TRANSFER OF DHP-DEGRADING BACTERIA FROM ADAPTED TO UNADAPTED RUMINANTS

In Australia the toxicity of Leucaena leucocephala for ruminants is known to be caused by the goitrogen 3-hydroxy-4(1H)-pyridone (DHP) - a ruminal metabolite of mimosine (Hegarty et al. 1979), which is subsequently excreted in the urine. In a number of other tropical countries leucaena toxicity has not been reported. Goats fed a sole diet of leucaena in Hawaii remained healthy and did not excrete DHP in their urine whereas goats in Australia fed only leucaena were grossly hypothyroid and excreted large quantities of DHP in their urine (Jones and Megarrity 1983). It was postulated (Jones 1981) that differences in the microbial populations in the rumen were responsible for the differences observed in the degradation of mimosine in goats eating leucaena in the two countries. The possibility, therefore, arose that the leucaena toxicity problem in Australia could be overcome by using the DHP degrading microbes in Australian ruminants. Quarantine restrictions in the USA and Australia prevented any direct animal movement between these countries to do the necessary experiments. It was however possible to take Australian goats to Indonesia, where it had been shown that village goats there could also degrade DHP (Lowry 1983).

Experiment in Indonesia (Jones and Lowry 1984) - Four goats were fed a pure diet of dried leucaena in Australia for five weeks and then flown to B.P.T. Ciawi, Bogor, Indonesia, together with their Australian grown feed. Two of the goats received 350ml rumen fluid (RF) from an Indonesian goat known to be degrading DHP. The other two goats, housed separately, acted as controls. The intake of mimosine and 3,4 DHP excretion in the urine and faeces were measured daily. Three days after infusion, excretion of DHP in the urine of the infused goats dropped to trace levels and their feed intakes doubled. Ten days after the infusion, one of the treated goats was used as a donor to provide RF for one of the control goats. Again infusion was followed by a dramatic increase in feed intake and a reduction in DHP output to about 5% of the measured mimosine intake expressed as DHP. These low outputs of DHP persisted to the end of the 25 day experimental period, confirming that transfer was effective.

Introduction of DHP degrading bacteria to Australia - Quarantine regulations prevented the introduction of rumen fluid from Indonesia. In the light of the potential benefits shown by the Indonesian experiment, consideration was given to the introduction of cultures of bacteria from Hawaii. These were obtained by using rumen fluid from a leucaena-adapted goat on the
island of Maui and repeatedly sub-culturing under anaerobic conditions by standard Hungate (1966) techniques. The 98-5 medium (Bryant and Robinson 1961) was enriched by adding either mimosine, 3,4 DHP or 2,3 DHP. The latter was mainly used because it is commercially available at low cost.

Mixed cultures at 10^{-12} dilution from the original rumen fluid were then introduced to Australia and infused into a goat and a steer fed leucaena in strict isolation at the Oonoonba Veterinary Laboratory of the Department of Primary Industries, Townsville, Queensland. No pathogens were detected when the animals were killed 60 days later and cultures were released for restricted field use. Infusion of a steer, previously fed a sole diet of fresh leucaena, with 400ml of the culture resulted in cessation of urinary excretion of mimosine and DHP, regrowth of hair on the tail and body, maintenance of normal serum thyroxine levels and excellent weight gain (275 kg in 364 days). Four control steers introduced to the same paddock with the infused steer stopped excreting DHP within five weeks and then gained weight at a similar rate to the treated steer. In vitro degradation studies using 0.5ml of RF in 9ml of 98-5 medium containing 3mg DHP/ml showed that the ability of RF to degrade the toxin was acquired and maintained after association with the infused steer. When two of the four steers were removed to pastures containing no leucaena, the ability of RF to degrade DHP (both 3,4 and 2,3 DHP) in vitro was maintained for at least six months. Rate of degradation of the toxins however decreased with length of time off leucaena, indicating a decline in numbers of DHP-degrading bacteria in the rumen in the absence of leucaena substrate.

Conclusions - The results show that transfer of DHP-degrading ability is possible by rumen infusion with bacterial cultures; that animal to animal transfer occurs in small paddocks; that the introduced bacteria are being maintained when leucaena is fed, and that they persist in the animal for at least six months after removal from leucaena feeding. Possibilities for the commercial use of such cultures to overcome problems associated with leucaena toxicity in Australia therefore appear to be good. Practical methods for the rapid culture, transport and infusion of the bacteria into cattle are being devised.

References:


Jones, R.J. and J. B. Lowry. 1984. Australian goats detoxify the goitrogen 3-Hydroxy-4(1H)pyridone (DHP) after rumen infusion from an Indonesian goat. Experientia (in press).