THE GROWTH AND COMPOSITION OF WOOL FOLLOWING DEFLEECING OF
SHEEP WITH N-[5-(4-AMINOPHENOXY)PENTYL]PHTHALIMIDE

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SUMMARY

In four sheep dosed with N-[5-(4-aminophenoxy)pentyl]phthalimide (400 mg/kg live weight) fibre growth stopped within 1-1.5 days and the sheep were readily defleeced after 9 days. Most follicles stopped growing fibres for 12-16 days. When wool growth resumed, autoradiographic measurements indicated that it was slightly enhanced in the early regrowth due to an increase in fibre diameter. This increase did not persist and mass of wool grown, measured by clipping a defined area, was unchanged. Staple crimp frequency was unaltered following dosing. The wool harvested 3-5 weeks after dosing contained significantly more high-sulphur and less high-tyrosine proteins than pre-treatment wool; these differences did not persist to 9-11 weeks.

INTRODUCTION

It has been shown that oral doses of N-[5-(4-aminophenoxy)pentyl]phthalimide (APP) cause loss of wool from sheep (Hughes 1959) and that it, and various related compounds, are potential defleecing agents for sheep (Rigby et al., 1980). For any defleecing agent that acts by causing a temporary cessation of wool growth, it is important to know the length of the period during which fibre growth stops and whether the growth rate and characteristics of wool are altered in the early regrowth. Such information has already been reported for cyclophosphamide and mimosine (Reis and Chapman 1974; Reis et al. 1976; Reis 1978), and this paper reports effects on wool growth following defleecing with APP.

MATERIALS AND METHODS

Four Merino wethers, live weight 45-50 kg, were kept indoors in a room maintained at a temperature of 23 ± 3°C. These weights include a fleece of 5-9 cm staple length. The daily ration, 800 g of a mixture of equal parts lucerne and wheaten hays, was ground and pelleted. Each sheep was given a single oral dose of APP at a rate of 400 mg/kg live weight; the compound was packed in gelatin capsules and administered with a balling gun (Reis et al. 1975).

Fibre growth before and after dosing was assessed by an autoradiographic technique (Downes et al., 1967). Sixteen intravenous injections of tracer amounts of L-[35S]cystine (2.60 μCi/injection) were given to each sheep at intervals of 4-7 days. Relative to the time of dosing the cystine injections were given at days -10, -4, 0, 4, 8, 12, 16, 21 and at 7-day intervals thereafter until day 77. Measurements were made of fibre diameter at the front of each radioactive zone, and of the distance between each radioactive mark. Diameter, length growth rate and volume growth rate of fibres were calculated from these values for each period (Reis and Chapman 1974). Fibre growth prior to dosing was measured on 'shed' fibres plucked from three sites along the side and one on the back of each sheep on day 7. 'Regrowth' fibres were collected from the same sites at the end of the experiment. Measurements were made on 70-90 fibres/sheep for shed fibres and on 60-80 fibres/sheep for regrowth fibres; at least 15 fibres from each site were measured. The autoradiographic data were also used to estimate the time required for wool growth to stop following dosing and the period during which fibre growth stopped, as outlined by Reis and

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Chapman (1974). The latter estimates were made from the lengths of fibres in the regrowth and from the number of $^{35}$S cystine marks on these fibres.

Growth of clean, dry wool was measured on a defined area (c. $10 \times 10$ cm) on the midside of each sheep as described by Reis (1978). Measurements were made over a two-weekly interval prior to dosing and at two-weekly intervals between weeks 3 and 11 after dosing. Cystine and tyrosine contents were measured in some of these wool samples, and the contents of high-sulphur and high-tyrosine proteins were calculated from these values using appropriate regression curves (Broad et al., 1970; Frenkel et al., 1974). Staple crimp frequency was measured over 2 cm at the base of staples collected at the time of dosing and 20 weeks after dosing. Measurements were made by two observers on staples collected from eight sites on each sheep. Statistical significance of differences was tested using a paired t-test.

RESULTS

All sheep were readily defleeced by hand 9 days after dosing. No adverse effects were observed apart from some feed refusals for up to 5 days.

When allowance was made for the spread of radioactivity in fibres after labelling with $^{35}$S cystine (Reis and Chapman 1974), it was estimated that fibres stopped growing in all sheep 1-1½ days after dosing. The average length of the period during which fibres were not growing after dosing, calculated from the length of fibres in the regrowth, was 12½-13½ days for three sheep but was 16½ days for the fourth sheep. Counts of the number of $^{35}$S cystine marks on the regrowth fibres (Table 1) showed that for the first three sheep most fibres resumed growth between 12 and 16 days after dosing, and all were growing by 21 days. In contrast, only 12½% of fibres had resumed growth by 16 days in the fourth sheep, but most were growing by 21 days after dosing.

TABLE 1 Regrowth of wool fibres following an oral dose of compound at a rate of 400 mg/kg live weight. The values were determined from the number of $^{35}$S cystine marks on the regrowth fibres and are means for 90 fibres/sheep

<table>
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<tr>
<th>Sheep</th>
<th>Percentage of fibres growing by day:</th>
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<tr>
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<td>12</td>
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<td>1</td>
<td>4</td>
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<td>2</td>
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Mean values for length growth, diameter and volume of fibres grown before and after dosing are given in Fig. 1. No measurements could be made for 16 days after dosing because virtually no fibres were labelled with $^{35}$S cystine. Because of individual variation, length growth rate was not significantly different from pre-treatment values at any time after dosing, whereas fibre diameter was significantly greater ($P < 0.05$) during the period 21-42 days after dosing but not thereafter. Fibre volume was significantly greater ($P < 0.05$) than pre-treatment values during the period 35-70 days after dosing. In contrast to autoradiography, clipping of defined areas of skin indicated no change in wool growth rate after dosing. Mean values for clean wool growth relative...
to pre-treatment values were 93%, 99%, 99% and 103% for the two-weekly periods 3-5, 5-7, 7-9 and 9-11 weeks respectively after dosing.

Fig. 1. Wool growth before and after an oral dose of compound at a rate of 400 mg/kg live weight. Values are means for four sheep for fibre diameter (●), length growth rate (——) and volume growth rate (-----). Measurements could not be made between days 0 and 21 as fibres were not growing.

On average, staple crimp frequency was unaltered by the defleecing treatment; values before and after dosing for individual sheep were 3.2 vs 3.9, 7.3 vs 6.4, 5.0 vs 4.8 and 5.2 vs 5.4 crimps/cm. The tip of the regrowth after defleecing (2-4 mm) was uncrimped in all sheep.

The first regrowth of wool that could be analysed (3-5 weeks after dosing) was significantly altered in composition. The average content of high-sulphur proteins in wool was increased from 22 to 28% (P < 0.05) and that of high-tyrosine proteins was decreased from 12 to 5% (P < 0.01). Wool grown between weeks 9 and 11 contained 21% high-sulphur and 11% high-tyrosine proteins and was not significantly different from pre-treatment wool.

DISCUSSION

A dose of APP at a rate of 400 mg/kg live weight is about the minimum required to achieve reliable defleecing of sheep by inducing a complete break in the fleece (D.A. Tunks, personal communication). A period of 1-1½ days for fibre growth to cease following dosing is similar to that found after a defleecing dose of mimosine (Reis 1978), but shorter than after a dose of cyclophosphamide (Reis and Chapman 1974). The estimates of the period of fibre growth lost are also similar to those following defleecing with mimosine (Reis 1978), but the occurrence of a delayed regrowth in one sheep indicates that this period may sometimes be longer than for mimosine. Variability in the onset of regrowth was also observed after defleecing with cyclophosphamide (Reis and Chapman 1974).
The autoradiographic data indicate that wool growth rate was temporarily enhanced after defleecing with APP, but the effects were variable between sheep. The apparent contradiction between the estimates of mass and volume of wool in the early regrowth may be explicable by a delay in the regeneration of all follicles, but this was not studied. In contrast, after defleecing with mimosine both length growth rate and diameter of fibres are increased in the early regrowth, and fibre diameter and hence wool growth rate may remain above pre-treatment values for as long as 17 weeks (Reis et al., 1976, 1978; Reis 1978).

Apart from the brief increase in fibre diameter and the lack of crimp in the tip of the regrowth, the physical characteristics of the wool after defleecing appear unchanged. The changes in composition of wool after defleecing are only temporary and are the same as those observed after defleecing with mimosine (Reis et al., 1976). As the high-sulphur and high-tyrosine proteins comprise the matrix of the wool fibre it is clear that the overall content of matrix proteins is little changed after dosing. The consequences, if any, of such changes on the mechanical properties of fibres are not known. However, in view of their transient nature and the fact that differences of this magnitude can occur in wool from individual sheep in a flock (Frenkel et al., 1974), they are unlikely to influence the textile properties of wool significantly.

ACKNOWLEDGMENTS

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REFERENCES