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The Yellowing Propensity of Rambouillet Wool

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Summary

The yellowing propensity of Rambouillet wool was evaluated. One hundred greasy side samples of Rambouillet ewes were collected in the spring of 2007, and 142 greasy side samples were collected from Rambouillet rams during the October 2006 Ram test. The propensity to develop yellow discoloration was determined on each of the greasy wool samples. After scouring, average-fiber diameters were obtained. Absorbance measurements of supernatant liquids clearly indicated there was a wide range in yellowing propensity for both the rams and the ewes. This would imply that is would be possible to include yellowing propensity in a selection program, allowing producers to discriminate against those animals with a propensity to develop yellow discoloration. There was no significant difference between the yellowing propensity of the ram or ewe wool and fiber diameter.

Key Words: Wool, Yellowing Propensity, Rambouillet

Introduction

The U.S. sheep industry has experienced a decline in numbers for the past 60 years. Income from sheep is based almost entirely on wool and market lambs. Income derived from wool sales is subject to worldwide price structuring. Currently, approximately 70 percent of the U.S. wool clip is exported due to the lack of domestic-processing capability. This requires competition with countries that for decades have used wool color as a selection criterion in the production of wools for export. For example, Australian Wool Exchange Identification (AWEX-ID) (Padula, 2006) is a system for the appraisal and description of non-measured characteristics of greasy wool (of which color is a component). AWEX market reports analyze and present price information using these measured and appraised wool characteristics. AWEX-ID benefits the wool industry, by providing a better understanding of the relationship between wool characteristics and their effect on price.

Wool color is an important characteristic that influences value. As far as color is concerned, superior wool is generally a creamy white color (Botkin, et al., 1988). The discoloration of the wool may for example, limit the dyeing potential of that wool. Clean-color specification is becoming increasingly more important for wool marketing (Australian Wool Corporation, 1987). The color of greasy wool is determined not only by the inherent color of the wool, but also by the grease, suint, dirt, and vegetable matter the wool contains. The susceptibility of a fleece to yellowing is related to the amount and properties of the suint and yolk contained within the fleece (Aitken, et al., 1994).

Thornberry et al. (1980) suggested there was a relationship between fleece rot and wool wax and suint concentrations. Wilkinson (1982) was unable to identify a role in fleece discoloration of wool wax or suint. More recently, Winder et al. (1998) have found that the removal of both wool wax and suint by either detergent scouring or solvent/aqueous extraction resulted in less discoloration of wool. When evaluating the effects of wool wax and suint individually, Winder et al. (1998) found that removal of the wool wax by solvent extraction actually increased slightly the propensity of wool to yellow, which suggests that wool wax may in fact have a protective role with respect to yellowing. They also found that when suint alone was removed by a water wash, that otherwise resistant wool actually had increased yellowing. This suggests that it is the suint, not the wool wax which is responsible for the yellow discoloration of wool and that the genetic basis of the susceptibility of wool to yellowing is due to the variability in the suint from the sweat glands. Aitken et al. (1994) found a positive relationship between the potassium concentration in suint and yellowing propensity.

Temperature and humidity are also important factors in the yellowing of wool under laboratory conditions (Winder, et al., 1998). Thus, because of the influence of environmental conditions, the color of wool may vary depending on the location that it was grown and the season it was shorn (Reid, 1993). Maximum yellowness occurs when wool that is susceptible to yellowing is exposed to high temperatures and humidity – an environmental challenge (Reid, 1993). Therefore in most areas, sheep shorn in late summer and fall typically have greater yellowing than those shorn in the spring or winter. Two tests have been developed to predict the susceptibility of wool to yellowing, one an indirect method (Yellow Predictive Test) (Aiken et al., 1994) and the other a direct method (Yellow Challenge Test) (Aliagra et al., 1996). It has been suggested (Reid, 1993; Wilkinson and Aitken, 1985) that fleece yellowing at shearing might be reduced if the selection of flock replacements are made using the basis of the propensity of the wool to yellow discoloration as a choice criteria. Any reduction in the yellowness at shearing would potentially improve the acceptability of the wool to processors and thus increase the price received by the wool producer (Reid, et al., 1996). For selection and breeding strategies to be successful, the characteristic selected must be heritable and have repeatable phenotypic variation (Reid, et al., 1996). The predictive test has been used in New Zealand for several years as a commercial test for woolgrowers to select sheep for reduced propensity to develop yellow discoloration (Reid, 1993).

The purpose of this study was to collect preliminary data on the propensity to develop yellow discoloration in wool of Rambouillet sheep.

Materials and Methods

Fiber Samples

One hundred greasy side samples of Rambouillet ewes were collected in the spring of 2007 from the University of Wyoming Rambouillet flock. In addition, one hundred and forty-two greasy side samples were collected from Rambouillet rams during the October 2006 Ram test. The side samples represented wool from 22 different producers located in four different states. Average-fiber diameters were determined for each wool sample.

Determination of Fiber Diameter

The Sirolan-Laserscan (AWTA, Sydney; ASTM D6466-99, 2003) was used to measure the fiber diameter of the wool samples. A sub-sample of each wool sample was mini-cored to obtain small (2 mm) fiber snippets that were utilized to determine average-fiber diameter, standard deviation, and coefficient of variation of the sample.

Determination of Yellowing Propensity

The indirect method–the yellow predictive test (YPT) involves incubating wool samples for five days under high humidity. Supernatant is then extracted, and the color of the liquid can be used as an indicator for the yellow discoloration of the wool. Propensity to yellow utilizing the yellow predictive test was determined according to Aitken et al. (1994) except that one-gram samples of fiber were used. Samples were placed in individual 10cm diameter petri dishes and incubated for five days at 98-percent to 99-percent humidity. Increasing absorbance of the supernatant liquid is an indication of increasing susceptibility to yellowness. Quadruplicate samples of wool were tested.

Statistical Analyses

Statistical analyses were conducted in accordance with procedures outlined by SPSS (SPSS, 2006). Frequencies, descriptive statistics, and T-tests were used to determine differences in yellowing propensity of grease wool.

Results and Discussion

Table 1 shows the mean results for quartiles of yellowing propensity of ram wool and average fiber diameters. The averages of the yellowing propensity for each quartile were 0.143 (range .096 to .171), 0.186 (range .171 to .202), 0.237 (range .206 to .283) and 0.330 (range .286 to .473), respectively. Fiber-diameter averages for each quartile were 24.8, 24.9, 24.9 and 24.7 microns, respectively. The yellowing-propensity color range for all the ram wools was 0.096 to 0.473. The largest yellowing variability occurred in those wools that had the highest yellowing propensity. Each quartile average for yellowing propensity is significantly different from the others, $P < 0.001$. There was no significant difference between the average-fiber diameters of each of the quartiles.

Table 1. Yellow Predictive Test Value Quartiles (Absorbance) and Average Quartile Fiber Diameters of Rambouillet Ram wool.

Quartile	Yellowing Propensity		Average Fiber Diameter (microns)	
	Mean	Std. Dev.	Mean	St. Dev.
1	0.143a	0.019	24.8a	1.7
2	0.186b	0.008	24.9a	1.9
3	0.237c	0.028	24.9a	2.3
4	0.330d	0.044	24.7a	1.7

Means with unlike superscripts differ, *P<.001*

Table 2 shows the mean results for quartiles of yellowing propensity of ewe wool and average-fiber diameters. The averages of the yellowing propensity for each quartile were 0.088 (.051 to .107), 0.128 (range .108 to .147), 0.177 (range .151 to .219) and 0.284 (range .220 to .401), respectively. Fiber-diameter averages for each quartile were 25.1, 24.9, 25.1 and 24.7 microns respectively. The yellowing propensity range for all the ewe wools was 0.051 to 0.401. The largest yellowing variability of the ewe wool also occurred in those wools that had the highest yellowing propensity. Each quartile average for yellowing propensity is significantly different from the others, $P < 0.001$. There was no significant difference between the average fiber diameters of each of the quartiles. The range of the yellowing propensities suggest that it should be possible to select Rambouillet sheep for breeding based on their propensity to develop yellow discoloration. It has been shown that selecting sheep based on their propensity to develop yellowness is possible. Reid et al. (1996) studied wool samples from 28 Merino wethers, 31 Corriedale ewes, 37 Perendale ewes and 30 Coopworth ewes. They found correlations between propensity-to-yellow, Y-Z (yellowness index) and mean-fiber diameter were low in the Corriedale, Perendale and Coopworth samples, but high in the Merinos.

Other studies (Aitken, et al., 1994; Raadsma and Wilkinson, 1990; Wilkinson and Aitken, 1985; James, et al., 1990) have shown that the propensity to develop yellow discoloration is dependent upon the breed of sheep and ranges from low heritability (0.19) to moderate (0.51). For example, James et al. (1990) found the heritability in South Australian merinos of the Collinsville family group to be 0.42. This indicates that measurement of yellowing propensity could be useful as a selection criterion in Rambouillets that are similar genetically to Australian Merinos.

Table 2. Yellow Predictive Test Value Quartiles (Absorbance) and Average Quartile Fiber Diameters of Rambouillet Ewe wool.

Quartile	Yellowing Propensity		Average Fiber Diameter (microns)	
	Mean	Std. Dev.	Mean	St. Dev.
1	0.088^a	0.014	25.1^a	2.4
2	0.128^b	0.014	24.9^a	2.1
3	0.177^c	0.021	25.1^a	2.2
4	0.284^d	0.049	24.7^a	1.2

Means with unlike superscripts differ, *P<.001*

Yellow discoloration of wool can be classified as scourable and non-scourable, however, there is no clear distinction between the two (Aitken, et al., 1994). Non-scourable yellow discoloration develops during growth, storage, and processing of wool fiber (Winder, et al., 1998). Genetic and environmental factors have been implicated in the yellow discoloration of wool. Wilkinson (1982) found that animals could be classified according to their genetic predisposition to yellow but that environmental factors, such as warmth, humidity, and dampness, tended to promote yellowness in genetically susceptible sheep. Non-scourable yellowing was also shown to be prevalent in sheep susceptible to fleece rot (Wilkinson, 1981).

It has been shown that yellow fleeces suffer a significant price discount in international markets (Cottle, et al., 1992). During the three wool seasons 1996-97 through 1998-99, New Zealand wools had Y-Z values ranging from -1.6 to 9.5 (higher values indicate greater yellow color). During this three-year period, price reductions of up to $NZ 0.10 were observed per Y-Z unit increase (Cottle, et al., 1992). This translated to an overall price reduction of 16.6 percent for a Y-Z of ≥6 compared to those wools with a Y-Z <6 (Cottle, et al., 1992). Thus, there is the potential for significant economic gain if it can be shown that U.S. wools do not have a propensity to yellow.

Conclusion

Clean color of wool is of major importance to the wool industry. Wool fabric is used primarily in the garment industry in the United States today. Discolored or especially yellow wools cannot, for example, be used in pastel shade apparel. This study has shown that there are differences in the yellowing propensity of the Rambouillet breed and that is could be possible to select sheep based on this data to improve wool. There was no correlation between fiber diameters and the yellowing propensity observed in this study.

Further research should be conducted to investigate the heritability and repeatability of the propensity to yellow discoloration of the Rambouillet. Once this has been established, the impact of selective breeding on the propensity of yellowing of progeny should be evaluated. There is potential for economic gain if wool does not have a propensity to develop yellow discoloration. We expect that through the use of a simple test, Rambouillet sheep can be selected to improve wool color. Additionally, future studies should include measurement of grease and suint content and composition of the samples in attempts to explain the observed yellowing propensities.

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