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Body condition score and fat mobilization as management tools for goats on native pastures

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ABSTRACT

Goats raised in extensive production systems in which nutritional requirements and feed availability are often mismatched are compelled to store and mobilize body reserves. It is the adipose tissue that is tasked with storing energy surpluses in the form of lipids when animals have a positive energy balance and of mobilizing the reserves when the energy balance is negative. As a result, caprine body reserves have to be properly managed over the course of the production cycle to achieve optimal production yields and ensure that herds are profitable. Different methods of estimating body composition and animals' fat reserves have been described. These include the body condition score, an effective, easy to use method that can help goat farmers to properly manage the nutrition of their herds.

1. Introduction

Extensive goat production systems are not compatible with a ration formulating program tailored to a herd's actual nutritional needs, inasmuch as the nutritional requirements of each animal at any given time, the nutritional value of the feeds making up the diet, and the daily feed intake are not known. Precise studies of the amount of forage actually ingested by animals according to breed, age, physical condition, and production levels are few and far between in most regions or countries where goats are raised at pasture. In addition, very little information exists as to digestive and metabolic rates both for forage eaten at pasture and for feed provided in the pen (Morand-Fehr, 2005; Lachica and Aguilera, 2005).

Goats have different nutritional requirements over the course of the production cycle depending on the stage they are going through: high at the end of gestation (especially for dam's carrying two or more kids) and during lactation, especially at the beginning. Nutritional inputs do not always cover requirements, either because of physiological reasons (reduced ability to eat at the end of gestation/beginning of lactation), or because of underabundance (winter and summer) or overabundance (spring and autumn pasturage in favourable weather conditions) of feed (Branca and Casu, 1989).

To meet high requirements in times when feed availability is low, goats mobilize body reserves stored during low production stages and/or when feed is abundant. Appropriate herd management involves matching stages when requirements are high to abundant feed availability (Mendizabal et al., 2007).

Proper nutrition in goats, i.e., the diet that is most economical without lowering yields, is based on proper management of body reserves, and for this purpose it is essential to take measurements at the start of each production stage: at weaning to ascertain the amount of replenishment of the dam needed before mating; during gestation to avoid fetal malnutrition; and lastly, postpartum, to assess the reserves available for mobilization (Santucci et al., 1991).

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2. The role of fatty tissue in accumulating and mobilizing energy reserves

The effects of nutritional surpluses and deficits vary with the nature of the nutrients. Excess protein is eliminated in the urine, while protein deficits nearly always result in decreased yields, since goats have very low protein reserves and are thus obliged to meet their protein requirements. The same does not hold for energy, as surpluses are stored in the form of fat reserves that can be mobilized when needed (Vernon, 1986; Lawrence and Fowler, 1997).

2.1. Fatty tissue: growth and metabolism

Fatty tissue is made up of fat cells, or adipocytes. The process of cell differentiation giving rise to adipocytes starts with a pluripotent cell that turns into a unipotential adipoblast. Some adipoblasts turn into preadipocytes, which start to accumulate lipids in their cytoplasm, becoming adipocytes, the cells within an organism that specialize in storing energy in the form of fat. At their maximum storage capacity, these cells can measure over 200 μm in diameter (Hausman, 1987; Ailhaud et al., 1992).

The various fat depots in goats undergo growth during growth spurts and fattening. The growth of fatty tissue has two causes, hyperplasia, an increase in the number of fat cells, and hypertrophy, an increase in adipocyte size. These two processes may take place concurrently or separately, though generally speaking hyperplasia takes place early in an animal's life (Vernon, 1980).

Adipocyte hypertrophy, i.e., an increase in volume, is the result of the accumulation of lipids in the cytoplasm, where lipids are stored in the form of triglycerides. Triglycerides are produced by esterification of glycerol 3-phosphate and fatty acids. The fatty acids may be synthesized *de novo*, ordinarily inside the adipocytes themselves, or may come from the diet. Synthesis is mediated by an enzyme, fatty acid synthase (FAS). At the same time, fatty acids may be taken up from the diet thanks to the enzyme lipoprotein lipase (LPL), which hydrolyzes blood lipoproteins into free triglycerides that can pass into the fat cells (Vernon, 1986).

2.2. The different stages of fattening

As in other species, fatty tissue in goat kids and lambs begins to develop during the fetal stage, particularly during the final trimester of gestation. Adipocyte hyperplasia usually takes place early in postnatal development. Fatty tissue development in lambs has been observed in the omental, subcutaneous, and intermuscular depots in the period between 10 and 50 days age as the result of both adipocyte hyperplasia and adipocyte hypertrophy. Only adipocyte hypertrophy was observed in the perirenal depot, the depot in which fat cell proliferation takes place earliest in development (Nouguès and Vézinhet, 1977; Broad et al., 1980).

Weaning is a radical change for young ruminants that have been feeding solely on mother's milk since birth. On the one hand, animals change from a diet consisting basically of mother's milk to a diet composed of solid food (concentrates and forage), which leads to both functional and metabolic changes in the digestive system. At the same time, weaning is a source of stress, which has a considerable effect on growth, resulting in a sharp decrease in fat deposition and may even bring about mobilization of body fat in kids, thereby reducing the amount of body fat (Bas et al., 1986). In lambs, fat losses on weaning have been estimated at up to 0.5 kg (Bocquier et al., 1988).

The period between weaning and prepubescence is marked by rapid increases in the amount of fat. The proportion of fat in the contribution by the different tissues (bone, muscle, fat) to body weight increases sharply. At the cellular level growth of fatty tissue is mainly attributable to adipocyte hypertrophy (Vernon, 1986).

Changes in the intensity of fattening in animals is influenced both by an animal's developmental stage and by such other factors as genotype, sex, and diet.

2.2.1. Genotype

An animal's genotype influences both the amount of fat deposited and how the fat is distributed among the different fat depots. Comparisons of animals having the same live weights or empty live weights have shown animals of different breeds to have differing amounts of fat (Soret et al., 1998; Oman et al., 1999, 2000). In terms of fat distribution among the different adipose tissues, generally speaking, dairy breeds can be said to lay down more fat in their internal depots (mainly perirenal and omental), whereas meat breeds deposit higher amounts of subcutaneous fat (Kempster, 1980–1981).

2.2.2. Sex

An animal's sex influences both the amount of total fat and the distribution of fat among the different fat depots. The source of these differences appears to be different hormonal balances between males and females from the critical time of gonad development, which has a variety of effects on the metabolism. As a general rule, fattening is observed to take place earlier in females than in castrated males and earlier in castrated males than in intact males, that is, fatty tissue development takes place earlier in females than in males (Thonney et al., 1987; Mahgoub et al., 2004). Larger amounts of fat are, on the whole, attributable to larger adipocyte size (Mendizabal et al., 1997).

2.2.3. Diet

Diet, in terms of both feed quality and feed intake, affects growth rate and the animal's body composition, i.e., both the growth and metabolism of adipose tissue. Diets based on a high-energy feed supplied *ad libitum* yields heavier carcasses with more fat than diets supplying small, low-energy rations (Cameron et al., 2001).

2.3. Storage and mobilization of fat reserves

Thus, fatty tissue plays a decisive role in the storage and mobilization of body reserves, ongoing processes in caprine production systems in areas with poor-quality land, with their alternating conditions of forage underavailability and abundance due to the effects of climate (Santucci et al., 1991).

Still, not all fat depots will be equally suitable for fat storage and mobilization. Mendizabal et al. (2007)