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ORIGINAL ARTICLE

Preliminary Study on the factors Affecting growth and Properties of Mohair and Wool fibers

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ABSTRACT
This review has highlighted several areas in which more information is needed regarding the effects of nutrition, and other environmental factors, on the quantity and quality of mohair and wool fibers produced by Angora goats and Merino sheep, respectively. Fiber production is influenced by nutrient supply. However, the importance of specific nutrients has not been established, apart from one study showing that mohair growth responded to parenteral supplementation with methionine. The nutritional variation within and among years is the most important climatic factor influencing mohair and wool production and quality. Mohair quality and growth is affected significantly by rate of stocking and during periods of live weight loss by supplementary feeding of either energy or protein. The influence and potential use of live weight manipulation in affecting mohair production and quality are described. Estimates of the energy requirements for the maintenance of fiber goats and the effect of pregnancy and lactation on mohair growth are summarized. The effects and importance of management and hygiene during fiber harvesting (shearing) in producing quality fiber is emphasized. The review concludes that it is important to assess the results of scientific experiments for the total environmental content within which they were conducted. In contrast to sheep, some studies indicate that length growth of mohair fibers may not be very responsive to changes in nutrient status.
Keywords : Mohair, Wool Fiber

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INTRODUCTION

Goat fiber production is affected by genetic and environmental influences. Environmental influences which are the subject of this review include bio-geo- physical factors (photoperiod, climate–herbage system and soil–plant trace nutrient composition), nutrition factors and management factors. The effects of nutrition of sheep on the amount of wool grown, on the components of fiber growth (length and diameter), and on the protein composition and strength of the fibers have been studied extensively. Although much of this information comes from studies with Merino sheep, other breeds and crossbred sheep have also been studied. In contrast, the effects of nutrition of Angora goats on the amount of fiber grown, and particularly on the length growth and diameter of fibers, have received limited research attention. The effects of nutrition on the protein composition and strength of mohair fibers have not been studied. Several reviews have summarized the information available from studies with sheep [1]. Russel, [2] outlined briefly the effects of nutrition on mohair production. Our review is an attempt to summarize the main features of the extensive information available from sheep and to outline the less extensive information available from studies with Angora goats. Comparative effects on sheep and Angora goats will be emphasized and differences between the species will be considered. Nutritional effects on both the quantity and quality of fiber produced are considered. The quality of wool or mohair may be regarded as the various characteristics and defects in the fleece, both inherited and acquired, that influence its end use. Some quality factors can be influenced by the supply of nutrients available to wool follicles, and presumably also to follicles in Angora goats, during the process of fiber growth. These factors are mean fiber diameter, fiber length, and fiber strength. In both Merino sheep [3] and Angora goats fiber diameter is the major determinant of the price paid for the cleaned fiber. The presence of medullated fibers is an important quality factor in the fleece of Angora goats. Although medullation is influenced markedly by genetics and age, possible effects of nutrition will be considered.

THE PROCESS OF FIBER GROWTH

To understand the effects of general nutrient status and of specific nutrients on the growth and properties of fibers, the process of fiber growth needs consideration. Fiber diameter and fiber length growth determine the amount of wool or mohair produced by an animal, as well as its quality. Most of the information on the process of fiber growth comes from studies with sheep, especially the Merino. The amount of wool grown by a Merino sheep over a defined period of time depends on 1) the number of wool follicles growing a fiber, 2) the rate of growth of each fiber, and 3) the diameter of the fiber. Virtually all follicles in Merinos are actively growing a fiber at any given time; there is little seasonal variation in the rate of fiber growth provided nutrition and environmental temperature are kept constant. The growth rate of an individual fiber depends on 1) the number and size of cells in the proliferative zone of the follicle bulb (bulb cells) and the proportion of newly formed cells that migrate from this zone, 2) the rate of division of bulb cells as measured by the time taken for the total cell population in the proliferative zone to be renewed (turnover time), 3) the proportion of migrating cells that enter the fiber, and 4) the increase in size of cells forming the fiber. Most of these events are influenced by the nutrient supply to the follicles. Because Merino wool fibers are essentially non medullated and have a constant specific gravity (4), the amount of wool grown by a sheep depends on changes in cross-sectional area (calculated from diameter) and length growth rate of fibers. The same considerations should apply to Angora goats, which usually have less than 4% medullated fibers in their fleece [5]. Mohair fibers have a specific gravity similar to that of wool, which presumably also remains constant. Thus, the quantity and quality of fibers produced by both sheep and Angora goats are determined largely by the same components (length growth and diameter).

The Ability of Angora Goats and Merino Sheep to Produce Fiber

The various strains of Australian Merino sheep vary in their ability to produce wool. Hogan et al. (1979) concluded that the genetic potential of various strains of Merino sheep ranged from 8.5 to 20.8 gld of clean, dry wool. The medium Peppin and South Australian strong wool strains had the highest potential.

Comparable assessments have not been made for Angora goats. Gallagher and Shelton [6] calculated that Angora goats were much more efficient than Rambouillet Merino sheep for fiber production. Mature goats in their study grew 12.5 g/d of clean fiber when provided ad libitum access to a diet of reasonable quality. However, their potential mohair production may be higher than this. Although the goats in their study grew fiber much more efficiently than did the Rambouillet sheep, the authors concluded that Angora goats produced fiber with efficiency similar to that of the Australian strong wool Merino strain. Recently reported rates of mohair production by Angora goats support this conclusion. Qi et al. [7] reported rates of clean mohair production for well-fed Angora goats of 10.1 to 11.7 and 12.1 to 16.7 g/d of clean fiber, respectively. Nixon et al. [8] measured mohair production per unit area of skin. It is possible to make estimates of the rate of clean mohair production from their data of 14 to 22 g/d. Relative fiber production by Merino sheep and Angora goats can also be calculated from the number of follicles growing fibers and the anticipated length growth and diameter of these fibers. These calculations are based on published values, but the actual values used will influence the result. However, it is apparent that Merino sheep and Angora goats should produce similar amounts of fiber. Moreover, calculated values for the mass of fiber grown are in the expected range.

The Influence of Nutrient Supply on Fiber Growth

This section will consider the effects of nutrient supply on fiber growth only during adult life of non pregnant, non lactating animals. The effects of nutrition in pregnant and lactating animals will be discussed later. Many studies have demonstrated the large effect of feed intake on wool growth in various breeds of sheep. Likewise, fiber growth in Angora goats responds to increased feed intake. Merino sheep have been reported to respond similarly to increased feed intake at any time of the year [9]; in contrast, most other breeds of sheep (e.g., Romney) are less responsive during periods of short day length. The rate of growth of mohair fibers may also be less responsive to nutrition during the winter months, but definitive data are lacking. To determine which specific nutrients influence fiber growth, it is necessary to avoid the degradative activity of ruminal microbes. The influence of various absorbed nutrients on wool growth has been reviewed by Reis (1989a). The major nutritional limitation to wool growth is the amount and composition of AA available to wool follicles; the supply of sulfur containing (S) AA (cysteine and methionine) often limits wool growth, and lysine supply is also important.

A large amount of cysteine is required to synthesize wool proteins, and much of this can be provided by conversion of methionine. However, methionine also plays a more specific role in stimulating wool growth. Oddy [9] established that rates of wool growth were near maximum at a maintenance energy intake when approximately 150 g of AA, given as casein via the abomasum, was provided for intestinal absorption.

Qi et al. [10] reported that yearling bucks grew 33% more mohair when fed diets with 18% CP compared to diets with 12 and 15% CP while feed intakes were similar. This response was probably a reflection of a high degree of protein 'protection'. Most protein consumed by ruminants is denatured during rumen digestion and is either used by rumen micro-organisms for their growth or converted into urea or ammonia. Diets with more than 15% CP can have substantial losses of nitrogen caused by rumen degradation. If additional protein fed to ruminants can be 'protected' from rumen degradation, then additional animal production can be obtained. 'Protected' or 'bypass' protein increases wool growth and mohair growth.

Similar values might be expected to apply to the energy requirement for synthesis of mohair fibers. However, Herselman and Smith [11] indicated that the energy requirement for fiber synthesis by Angora goats may be somewhat higher than the above estimate for sheep. They calculated the energy cost of fiber production to be 136k J of ME/g of fiber synthesized. Clearly, more data are needed to establish the energy requirements for fiber growth. Several feeding experiments with Angora goats have shown that mohair growth responds to the intake of extra nutrients in both wethers and dry does. These experiments do not define which nutrients are required by the follicles because ruminal microbes alter the nutrient content of digesta before absorption. When Angora goats were totally hand-fed, increasing dietary protein (supplied by cottonseed meal) increased clean fleece weight and fiber diameter [12]. In another study, supplements providing either protein or energy increased mohair production of goats on pasture. Several studies with Angora goats have shown that both the rate of fiber growth and fiber diameter were increased as the energy [12] or protein [13] in the diet was increased. In the study of Sahlu et al.,[8] yearling Angora wethers were fed isocaloric diets containing three levels of dietary protein [9, 15, and 21% CP on a DM basis). Clean mohair production increased linearly with increasing protein in the diet. Because AA supply influences wool growth, the effects of providing proteins or AA, treated to reduce the extent of degradation by the ruminal microbes, have been tested with Angora goats. Both formaldehyde-treated casein and heat-treated soybean meal increased the growth rate of mohair fibers. However, responses by Angora goats given encapsulated methionine (to protect against ruminal degradation) have been inconclusive. Craddock and Bassett (1977) found no increase in mohair production when encapsulated methionine was included in the diet. However, encapsulation may have been ineffective. In contrast, Bassett et al. (1981) observed that mohair growth increased when .1 and .2% of a different polymer encapsulated methionine was included in the diet. Only one study with Angora goats has tested responses to parenterally infused AA. Sahlu and Fernandez [8] administered L-methionine and Llysine intraperitoneally. Small increases in clean fiber growth and fiber diameter were obtained with methionine, but not with lysine. Because the goats received a high intake of a good-quality diet, the basal rate of mohair growth was high and there was limited potential to increase production. Also, the short duration of the period of fiber measurement (14 d) reduced sensitivity. Further studies with infusions of AA in Angora goats are required to establish the importance of specific AA for fiber growth.

Effects of Minerals and Vitamins on Fiber Growth

In addition to the major nutrients, several vitamins and trace elements are required for fiber growth. The importance of an adequate supply of vitamins and trace elements for wool growth has been reviewed by Purser [13] and Reis (1989a). Although vitamin supply has not been shown to restrict wool growth in adult sheep, folic acid and pyridoxine are especially important for wool growth. Copper and Zn are required directly in the process of fiber growth [13], and deficiencies of these elements can substantially reduce wool growth and weaken fibers. Except for S, the mineral requirements for mohair growth in Angora goats have not been investigated. In particular, the requirements for Cu and Zn for Angora goats should be investigated. Huston et al. [7] fed Angora goats diets based on bermudagrass hay, ground peanut hulls, and ground corn, supplemented with Cas04 to provide .16 to .34% S (DM basis). Clean mohair production was increased by sulfate supplementation; for maximum mohair growth .267% dietary S was required. This gave a N:S ratio of 7.2:1, which suggested that the N:S ratio of 10: 1 recommended for goats was inadequate for Angora goats. Wool growth requires high levels of S-amino acids; by analogy, with sheep, the effects of S supplementation in the above experiment most likely were mediated by way of effects on digestion in the rumen and flow of nutrients (S-AA) from the rumen.

Effects of Pregnancy and Lactation on Fiber Growth

Corbett [13] reviewed the effects of pregnancy and lactation on wool growth in sheep. Maturation of secondary follicles in lambs is retarded by a restricted nutrient supply of their dams during late pregnancy; adult wool production of these animals may be reduced if the restriction is severe. Wool growth by the ewe typically is reduced during the last 2 mo of pregnancy and during early lactation. Corbett [13] estimated that the full cycle of reproduction in ewes reduces annual fleece production by 10 to 14%. A reduced supply to wool follicles of one or more essential nutrients is presumably responsible for these effects. In contrast to nonlactating, nonpregnant sheep, wool growth was not primarily limited by the availability of S-AA (cyst[e]ine and methionine) during late pregnancy and early lactation. However, Stewart et al. [15] found that methionine may limit wool growth during early lactation. On the basis of changes in plasma AA concentration, Masters et al. [15] suggested that the supply of other AA (arginine, lysine, or threonine) may limit wool growth during pregnancy and lactation, but they failed to obtain a response to abomasal injections of these AA [15]. Comparable studies with Angora goats have not been reported. In a recent study milk yield and mohair production were measured in an experiment in which Angora does during early lactation were offered isoenergetic diets containing 10, 13, 16, and 21% CP. Although milk production increased as dietary protein was raised to 16%, mohair production was decreased at 16% protein. Somewhat surprisingly, milk production was reduced with 21% protein in the diet, whereas mohair production was increased. This result may reflect competition for nutrients in which the requirements for milk production take priority. It is also conceivable that the 21% CP diet provided excess protein, resulting in energy expenditure for urea synthesis. This energy drain may decrease milk production (but not mohair) and may, in fact, spare AA for mohair production. Compared with three does that kidded but were unable to lactate, mohair production by lactating does was reduced by as much as 29% in the group receiving 16% protein in the diet, and an overall reduction of 14% due to lactation was observed across treatments. This study suggests that the effects of pregnancy and lactation on fiber production by Angora goats may be similar to those reported for sheep.

Nutrition and Modulation

The presence of medullated fibers (both kemp and med) in mohair reduces the value of the fleece. Kemp fibers are produced by primary follicles. The major factors influencing the proportion of medullated fibers are genetics and age [16]. Because many of the secondary follicles that produce mohair fibers are not mature at birth, the fleeces of young Angora goats contain a higher proportion of kemp. Data from New Zealand indicate that nutrient supply may alter the kemp content of the fleece. Thus, Nixon et al. [17] reported that Angora goats receiving a high level of nutrition had higher proportions of kemp fibers. This subject has been reviewed by Tiffany-Castiglioni [18] and Lupton et al. [19], who both concluded that the proportions of medullated and kemp fibers are not markedly affected by nutrient supply.

CONCLUSION

The quantity and quality of fiber produced by sheep is markedly influenced by nutrition. Both length growth and diameter of fibers respond to changes in nutrient supply. The major limitation to wool growth is the amount and composition of AA available to wool follicles; the S-amino acids are especially important. Maximum rates of wool growth can be sustained on maintenance intakes of energy if the supply of essential AA is adequate. Data regarding the nutrient requirements for mohair production by Angora goats are limited. The energy requirement for fiber growth may be greater in goats than in sheep but further studies are needed. An increased protein supply to the follicles can increase mohair production, but the importance of specific AA has not been established. Some studies with Angora goats indicate that length growth of fibers is not very responsive to nutrition; further work is needed to establish whether Angora goats differ from sheep in this respect.

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