

0.05) glucose utilization by ovine AT on d 3–4 (+33%) and d 5–7 (+45%), but tended to decrease this utilization by bovine AT. The addition of Dex alone decreased glucose utilization by ovine (-43%) and bovine (-51%) AT explants during the first 4 d of culture.

The addition of insulin tended to increase acetate utilization by ovine and more markedly by bovine AT explants. The addition of Dex to the insulin-supplemented medium increased further ($P < 0.05$) acetate utilization by ovine AT on d 3–4 and d 5–7 (increases by 74 and 120%, respectively), although it had no significant effect with bovine AT. The addition of Dex alone decreased (about 50%, $P < 0.05$) acetate utilization on d 1–2 in the 2 species.

These results show large interactions between hormone and animal species effects on substrate utilization during 1 week's culture of ruminant AT.

Nutritional regulation of insulin regulable glucose transporter in bovine muscle. JF Hocquette¹, F Bornes¹, B Graulet¹, D Dardevet², M Vermorel¹, Y Geay¹, P Ferre³ (¹INRA, Laboratoire Croissance et Métabolismes des Herbivores, UR Métabolismes Énergétique et Lipidique; ²INRA, Laboratoire d'Étude du Métabolisme Azoté, 63122 Saint-Genès-Champanelle; ³INSERM U342, 82, avenue Denfert-Rochereau, 75014 Paris, France)

Growing ruminants convert ingested proteins and energy to body tissues relatively inefficiently. For a better understanding of basic biological mechanisms that could improve nutrient utilization, the regulation of rate-limiting processes of muscle metabolism must be studied. Glucose transport across the plasma membrane is a rate-limiting step for glucose utilization. GLUT4 is the main isoform of glucose transporter in the muscle of monogastric mammals. Moreover, GLUT4 is the primary isoform responsible for acute insulin-stimulated glucose transport. The aim of this work was to characterize GLUT4 and to study its nutritional regulation in calves at the time of weaning. Weaning induces large nutritional changes which could alter regulation of glucose metabolism: bovine suckling is characterized by

dietary supply of fat and carbohydrate (35–45 and 30–40% of energy intake, respectively). In contrast, short-chain fatty acids and ketone bodies are the main energy-yielding substrates after weaning (60–70% of energy intake) because of food degradability and digestion by microbes in the reticulo-rumen.

The present experiment was conducted on 2 groups of 7 Montbéliard calves: 1 group of suckling calves and 1 group of weaned calves. Net energy intake from birth and age (170 d) and empty body weight (194 kg) at slaughter were identical for the 2 groups so that only the effect of energy-yielding substrate changes was studied.

Glucose transport rate was measured *in vitro* for 20 min using 2-deoxyglucose in muscle fiber strips of Rectus Abdominis (an oxido-glycolytic muscle), which were incubated at 37°C in the absence or presence of insulin (10^{-6} M) for basal or stimulated glucose transport rate measurements. Glucose transport rate was increased by weaning or insulin ($p < 0.01$). The acute stimulation of glucose transport by insulin suggested that GLUT4 was expressed in bovine muscle. Basal and insulin-stimulated glucose transport rates were higher in weaned calves than in suckling calves (+31% and +43% respectively; $p < 0.01$). Stimulation of glucose transport by insulin was higher in weaned calves than in suckling calves (+ 325 vs + 201 nmol DOG/g of wet tissue/20 min; $p < 0.01$).

It has been previously reported that the change in glucose transport rate and insulin sensitivity in rats at the time of weaning were associated with an increase in the amount of GLUT4 in muscle. To test this hypothesis, GLUT4 protein was quantified by immunoblotting using a polyclonal antibody raised against a 12 amino acid peptide of the carboxy terminus of rat GLUT4 sequence. Studies were performed after muscle homogenization and protein solubilization by Triton X-100 on samples taken from 7 muscles. A specific band of 42 kD corresponding to GLUT4 was observed. However, no difference in the amount of GLUT4 transporters was detected between suckling calves and weaned calves in the 7 studied muscles. This suggested another level of regulation of GLUT4 activity, for instance, a modification of the intrinsic activity of the protein or a change in the efficiency of GLUT4 translocation following insulin-stimulation.

Whatever the nature of the feed (milk or forage), the concentration of GLUT4 was much

higher (at least 4–10-fold) in oxido-glycolytic bovine skeletal muscles than in oxidative muscles or heart. On the contrary, it has been previously shown in the rat that heart and oxidative muscles contain higher amounts of GLUT4 than glycolytic muscles. This species-specificity of GLUT4 expression may favour short-chain fatty acids and ketone body utilization by oxidative muscles in bovine and glucose utilization by oxidative muscles in the rat.

Differences in food digestion and metabolism between ruminant and monogastric species are well known. However, these results demonstrated large differences in the basic biological mechanisms of molecular regulation of muscle metabolism in ruminant and monogastric animals. These differences affect energy metabolism and particularly glucose transporters.

D-Glucose has an immediate and specific sensitizing effect on chicken pancreatic β cells. N Rideau¹, C Saulnier² (¹ INRA, Station de Recherches Avicoles, 37380 Nouzilly; ² CNRS URA 307, Laboratoire de Physiologie du Développement, Université Paris VII, 2, place Jussieu, 75251 Paris cedex 05, France)

The perfused isolated chicken pancreas is insensitive to both D-glucose and other known 'initiators' of insulin release when used alone. For example the total cumulative insulin output in response to 10, 20 or 40 mM α -ketoisocaproic acid (KIC) perfused alone was low, 7 ± 3 , 1 ± 1 , 2 ± 1 ng/30 min (mean \pm SEM, $n = 4$, $p > 0.05$) respectively. The potentiation of α -KIC (10 mM) was studied by associating α -KIC with various fuel nutrients perfused at non-insulinotropic concentration in the chicken. The total cumulative insulin output (ng/30 min, mean \pm SEM, $n = 4$) was :

1. α -KIC (10 mM) in the presence of carbohydrates:

| | | |
|-----------|----------------------------|---------------------------------|
| alone | + D-glucose 14 mM | + 3-O-methyl-D-glucose 14 mM |
| 7 ± 3 | 212 ± 49 | 11 ± 6 |
| | + D-glyceraldehyde 5 mM | + D-mannose 50 mM |
| | 156 ± 49 | 16 ± 13 |

2. α -KIC (10 mM) in the presence of amino acids:

| | | |
|-------|--|------------------------------|
| alone | + L-asparagine 10 ± 10 | + L-glutamine 24 ± 10 |
| | + L-asparagine 17 mM + L-glutamine 17 mM 127 ± 31 | |

α -KIC was significantly ($P < 0.05$) potentiated by D-glucose (14 mM), D-glyceraldehyde (5 mM) or L-asparagine (17 mM) + L-glutamine (17 mM). The response with the last 2 nutrients was however delayed (7–70 min) as compared to that observed in the presence of D-glucose. These results suggest that D-glucose at non-insulinotropic concentrations exerts an immediate specific sensitizing effect on the chicken pancreatic β cell. A sensitizing effect of glucose was also observed with D-glyceraldehyde (poorly insulinotropic alone) or D-mannose (non-insulinotropic alone). Thus the metabolic step initiating insulin release is only found in the chicken. Before testing this hypothesis, it is necessary to isolate and characterize the A and B islets of Langerhans in the chicken. An immunohistochemical identification (immuno-peroxidase) method of isolated chicken islets is in progress.

Insulin resistance induced by post-weaning high fructose diet in Wistar rats: reversal by metformin. S Halimi¹, E Rosini¹, PY Benhamou¹, P Faure¹, P André² (¹ Laboratoire de Recherches Métaboliques GREPO, Université et CHU de Grenoble; ² Groupe Liphia, France)

The fructose intake in the western diet is increasing and can sometimes reach 30% of the total carbohydrate intake. Fructose is known to have smaller hyperglycemic and insulinosecretory effects than glucose. Fructose has been recommended as sweetener of natural foods for both diabetic patients and normal subjects, including children. Some deleterious effects have been described, such as hypertriglyceridemia, hyperuricemia and hepatic insulin resistance in some circumstances or subjects. The aim of this work was to study hepatic and peripheral insulin sensitivity in post-weaning male Wistar rats fed a high fructose diet (58% of total carbohydrates, Fr58) for 4 weeks. They were compared with control animals fed a standard chow (Cer) and with another group of animals fed a high fructose diet