basal hay and grain diet with 90 g rumen degradable crude protein in the DM, was not significantly related to any increase in nitrogen accretion. Fish meal addition, on the other hand, gave a significant curve-linear increase in nitrogen retention in milk. Optimal level of fish meal inclusion was depended on fish meal quality, but was in the range 10 to 12 % in the concentrate.

Key words : Feed intake, nitrogen retention, goat, urea, fish meal.

Effect of addition of animal or vegetable fat to a hay based diet on digestibility and nitrogen balance in the lactating goat

R. DACCORD

Swiss Federal Research Station for Animal Production, Grangeneuve, CH-1725 Posieux

At the beginning of lactation, the high producing ruminant is subjected to the energy deficiency. In production systems where forage intake is predominant like in Switzerland, energy deficiency can be coupled with a low intake of fatty acids, particularly when hay rations are complemented with fodder beets. Supplementation of such diets with animal or vegetable fat was studied in a balance experiment performed in goats.

A total of 15 lactating goats were assigned to three diets based on hay, fodder beets and on the following concentrates : A = cereals and soybean meal (16 %), B = as A, but with an addition of 4 % micronized animal fat, C = as A, but replacing soybean meal by extruded soybean (20 %). Concentrates were iso-nitrogenous, containing 2.0, 5.9, 6.0 % crude fat in the DM respectively. All diets were given *ad libitum*. On a net energy basis, they were made up of 50 % hay, 25 % fodder beets and 25 % concentrates.

Goats fed diet A had the highest intake (kg/day : A = 2.152 ; B = 2.061 ; C = 2.027 ; $s_{\bar{x}} = 0.114$). Digestibility of all the main nutrients except crude fat was lower with diet B. Digestibility of organic matter, crude protein and crude fat was higher with diet C. The fibre fraction had the highest digestibility with diet A (A = 62.0 ; B = 59.1 ; C = 60.7 ; $s_{\bar{x}} = 1.2$). Diet C decreased the proportion of faecal N and increased the proportion of urine N (N-urine, % N-intake : A = 25.8^{ab} ; B = 22.2^{a} ; C = 29.7^{b} ; $P < 0.05$). Diet B had the best efficiency of N utilization. The main mineral balances were not affected by the diet.

Production of 3 % fat corrected milk was lowest with diet C (kg/day : A = 3.58 ; B = 3.73 ; C = 3.15, $s_{\bar{x}} = 0.22$). Both diets with higher fat content increased the protein and fat content of milk (protein % : A = 2.67^{a} ; B = 2.81^{b} ; C = 2.86^{b} ; $P < 0.05$; fat % : A = 2.83 ; B = 3.20 ; C = 3.28). These diets decreased the content of middle chain fatty acids and increased that of long chain fatty acids.

The dietary treatments had no significant effect on the concentration of blood metabolites and enzymes, except for cholesterol, whose level was increased with fat supplements.

In conclusion, addition of a limited amount of a good quality fat (of animal or vegetable origin) to a forage-based diet can be a valuable solution for increasing concentrated energy and fatty acids in the diet of high producing ruminants.

Key words : Fat, nitrogen balance, digestibility, goat.

Effect of a high dietary potassium content on Mg-, K- and Na-metabolism in the lactating goat

J. KESSLER

Swiss Federal Research Station for Animal Production, Grangeneuve, CH-1725 Posieux

Only fragmentary information on K-requirement of goats is available. As in sheep the net minimum endogenous requirement can be fixed at 20 mg K/kg live weight. The net requirement

for lactation is 2.1 g K/kg milk. Like in other ruminants, the coefficient of absorption could amount to 90 %.

Due to the high K-content of common goat diets, there are few K-deficiencies in the practice. However, the sometimes massive K-oversupply and its possible negative effects on the metabolism of Mg, Na, I, Vitamin A, etc. represents a bigger problem. Therefore, the influence of high K-contents and of different K : Na ratios in the diet on Mg- and Na-metabolism of the goat were studied in a balance trial.

A hay-concentrate diet with varying K- and Na-contents was given to 3 × 5 lactating Saanen goats : Treatment A : 17.7 g K and 0.6 g Na/kg DM (normal K- and Na-supply, K : Na = 29.1) ; treatment B : 30 g K and 0.7 g Na/Kg DM (high K- and normal Na-supply, K : Na = 43 : 1) ; treatment C : 30 g K and 2.7 g NA/kg DM (high K-and Na-supply, K : Na = 11 : 1). At the beginning of the trial (pre-period) as well as from the 32nd to the 42nd day (main period) a balance period with faeces- and urine-sampling took place.

A negative influence of the high K-supply in diets B and C on the Mg-metabolism was already observed in the pre-period. Moreover, animals with high K- and Na-supply (treatment C) showed an absolute and relative increase in Na-excretion in the urine. However except for the first balance day, the Na-urine excretion of treatment B (high K-supply and correct Na-intake) corresponded to that of treatment A.

Confirmed by the results of the main period, the negative influence of high K-levels on Mg-metabolism of cattle and sheep was also found in goats. Besides the apparent Mg-digestibility which tended to be lower (A : 38 % ; B : 33 % ; C : 30 %) the animals fed diets B and C also exhibited significantly lower Mg-retention (A : 0 g ; B : − 0.09 g and C : − 0.11 g/animal per day ; $P < 1$ %). The extreme K-supply and the simultaneous wide K : Na ratio in diet B did not lead to an increased Na-excretion as it is sometimes reported in the literature. Concerning Na-excretion, there was no statistical difference ($P > 5$ %) between treatments A and B. The same applies to Na-retention (A : − 0.54 g and − 0.43 g/animal per day respectively in B). However, with a Na-retention of − 1.57 g/animal per day there was a significant difference ($P < 1$ %) between the animals of treatment C (high K- and Na-supply with correct K : Na ratio) and the remaining treatments.

In the milk, the content of Mg (A : 0.14 g ; B : 0.14 g ; C : 0.13 g/kg milk), of K (A : 2.05 g ; B : 2.12 g ; C : 2.11 g/kg milk) and of Na (A : 0.42 g ; B : 0.43 g ; C : 0.42 g/kg milk) were not influenced by the varying supply of K and Na ($P > 5$ %). The same applies to the serum values for Mg (A : 1.11 mmol ; B : 1.05 mmol ; C : 1.07 mmol/l serum), K (A : 4.05 mmol ; B : 3.916 mmol ; C : 4.66 mmol/l serum) and Na (A : 147 mmol ; B : 149 mmol ; C : 149 mmol/l serum). There were, however, highly significant differences ($P < 5$ %) in the course of the day. The stability of the K- and Na-serum values in the trial clearly showed that they are not — as in other ruminants — suitable indicators for the estimation of the supply in the urine that might give more information on Na-intake, as there was a correlation of − 0.87 ($P < 1$ %) between Na-intake and this ratio in the present experiment.

Key words : Potassium, sodium, magnesium, goat.

Variations in the *in sacco* by product degradation in goats

P. CHAPOUTOT, D. SAUVANT

Station de Nutrition et Alimentation (INRA), Institut national agronomique Paris-Grignon, 16, rue Claude-Bernard, 75231 Paris Cedex 05

A total of 18 current agro-industrial by-products were studied in goats with a standardized « in sacco » procedure : wheat bran (WBR), corn glutenfeed (CGF), brewer's grains (BWG), wheat distiller's grains (WDG), groundnut meal (GNM), maize germ meal (MGM), coconut meal (CCM), palmkernel meal (PKM), soyabean hulls (SBH), sunflower hulls (SFH), sugar beet pulp (BTP), citrus pulp (CIP), pea by-products (PBP), spinach by-products (SPI), tomato pulp (TOP), grape pulp (GRP), grape kernel (GRK), dehydrated lucerne (DLU).