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Strategies for the genetic improvement of South African Angora goats☆

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ABSTRACT

Selection of Angora goats over the past decades has focused on traits related to fitness, body weight and fibre production. Research for genetic improvement of the Angora has been based on quantitative selection and more recently molecular technology has been applied. Although considerable progress has been made at increasing fine mohair production, the inability of Angora goats to survive sub-optimum conditions has become a concern. Selection emphasis on fibre production resulted in unthrifty animals and the South African (SA) Angora industry is still hampered by the loss of young goats. DNA marker information assists conventional selection by increasing selection accuracy, improving the rate of genetic improvement and leading to a better understanding of the physiological background of traits. The genetic diversity of the SA Angora goat breed was estimated and an improved linkage map was recently developed. The extensive production systems in South Africa pose a challenge for pedigree integrity, and a microsatellite panel was constructed for parentage verification. Selection for quantitative trait loci (QTL) will lead to increased genetic progress and offers the opportunity to improve understanding of and exploit phenotypic variation. Putative QTL associated with fleece and growth traits have been identified in the South African Angora goat population. The current goat SNP chip does not include any fibre-producing goat breed, and this chip is currently being verified in the SA Angora goat population, in conjunction with the sequencing of certain keratin genes.

1. Introduction

The Angora goat was domesticated in Turkey, from where they were exported to Europe during the sixteenth century in an attempt to establish a mohair industry. The European climate was however not suited to these goats and South Africa (a British colony at the time) presented a favourable region for Angora goat production. The first Angora goats were imported to South Africa during 1838, followed by another 3000 goats between 1856 and 1896 (Friedrich, 2009). The Karoo and semi-arid Eastern Cape region proved to be well-suited to the Angora goats, and a successful industry evolved from this. Today the mohair industry in South Africa consist of approximately 644 000 Angora goats (www.mohair.co.za), most of which are still farmed with in the Eastern Cape.

The Angora goat serves a small, niche industry by producing a lustrous and specialized fibre. Mohair is admired for its superior lustre, handle and high quality and is marketed and promoted by a well-organized international mohair industry. South Africa is the major role player, producing almost 50% of the world product. Mohair is also produced in several other countries, in climatic areas as diverse as the arid areas of southern and south-western USA (Texas, Arizona and New Mexico) and Patagonia in Argentina, to the colder highlands of Lesotho, Great Britain and New Zealand. Most of the world mohair production

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are imported to South Africa for further processing, and exported with the locally produced mohair (DAFF, 2011). World production of mohair decreased sharply between 1988 and 2003, with a drop of 70% to 6.6 million kg (Van der Westhuysen, 2005) owing mostly to a shift towards synthetic fibres in the fashion industry. Global production has decreased further over the past seven years, primarily due to the global financial crises. Goat-produced fibres make up about 0.04% of the world textile fibre production (Lupton, 2004), to which the total mohair production contribute less than 0.02%.

South Africa is widely considered as the most reliable producer of a good quality clip of mohair worldwide, and produces approximately 48% of the world product annually (DAFF, 2011). Early processing (e.g. scouring and combing) of the mohair is performed in South Africa and then sold as "tops", while raw (unprocessed) mohair is also sold. Mohair in either of these forms is mainly sold at orderly "open-cry" auctions, although a few companies market their product exclusively under brand names (e.g. Camdeboo) (Van der Westhuysen, 2005; DAFF, 2011). Mohair production in South Africa has decreased by almost 30% from 3.7 million kg in 2004 to 2.3 million kg in 2010. This decrease has been attributed to a continuing drought in large parts of the production region (Eastern Cape Province), as well as the global financial crises (DAFF, 2011). South African producers are facing challenges to remain productive and competitive and breeders have to adapt to demands for finer fibres, decreasing profit margins, a challenging production environment and changed land-use patterns. Therefore, the continuous evaluation and improvement of selection criteria and breeding goals are of the utmost importance to maintain the world-renowned quality clip and efficient production of South African mohair.

The aim of this review was to provide an overview of the genetic improvement of the South African Angora by discussing (i) selection criteria and genetic parameters, (ii) selection programmes based on quantitative selection, and (iii) molecular approaches to genetic improvement.

2. Selection criteria: fibre traits

Mohair traits include both physical and quality traits with fibre diameter (FD) still being the most important economically, determining both the price and the processing of the fibre. Fibre diameter is moderate heritable, with estimates varying between 0.30 and 0.45 for the SA Angora goat population, and fleece weight (FW) being lowly to moderately heritable (Table 1). Genetic parameters have been estimated for fleece weight and fibre diameter in French (Allain and Roguet, 2003), Argentinean (Taddeo et al., 1998), Australian (Gifford et al., 1991) and South African (Snyman and Olivier, 1996, 1999; Visser et al., 2009) Angora goats. Staple length and subjective fleece traits such as the general appearance and the style, character and evenness of the fleece have a smaller influence on the price. Very few reliable variance estimates are available for these traits (Snyman, 2002; McGregor and Butler, 2004). Breeders tend to place emphasis on the subjective traits despite the low heritability and repeatability estimates, and this is currently discouraged.

Table 1
Heritability and repeatability estimates for mohair traits in South African Angora goats.

Trait	Heritability	Repeatability
Greasy fleece weight (FW)	0.19[a] 0.24[b]	0.41[a]
Fibre diameter (FD)	0.30[a] 0.45[b]	0.68[a]
Coefficient of variation of fibre diameter (CVFD)	0.37[b]	
Standard deviation of fibre diameter (SDFD)	0.32[b]	
Comfort factor (CF)	0.63[b]	
Spinning fineness (SF)	0.61[b]	
Standard deviation of fibre diameter along the length of staple (SDA)	0.14[b]	
Softness		
Face cover	0.07[a]	0.32[a]
Style	0.33[a]	0.37[a]
Evenness	0.13[a]	0.24[a]
Character	0.26[a]	0.23[a]
Kemp	0.14[a]	0.35[a]
Pigmentation	0.01[a] 0.43[a]	0.29[a] 0.62[a]

[a] Snyman and Olivier (1999).
[b] Visser et al. (2009).

An important contribution in recent years was the addition of quality traits in selection programmes; especially those measured using Optical Fibre Diameter Analyser (OFDA) technology. OFDA2000 technology is currently routinely used for fleece measurement in most animal fibre producing countries, including South Africa. The measurement of fibre diameter, as well as other important quality traits has offered the inclusion of new criteria in the selection objective. The quality traits are associated with the full diameter profile, and include coefficient of variation of fibre diameter (CVFD), standard deviation of fibre diameter (SDFD), comfort factor (CF), spinning fineness (SF) and standard deviation of fibre diameter along the length of the staple (SDA). These traits have however largely been ignored by the mohair industry, and there is a dearth of information on genetic parameters for them, with estimates only for French and South African Angora goats (Allain and Roguet, 2006; Visser et al., 2009). In Table 1 a summary is provided of the heritability estimates that have been estimated for some quality traits in SA Angora goats.

In the selection for fine mohair, breeders have been challenged with unfavourable correlations between fibre diameter and fleece weight. Medium to strong positive correlations of 0.35 (Allain and Roguet, 2003) to 0.55 (Snyman and Olivier, 1996) have been reported, while lower positive (0.08, Visser et al., 2009) and even negative values (−0.29, Pattie et al., 1990) have also been published. General consensus is that fibre diameter and fleece weight should both be selected on by making use of a selection index. Quality traits should also receive consideration for inclusion in a selection index, but the economic weighting factors of these should first be determined.