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Effects of genetic variant for α S1 casein and diet nitrogen content on the response of some plasma characteristics after alanine infusion in early and mid lactation goats

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SUMMARY - The effects of the 3 main genetic variants of α S1 casein fed three levels of crude protein on milk production and composition, and on metabolic responses after infusion of alanine were studied in early or mid lactation dairy goats. Milk production and composition were not affected by level of CP in diet. Milk yield and fat content were not affected by type of variant; CP content in milk was significantly higher in variant AA than in variant EE and FF. Increases in plasma glucose, non esterified fatty acids (NEFA), or insulin after infusion of alanine were not affected by type of variant or CP content of diet. The continuous increase in plasma urea after beginning of infusion was higher for the low CP diet than for the other diets. The continuous decreases in plasma BHB was significantly higher in variant AA than in the other variant.

Key words: Lactating goats, α S1 casein, alanine, dietary nitrogen content, milk composition.

RESUME - "Effets du variant génétique pour la caséine α S1 et la teneur en azote dans le régime sur la réponse concernant certaines caractéristiques du plasma après une injection d'alanine chez des chèvres en début et à mi-lactation". Les effets des trois variants génétiques principaux pour la teneur en caséine α S1, recevant trois niveaux de protéine brute, sur la production et la composition du lait, et sur les réponses métaboliques après une injection d'alanine, ont été étudiés chez des chèvres laitières en début et à mi-lactation. La production et la composition du lait n'ont pas été affectées par le niveau de protéine brute dans le régime. Le rendement en lait et la teneur en gras n'ont pas été affectés par le type de variant ; la teneur en protéine brute dans le lait a été significativement plus élevée chez le variant AA par rapport aux variants EE et FF. Les augmentations du glucose dans le plasma, les acides gras non estérifiés (NEFA), ou l'insuline après injection d'alanine, n'ont pas été affectés par le type de variant ou la teneur en protéine brute du régime. L'augmentation continue de l'urée dans le plasma après le début de l'injection a été plus élevée pour le régime à faible protéine brute que pour les autres régimes. Les diminutions continues du BHB du plasma ont été significativement plus élevées chez le variant AA que chez les autres variants.

Mots-clés : Chèvres en lactation, caséine α S1, alanine, teneur en azote du régime, composition du lait.

Introduction

In Alpine and Saanen goats, the different alleles at the locus of α S1 casein are related to different levels of synthesis of mammary α S1 casein (Mahé *et al.*, 1994). These levels are highly correlated with total casein content and crude protein (CP) content in milk as well as with milk fat content, with no significant effect on milk yield (Barberi *et al.*, 1995). In the French dairy goat population, 3 main variants A, E and F have been identified with their allelic frequencies of 0.41, 0.31 and 0.21 respectively in Alpine goats, and 0.11, 0.56 and 0.30 respectively in Saanen goats (Manfredi *et al.*, 1995). Goats with alleles A, E and F are characterized with high (3.6 g/l), intermediate (1.6 g/l) and low (0.6 g/l) level of α S1 casein in milk, respectively.

Protein need for lactation is essential for a good level of production, but its partition between milk yield and CP content of milk remains to be elucidated. Moreover, this partition may have been altered in goats of different genetic variants, for which physiological and metabolic characteristics need to be studied. Consequently, the study aimed to determine the effects of the 3 main genetic variants of α S1 casein fed three levels of CP on milk production and composition, and on their metabolic responses after infusion of alanine in early or mid lactation dairy goats.

Materials and methods

Eight Alpine or Saanen multifarious goats (Body weight = 61.6 ± 2.1 kg), homozygous for the genetic variant of α S1 casein in milk were allotted in a 3 x 3 x 3 Latin square design according to their genotypes (variant AA: n=3; EE: n=3; FF: n=2), and to the level of CP low (L): 12%, medium (M): 16%, and high (H): 20% CP/DM) in a complete diet (1.59 MCal Net Energy for lactation/kg DM), constituted on a DM basis with alfalfa hay, ensiled sugar beet pulps and concentrate (30/40/30%).

During the first 2 weeks post-partum, the goats were fed *ad libitum* on the M diet. The 3 experimental diets were fed for 3 periods of 4 weeks, in the following order for each variant: AA: diet L, H, and M; EE: H, M, and L; FF: M, L, and H. At the end of each experimental period (4 weeks), alanine (ALA, 0.1M/l) was infused before morning meal during 120 min at a rate of 60 ml/h, which represents around 20% of daily ALA production for a milk yield of 5 kg/d. ALA was infused through a catheter inserted in the jugular vein the day before the infusion. Blood samples were collected by venipuncture before (basal), and at T =15, 30, 45, 60, 75, 90, 105, 120, 150, and 180 min after the beginning of infusion. Plasma was harvested and plasma glucose (GLU), non esterified fatty acids (NEFA), β -hydroxy-butyrate (BHB), urea and insulin (INS) were determined.

Results and discussion

Milk yield and characteristics. During the whole trial, milk yield (kg/d) was 4.2, 4.4, and 4.7 (sem=0.5, NS), fat content (g/kg) was 38.4, 35.8, and 34.8 (sem=3.0, NS), CP content (g/kg) was 32.3, 27.9, and 29.0 (sem=1.4, $P<0.001$) for variant AA, EE, and FF respectively. These results are in accordance with Barbieri *et al.* (1995), who showed no effect of type of variant on milk yield, and an increased milk CP content in variant A above variant E and F. No effect of variant on fat content was observed here, probably because part of the trial was in early lactation and goats had adipose tissue mobilization which could have masked between-variants variations for milk fat content. Milk production and composition were not affected by level of CP in diets, though the lower value of milk production for AA than EE or FF goats could reflect nitrogen deficiency for milk production (but not for CP content) at the beginning of the trial for these goats. Possible interaction between level of CP and genetic variant for α S1 casein need to be studied in order to precise CP dietary recommendations, at least in early lactation.

Plasma characteristics and responses after ALA infusion. Basal INS, GLU, NEFA, or BHB did not differ among variants or diets all along the trial.

After the beginning of ALA infusion, plasma GLU concentration increased slowly until T75 (Fig. 1), but this increase was only significant at T60 (+15 mg/l) and T75 (+20 mg/l); GLU decreased thereafter to basal values until T180. *In vivo*, ALA is the most potent neoglucogenic amino-acid (Lindsay, 1982), but infusing ALA does not necessarily increase plasma GLU concentrations, but more probably it reduces the use of other neoglucogenic precursors (lactate) (Reynolds *et al.*, 1994). Plasma GLU variations after infusion were not affected either by type of variants nor CP content of diets.

Surprisingly, plasma NEFA increased throughout the whole sampling period, at a similar rate between variant or diet. Inversely, plasma BOHB decreased throughout the sampling period with a rate affected by type of variant: -0.10, -0.06 and -0.04 mg/l/mn in variant A, E and F, respectively (sem=0.04, $P<0.07$). This suggests a positive relationship between CP content of milk and the plasma clearance rate of BHB. Despite the weak increase of GLU, total hepatic GLU production could have been increased after ALA infusion, as plasma BHB concentration linearly decreased despite the sharp increase in NEFA. However, tissular BHB utilization through stimulated INS concentration after ALA infusion can not be ruled out (see below).

Plasma urea concentrations increased regularly until T180. Maximal increase obtained at T180 in urea were 18, 51, and 102 mg/l (sem=20, $P<0.01$) for H, M, and L diets respectively, where basal urea were 690, 507 and 287 mg/l respectively (sem=60, $P<0.01$). This continuous increase in blood urea could reflect liver deamination of ALA infused and hepatic urea release. Basal urea as well as changes in urea concentration after ALA infusion were not affected by type of variants. INS increased

non significantly until T120 (+2.5 μ U/ml, sd=5), and more markedly until T180 (+8 μ U/ml, sd=5); these changes were not affected by type of variant or diet.

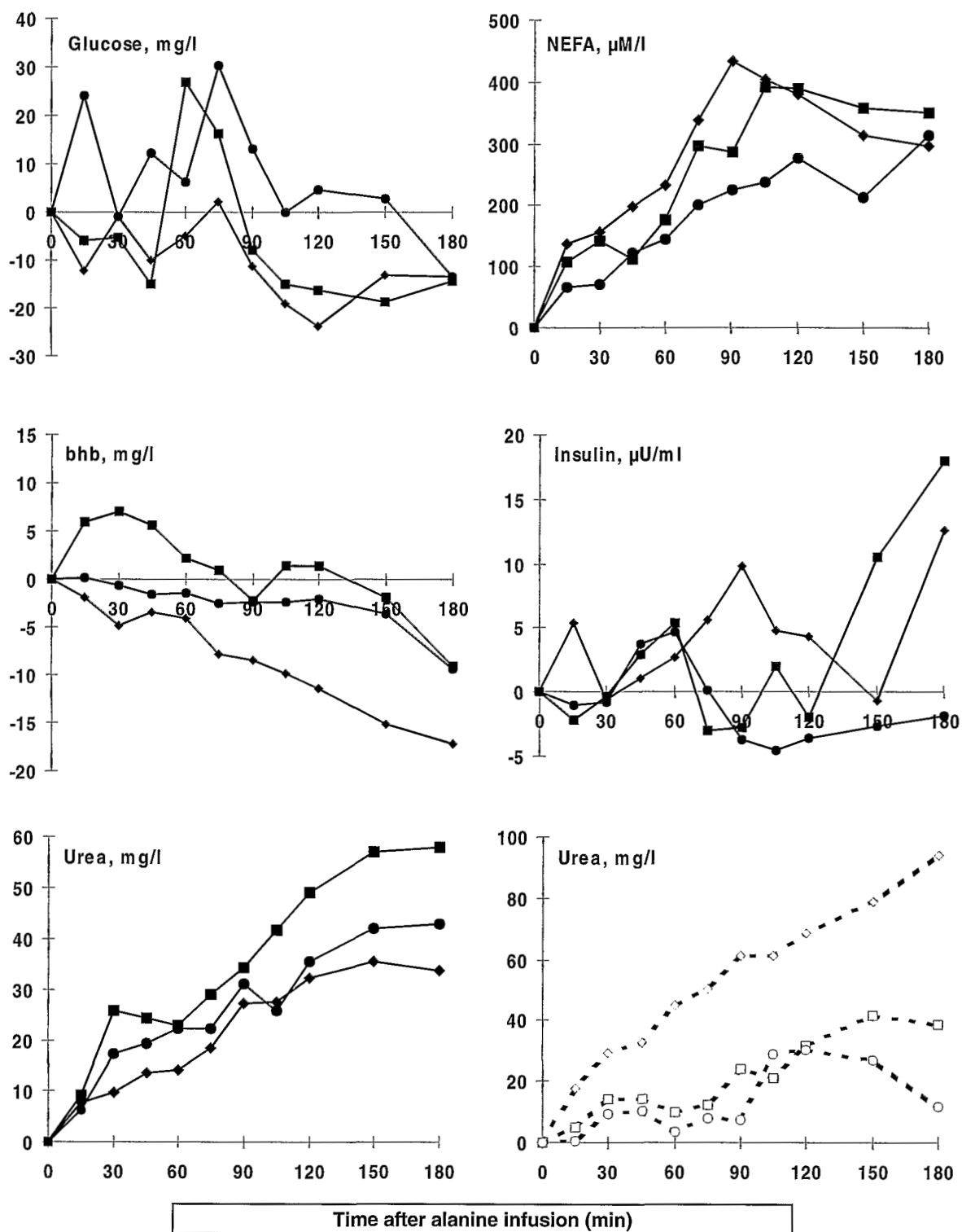


Fig. 1. Effect of alanine infusion on the variations from basal values of plasma concentrations of glucose, non esterified fatty acids (NEFA), β -hydroxy-butyrate (BHB), insulin, and urea in dairy goats differing by their genotype for α S1 casein (variant AA: \blacklozenge , variant EE: \blacksquare , variant FF: \bullet), or fed three levels of crude protein content in the diet (low: \diamond , medium: \square high: \circ).

Conclusion

Our results show that a saturation of hepatic ureagenesis may occur in relation to nitrogen intake, but this is independent of type of variant. There is also a slight effect of ALA on gluconeogenesis as, despite the NEFA increase, BHB is reduced after infusion and this is related to type of variant according to their milk CP content. The relation between BHB production or use and CP content of milk needs further investigation. Dietary recommendations for CP needs to be precise in variants with genetic high CP content in milk.

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