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Divergent selection for total fleece weight in Angora rabbits: Correlated responses in wool characteristics

S.A. Rafat [a,b], H. de Rochambeau [a], R.G. Thébault [c], I. David [a], S. Deretz [c], M. Bonnet [c], B. Pena-Arnaud [a], D. Allain [a,*]

[a] *INRA UR631, Amélioration Génétique des Animaux, BP 52627, 31326, Castanet Tolosan, France*
[b] *Department of Animal Science, Faculty of Agriculture, University of Tabriz, 51666, Tabriz, Iran*
[c] *INRA UE967, Génétique Expérimentale en productions Animales, Phanères, Le Magneraud, BP 52, 17700 Surgères, France*

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Abstract

An experiment was carried out to study direct and indirect responses to selection in the Angora rabbit. There were two selection lines, one selected for high fleece weight and the other for low fleece weight. Data from 669 female rabbits born in 1994–2001 and having produced a total of 2923 harvest of wool were analysed to quantify the correlated responses to selection. By 2001, there had been eight cohorts of selection. The correlated responses analysed included compression, resilience, fleece quality traits (bristle and down length, average fibre diameter, comfort factor, bristle diameter) and secondary to primary follicle ratio (*S*/*P*). Genetic correlations were obtained by restricted maximum likelihood techniques. In response to selection, a positive difference of 0.92, 0.21 and 0.55 genetic standard deviation were observed for bristle length, comfort factor and *S*/*P*, respectively. No correlated response was observed on down length while negative differences of 1.00, 1.31, 0.38 and 0.50 genetic standard deviations were observed for compression, resilience, bristle diameter and average fibre diameter, respectively. Selection for increasing total fleece weight results in an increase of qualitative component traits of wool production in the French Angora rabbit. The quantitative traits were examined in the first (published) part of the paper.

Keywords: Angora rabbit; Bristle; Divergent selection; Down; Fibre diameter; Follicle; Wool

1. Introduction

Angora rabbit fibre is categorised in the luxurious especially fine animal fibre group along with mohair, cashmere and alpaca. After wool and mohair, Angora fibre production is the third largest fibre industry in the world. Angora rabbit production in France was estimated to be approximately 2000–3000 rabbits with an annual production of 2 tonnes of fibre in 2005 (personal communications with the Union of French Angora Rabbit Breeders).

Selection for total fleece weight was successful in sheep (Wuliji et al., 2001; Bray et al., 2005), in goat (Merchant and Riach, 2003; Bai et al., 2006) and in French Angora rabbit (Rafat et al., 2007). It is unclear, however, whether a higher fleece weight is associated with an increase in other fleece characteristics (length, diameter, compression and secondary to primary follicle ratio) of Angora rabbits. In sheep, Morris et al. (1996) found an unfavourable

* Corresponding author. Tel.: +33 561285171; fax: +33 561285353.
E-mail address: daniel.allain@toulouse.inra.fr (D. Allain).

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correlated response in mean fibre diameter when selecting for high fleece weight. In a companion paper, Rafat et al. (2007) presented results of a divergent selection experiment on total fleece weight in French Angora rabbits. The first results indicated that an important direct response on total fleece weight was obtained on the two divergent lines. A divergence of three genetic standard deviations on both total fleece weight and weight of the bristly wool was observed between the high and low lines after 8 years of selection. An increase in live body weight was also obtained by selection for total fleece weight. The objective of this paper was to evaluate the correlated responses to selection for fleece characteristics.

2. Materials and methods

2.1. Animals

The animals came from a divergent selection experiment on total fleece weight described by Rafat et al. (2007). Studies were made on the wool production of 669 female Angora rabbits born between 1994 and 2001 under a divergent selection program to assess direct and correlated responses. There were 3567 animals in the pedigree file. The aim of the selection experiment was to obtain two divergent lines for total fleece weight. The selection criterion was the total fleece weight of the does measured for the third and later harvests. The selection method was based on a BLUP procedure using a repeatability animal model. The management, reproduction and housing conditions of these animals have been previously described (Allain et al., 1999; Rafat et al., 2007).

2.2. Traits

The rabbits were plucked for the first and second times at the ages of 8 and 21 weeks, respectively. Thereafter they were plucked at regular intervals every 14 weeks until the 12th harvest. The data of the 3rd to 12th harvests for each cohort were utilised in this study. At each harvest, total fleece weight (TFW) was recorded. The live body weight (9LW) was measured 9 weeks before each harvest. At the fifth and seventh harvests from cohorts of 1994 to 2000, and at the 3rd to 12th harvests from the last cohort born in 2001, the following variables were recorded: compression, resilience, the length of bristles (BL) and downs (DL) measured on locks taken from the haunch. The first two measurements were used to judge the quality of the fibre (Allain et al., 1999). Compression and resilience were measured according to the method of de Rochambeau et al. (1991).

On animals born in 2001 and issued from the last selected cohort, additional biological samples were made at the fifth and the seventh harvests (Table 1). Two wool samples were taken from the haunch. The first sample including all kinds of fibre was obtained to determine average fibre diameter (AFD) and comfort factor (CF, percentage of fibres ≤ 30 µm) according to the Optical Fibre Diameter Analyser (OFDA) methodology (IWTO-47, 1995). The second sample was obtained by extracting bristles by hand from a total lock in order to determine bristle diameter (BD) according to the cross section methodology (Allain and Thébault, 1996). Skin samples were taken from the back by biopsy 5 weeks after the fourth and the sixth harvest to determine the primary to secondary hair follicle ratio within the hair follicle group. Details of the methodology of skin histology and *S*/*P* ratio measurement are described by Rougeot and Thébault (1983). Because of the shrinkage of skin specimens during histological procedures, there is a strong case for using the relative density of primary and secondary follicles expressed by the *S*/*P* ratio to overcome the difficulties of making an accurate estimate of total population of wool follicles (Abouheif et al., 1984).

2.3. Statistical analysis

2.3.1. Testing of fixed effects

The least squares method of the GLM procedure (SAS, 2001) was utilised to determine the significance of the fixed effects and covariate. TFW was analysed with a model that initially included year and season of birth, harvest season, harvest number and reproduction as fixed effects and 9LW such as a covariate. BL, DL, compression and resilience were analysed with the same

Table 1
Number of records (*N*), means and standard deviation (SD) of the means for the studied traits

Trait	Unit	*N*	Means	SD
Total fleece weight [a]	g	2923	213.27	56.60
Bristle length [b]	mm	1171	101.93	9.41
Down length [b]	mm	1170	67.04	8.78
Compression [b]	mm	1165	26.52	2.64
Resilience [b]	mm	1165	60.08	5.33
Bristle diameter [c]	µm	149	46.41	3.45
Average fibre diameter [c]	µm	157	14.91	0.94
Comfort factor [c]	%	157	97.85	0.83
Secondary to primary follicle ratio [c]	–	102	48.18	10.32
Live weight before wool harvest [a]	g	2923	3802.1	473.99

[a] This trait was measured at all fleece harvests of all cohorts.
[b] This trait was measured at all harvests of the last cohort, and fifth and seventh harvests from previous cohorts.
[c] This trait was measured at the fifth and seventh harvests of the last cohort.