Portal effects on mammary nutrient uptake and milk production and composition in cows fed high and low protein diets

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The composition of milk, in particular the protein content and composition, has a marked effect on milk quality. Australian dairy farmers are currently being rewarded/penalised for the protein and fat content of their milk. Nutritional manipulation appears to be the quickest way to alter milk composition, however attempts to increase milk content by dietary means are proving to be difficult, with variable results reported to date. This study was the third in a series investigating the effect of dietary protein on mammary nutrient uptake and milk production and composition (1, 2). Our previous results have suggested that the liver may influence the concentration of nutrients available to the mammary gland for milk synthesis.

Six multiparous, midlactation Friesian cows were paired for age, calving date and milk production, and assigned to either a high protein (HP, 18%) or low protein (LP, 12%) diet. The two diets were isoenergetic, but contained different levels of degradable and undegradable protein. After a 10 day accustomisation period, 16 mm ultrasonic blood flow probes (Transonic Systems Inc., New York) were surgically implanted around the right pudendal artery to measure blood flow to the right udder. A catheter was inserted into the porta hepatis via the mesenteric vein to measure nutrient supply to the liver from the portal drained viscera. The facial artery and milk vein were catheterised to measure arteriovenous differences of nutrients across the udder. Following recovery from surgery, blood flow and milk yield (separate left and right udder) were measured for 22 days. Milk and blood samples were taken every two days. The results for the control period (first three days) only are presented here.

There was no difference in dry matter intake between the two groups. There was a non-significant trend to higher mammary blood flow, right udder milk yield, protein content and yield, and fat yield in HP cows, as has been seen previously (2). Portal and arterial β–hydroxybutyrate levels were significantly higher ($P<0.05$) in HP cows, as was mammary uptake ($P<0.1$). This indicates increased mobilisation and utilisation of ketones to support the increased milk production. Portal ($P<0.05$) and arterial ($P<0.001$) urea levels were also higher implying wastage of some of the extra protein fed. There was no difference between groups in portal or arterial α-amino nitrogen levels, or in their uptake or extraction by the gland. Interestingly, HP cows had higher portal ($P = 0.1$) and arterial ($P<0.1$) concentrations of alanine, and significantly higher arterial glutamine levels ($P<0.05$) with a trend to higher portal levels. This may indicate increased tissue mobilisation of these amino acids for liver gluconeogenesis, in order to support the increased production. There was a trend to higher portal and methionine levels in HP cows, suggesting that methionine was probably not limiting in these animals.

1. Rajczyk ZK, Lean IJ, McKean K and Gooden JM. The effect of dietary protein on milk composition. Proc Nutr Soc Aust 1994;18:178.
2. Rajczyk ZK, Lean IJ and Gooden JM. The effect of dietary protein on mammary blood flow and milk production. Proc Nutr Soc Aust 1994;18:127.