THE INFLUENCE OF DIETARY CARBOHYDRATE SOURCE ON LIVER METABOLISM IN SHEEP

K.S. SAINI and J.R. MERCER

When high starch diets such as maize are fed to sheep, significant quantities of glucose are absorbed from the small intestine and contribute to the whole-body glucose turnover rate so that the endogenous production of glucose is decreased relative to that when dried grass diets are fed (Janes et al. 1985a). The mechanism of the inhibition of endogenous glucose production is unclear as insulin plays only a minor role in glucose homeostasis in ruminants (Janes et al. 1985b). High starch diets such as maize support a different pattern of rumen fermentation to that seen on roughage based diets. Although the production rate of propionate is higher on high starch diets, the extent of its conversion to glucose is lower (Judson et al. 1968).

We report here the different effects of high starch and high roughage diets on liver metabolism in sheep. Three isoenergetic diets containing 20% CP were fed to wethers. The major carbohydrate sources in decreasing order of starch content were wheat + maize (WM), oats + maize + molasses (OM) and oats + lucerne chaff (OL). Each diet contained 12.3 MJ ME/kg DM. The soluble carbohydrate content as NFE (g/kg DM) was 566, 457 and 347, and the CF (g/kg DM) 62, 130 and 180 on the WM, OM and OL diets respectively. The animals were fed to maintenance and were fasted for 24 h before being killed for liver samples and liver cell preparation. The results are presented in the table.

The effect of a decreasing proportion of soluble carbohydrate in the diet on liver metabolism in sheep (n=5). Significant differences between treatment means ($P < 0.05$) are indicated by unlike superscripts.

		Diet		
		WM	OM	OL
Pyruvate kinase	U/g	12.0^{a}	9.9^{ab}	7.8^{b}
Fructose 1,6-diphosphatase	U/g	13.8^{b}	16.7^{a}	18.1^{a}
Pyruvate carboxylase	U/g	0.8^{a}	0.9^{a}	1.6^{b}
Pep-ck cytosolic	U/g	3.3	4.1	4.1
Pep-ck particulate	U/g	1.6	2.9	2.1
Glycogen	g/100 g	2.7^{b}	1.3^{a}	1.5^{a}
NAD/NADH cytosolic		297	357	396
NAD/NADH particulate		7.0	6.8	7.1
Glucose from propionate (10 mM)	nmol/mg dw/h	165	162	194
Plasma propionate (pre-feed)	mM	0.02	0.01	0.01

The decrease in dietary starch content was accompanied by changes in pyruvate kinase, fructose 1,6-diphosphatase, pyruvate carboxylase and cytosolic NAD/NADH which were compatible with an increased capacity for hepatic gluconeogenesis. The higher pre-feeding concentration of propionate in the plasma on the WM diet was not accompanied by an increased potential for glucose synthesis from propionate by isolated liver cells.

JANES, A.N., WEEKES, T.E.C. and ARMSTRONG, D.G. (1985a). Br. J. Nutr. 54: 449.

JANES, A.N., WEEKES, T.E.C. and ARMSTRONG, D.G. (1985b). Br. J. Nutr. 54: 459.

JUDSON, G.J., ANDERSON, E., LUICK, J.R. and LENG, R.A. (1968). Br. J. Nutr. 22: 69.

Department of Animal Husbandry, University of Sydney, New South Wales 2006