to climate changes and diverse environments, a key challenge for the future of livestock production. Sejian *et al.* (2018) discussed the need to identify phenotypic and genotypic indicators of heat stress susceptibility that can be included in breeding programs in an effort to develop thermo-tolerant breeds using marker-assisted selection. Henry *et al.* (2018) reviewed the research on the impact of climate change on ruminant livestock production and the effective adaptation together with evidence of practical adaptive management, and proposed potential strategies and gaps in knowledge to be filled.

The final session focussed on converting scientific knowledge into innovation in herbivore nutrition. Lapiere *et al.* (2018) presented a case study comparing different protein feeding systems in their ability to predict milk protein yield in dairy cows. An adequate prediction of milk protein yield will allow a reduced protein content in dairy rations, which has the dual effect of decreasing feed cost and increasing the farm net income while reducing N excretion and emissions. The comparative study highlights the importance to take into account the variable efficiency of utilisation of supplied protein. This concept should probably also be adopted for the supply of essential amino acids.

We hope reading this special issue of animal will help you learn more about herbivore nutrition and find inspiration for future research and development in this area.

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Declaration of interest

None

Ethics statement

None

Software and data repository resources

None

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