Do Queensland cattle possess rumen bacteria capable of degrading Leucaena toxins?

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Leucaena leucocephala is a leguminous fodder tree used by northern Australian producers to provide protein and boost the weight gains of extensively grazing cattle. There is a range of commercial Leucaena cultivars available which all contain a toxic non-protein amino acid, mimosine. Many rumen bacteria can degrade mimosine to 3,4-dihydroxy-pyridine (3,4-DHP), which is also toxic to cattle. To enable cattle to safely gain the full benefits of Leucaena, a bacterium, *Synergistes jonesii*, was isolated that could degrade the toxic metabolites 3,4 DHP and 2,3-hydroxypyridine (2,3-DHP) (Allison *et al*. 1992). A fermenter-grown mixed bacterial inoculum, containing *S. jonesii*, has been produced by DAF for over 20 years as an oral drench for cattle to prevent Leucaena toxicity and maximise weight gains (Klieve *et al.* 2002).

The necessity for this inoculum has been a contentious topic with speculation that Australian cattle now all possess rumen microbial populations capable of breaking down the three Leucaena toxins. The aim of this research is to survey cattle for rumen bacteria able to completely degrade all three of the Leucaena toxins, mimosine, 3,4-DHP and 2,3-DHP.

A survey was developed, and animal ethics approval obtained, to sample the rumen of cattle on properties throughout Queensland, in a randomised experimental design with four treatments consisting of different production scenarios with the experimental unit being the property. The treatments included properties where cattle have: (1) never received the DAF inoculum but are grazed on Leucaena; (2) received either rumen fluid from the original CSIRO cattle or the fistulated cattle held at Brian Pastures Research Station (pre-1993) and have not received the DAF inoculum and are grazed on Leucaena; (3) received the DAF inoculum and are grazing Leucaena; or (4) never been exposed to Leucaena (naïve).

In total, the survey will visit a minimum of three and maximum of five properties or research stations for each treatment and the primary variable is the concentration of the Leucaena-associated toxins mimosine, 3,4-DHP and 2,3-DHP. A mobile laboratory, including a portable incubator and micro-centrifuge, was established to enable crush-side processing and immediate incubation of collected rumen fluid, in toxin degradation assays. Cattle were rumen sampled via a stomach tube to obtain samples of rumen contents. Duplicate 10 mL volumes of the freshly collected rumen fluid were pipetted into pre-gassed Hungate tubes, an aliquot of one of the three purified toxins added and, after mixing, a time 0 (h) subsample was removed and frozen on dry ice. The Hungate tubes were placed into the portable incubator at 39°C, with further samples taken after 48 h and 168 h incubation. The concentration of the three toxins in the degradation assay subsamples were determined using high performance liquid chromatography (HPLC) (Lowry *et al.* 1985).

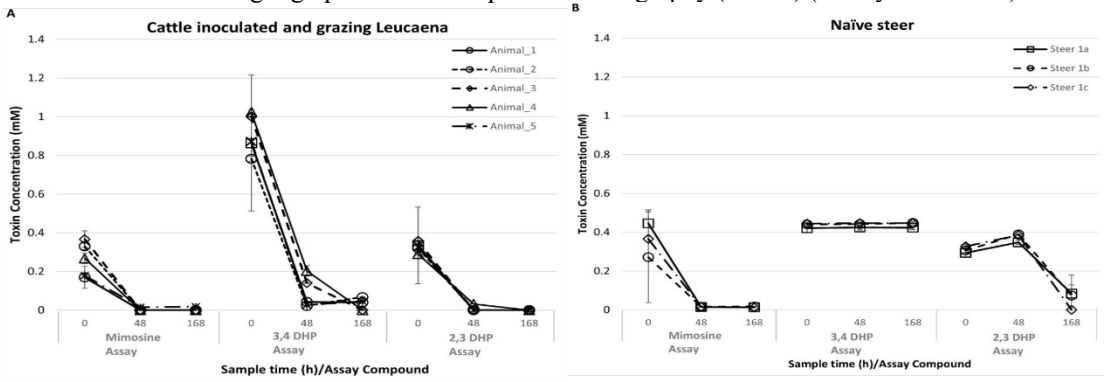

Fig. 1. Degradation assay of mimosine, 3,4-DHP or 2,3-DHP at time 0 (h), 48 h and 168 h samples from (A). Five cattle (received DAF inoculum, grazing Leucaena); (B) Naïve steer (never exposed to Leucaena); three replicate assays shown.

The mobile laboratory is proving to be operationally successful with initial toxin degradation assays showing that cattle receiving the DAF inoculum and grazing Leucaena possessed rumen bacterial populations capable of completely detoxifying all three toxins (Fig.1A). A steer which had never grazed Leucaena (naïve) did possess rumen bacterial populations able to degrade mimosine within 48 h and 2,3-DHP by 168 h but the levels of 3,4-DHP remained constant indicating that this compound was not degraded by the rumen bacteria (Fig. 1B). It is anticipated that this on-property survey will provide clarification whether all cattle possess rumen microbial populations capable of breaking down the three Leucaena toxins. The results from this study will be used to develop recommendations to industry concerning the use of the DAF inoculum for cattle grazing Leucaena pasture systems.

References

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