

TOWARDS EFFICIENT CELL WALL BREAKDOWN AND IMPROVED FIBER UTILIZATION IN RUMINANTS

Understanding how ruminants break down plant cell walls and digest plant fibers can help improve the efficiency of livestock production



WHAT STEPS ARE BEING TAKEN TO INCREASE THE INTAKE, PASSAGE, AND DIGESTIBILITY OF FIBROUS FEEDSTUFFS IN RUMINANTS?



International Symposium on Forage Cell Wall Structure and Digestibility (1991)



Forages and Pastures Symposium (2022)



Discussion on research advances

OPPORTUNITIES



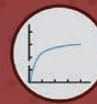
Delineating cell wall interactions with ruminal/post-ruminal digestive processes



Identification of rumen microbial genera/species vital to fiber degradation



Modification of the lignification model



Mathematical descriptions of digestive kinetics

KEY TRENDS



Downregulation of lignin biosynthesis



Optimization of the rumen microbial environment by introducing beneficial microbes



Mechanical/chemical/enzymatic treatment of fibrous feedstuffs



More accurate modeling-based prediction for cell wall nutritive value



Increased equipment commercialization/standardization/screening



Efficient measurements of ruminal digestive kinetics



Next-generation sequencing for a deeper understanding of the rumen microbial ecosystem

Adding to the insights obtained over the last 30 years, research is underway to **improve cell wall breakdown and fiber utilization in ruminants to increase the sustainability of food animal production systems**

Smith et al. (2023)

Conceptualization and Implementation of the Fiber Utilization and Cell Wall Constituents Symposium





Conceptualization and implementation of the Fiber Utilization and Cell Wall Constituents Symposium

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In 1991, researchers in animal and plant sciences met at the International Symposium on Forage Cell Wall Structure and Digestibility in Madison, WI (Front Matter, 1993). At that meeting, seven sessions were organized, representing some of the biggest names in forages and ruminant nutrition, to discuss and debate the cell wall, its role in ruminant nutrition, and the advances made in the science of forage nutrition. Out of that meeting was born *Forage Cell Wall Structure and Digestibility* (Jung et al., 1993), a seminal text on the subject. Since that time, many researchers have tasked themselves with building upon the basis set by these researchers. However, to the best of our recollection, no other conference or symposium has been organized to provide an update of events in this field. Thus, given the vital role that cell wall structure plays in the nutrition of herbivorous species, we (the Forages and Pastures Programming Committee) proposed a session to revisit this topic. The resulting Forages and Pastures Symposium brought together a set of four presentations (Callaway et al., 2022; Fahey, 2022; Foster, 2022; Tedeschi and Vieira, 2022), each directed at updating the animal science community on advances made since that pivotal symposium.

In order to further the discussions generated in this symposium and stimulate future efforts in the field of forage cell wall structure and digestibility, a set of reviews were invited. Tedeschi et al. (2023) stated that the primary limitation to digestibility of fibrous feedstuffs is the complex interactions of the cell wall matrix with the ruminal and post-ruminal digestive processes. The authors note that key advances have been made in manipulation of the cell wall (such as down-regulation of lignin biosynthesis) and the rumen microbial environment (such as introduction of white-rot or brown-rot fungi) as well as mechanical, chemical, and enzymatic treatment of fibrous feedstuffs that have led to increased cell wall biodegradability. These advances in biodegradability have led to increased precision in predicting the nutritive value of the cell wall through intensive modeling efforts. Foster et al. (2023) honed in on the experimental methods by which digestibility of fiber and cell wall constituents are measured. Commercialization of equipment (such as the Ankom Daisy^{II} incubator) has led to increased standardization of in vitro methods and

higher throughput of digestibility screening. Likewise, standardization efforts have been undertaken to streamline in situ measurements of ruminal digestive kinetics. However, there remain significant limitations to the techniques, and authors offer insight into current and continuing efforts to address these limitations. At the time of the original symposium, the field of rumen microbiology was in its (relative) infancy. An understanding of the rumen microbial community was limited to the species that could be cultured in the laboratory. Osorio-Doblado et al. (2023) point out, however, that techniques such as next-generation sequencing have allowed for a deeper understanding of the rumen microbial ecosystem. “Snapshot” images of microbial populations and enzyme concentrations (such as CAZymes) have allowed researchers to link individual genera and species to efficient utilization of fiber in the rumen.

Though many questions have been answered over the past 30 years, we still have many opportunities to advance the field of fiber and cell wall utilization. The foundation set by Jung et al. (1993) From the perspective of cell wall manipulation, modification of the lignification model appears to present the most promise for further research efforts. Knockout of lignin polymerization pathways or enzymes or replacement of lignin monomers could lead to increased bioavailability of cell wall fibers. Coupled with that, efforts are being made to further elucidate and evaluate the mathematical descriptions of digestive kinetics from in situ and in vitro experiments. These descriptions of the dynamic processes of the rumen should aid to further identify the role of critical rumen microbial genera and species vital to fiber degradation. All of this will lead to improved models predicting intake, passage and digestibility of fibrous feedstuffs in the animal, thereby supporting a more efficient and sustainable food animal production system.

The authors declare no conflict of interest.

Literature cited

Callaway, T. R., J. M. Lourenco, R. L. Stewart, and W. B. Smith. 2022. 201 Forage biodegradation: Advances in ruminal

- microbial ecology. *J. Anim. Sci.* 100(Supplement_3):91. doi: [10.1093/jas/skac247.178](https://doi.org/10.1093/jas/skac247.178)
- Fahey, G. C. 2022. 200 Forage cell wall organization, complexes and components. *J. Anim. Sci.* 100(Supplement_3):90. doi: [10.1093/jas/skac247.176](https://doi.org/10.1093/jas/skac247.176)
- Foster, J. L. 2022. 202 An update on in vitro and in situ experimental techniques for approximation of ruminal fiber degradation. *J. Anim. Sci.* 100(Supplement_3):91-92. doi: [10.1093/jas/skac247.179](https://doi.org/10.1093/jas/skac247.179)
- Foster, J. L., W. B. Smith, F. M. Rouquette Jr, and L. O. Tedeschi. 2023. An update on in vitro and in situ experimental techniques for approximation of ruminal fiber degradation. *J. Anim. Sci.* [10.1093/jas/skad097](https://doi.org/10.1093/jas/skad097)
- Front Matter. 1993. In: H. G. Jung, D. R. Buxton, R. D. Hatfield and J. Ralph, editors, *Forage Cell Wall Structure and Digestibility*. ASA-CSSA-SSSA, Madison, WI, USA. p. i-xxv.
- Jung, H. G., D. R. Buxton, R. D. Hatfield, and J. Ralph. 1993. *Forage cell wall structure and digestibility*. ASA-CSSA-SSSA, Madison, WI, USA.
- Osorio-Doblado, A. M., K. P. Feldmann, J. M. Lourenco, R. L. Stewart Jr., W. B. Smith, L. O. Tedeschi, and T. R. Callaway. 2023. Forages and Pastures Symposium: Forage biodegradation: Advances in ruminal microbial ecology. *J. Anim. Sci.* doi: [10.1093/jas/skad178](https://doi.org/10.1093/jas/skad178)
- Tedeschi, L. O., J. M. Adams, and R. A. M. Vieira. 2023. Revisiting mechanisms, methods, and models for altering forage cell wall utilization for ruminants. *J. Anim. Sci.* doi: [10.1093/jas/skad009](https://doi.org/10.1093/jas/skad009)
- Tedeschi, L. O., and R. A. Vieira. 2022. 199 Revisiting mechanisms, methods, and models for altering cell wall utilization for ruminants. *J. Anim. Sci.* 100(Supplement_3):90-91. doi: [10.1093/jas/skac247.177](https://doi.org/10.1093/jas/skac247.177)