Wool, isotopes and diet selection in grazing sheep

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The ratio of ^{13}C:^{12}C ($\delta^{13}C$ ‰; number of ^{13}C atoms per 1000 atoms of carbon) has been used to estimate the proportion of C_3 (most woody species, forbs and temperate grasses) and C_4 (tropical and subtropical grasses) species eaten by grazing animals in dietary and metabolism studies (Jones et *al.* 1979, Tyrrell et *al.* 1984). The photosynthetic pathway of a plant is primarily responsible for the $\delta^{13}C$ of its tissue, and this ratio is not significantly altered when the plant matter is converted to animal tissue. Thus, an animal on a pure C_4 diet would have tissue $\delta^{13}C$ values in the order of –13‰ (per ml, relative to the PDB standard) while animals consuming only C_3 plants would be approximately –27‰ (Minson et *al.* 1975). Wool is a major carbon sink in sheep (Reis 1979). Given that wool grows continuously and that skin is metabolically very active, the carbon in wool fibres should represent a permanent ongoing record of the isotopic composition of a sheep's diet. This was tested experimentally. Our results have implications for animal nutrition studies. We also suggest that animal tissue which is laid down chronologically (such as wool) can be used to monitor the availability of grasses in sub-tropical and tropical environments (see also Witt *et al.* 1997).

Two sheep, individually penned, were fed 2 diets in a switch over design. Diet 1 (C_3 diet) was a mixture of lucerne chaff and oat straw (2:5). Both of these are C_3 plants. Diet 2 (C_4 diet) was lucerne chaff (C_3) and rhodes grass (C_4) mixed at 2:5. Both sheep were fed their respective diets for 6 weeks with a 3–day change over at the end of the 4th week. At the end of the 6th week, diets were switched between the sheep and the experimental procedure outlined above was repeated. Wool was clipped every 3 days from a midside patch, scoured and analysed for its stable isotope ratio (reproducibility better than ± 0.1‰). Feed intake was recorded and samples of the diet were analysed to determine their $\delta^{13}C$ values.

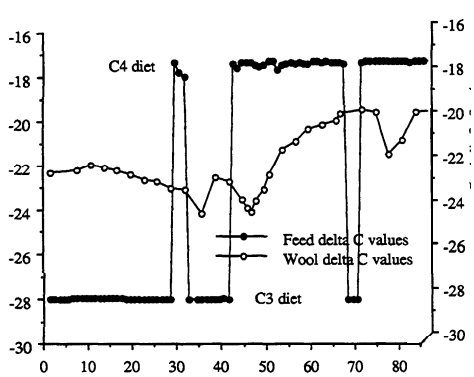

Figure 1 Diet and wool delta C values for sheep 1.

Figure 1 shows the relationship between the $\delta^{13}C$ of clipped wool and the changing isotope composition of the diets. Our results suggest that wool is a rapid assimilator of dietary carbon. After the major change over, at week 6, most carbon in the wool is derived from the new diet within a 2–week period. The transition to the new isotopic equilibrium in the wool resembles an exponential decay function (see $\delta^{13}C$ of wool in Figure 1 between days 50 and 75). Clearly the $\delta^{13}C$ of wool does not reach isotopic equilibrium with either diets 1 or 2. Wool is approximately 3‰ depleted in ^{13}C relative to the C_4 diet while being 3‰ enriched relative to from the C_3 diet. We attribute this to 2 main factors:

1 The C_4 feed mixture contained rhodes grass chaff (C_4) which was low in digestibility relative to the lucerne (C_3). For this reason the proportion of carbon derived from rhodes grass would be much lower than the amount contained in the bulk feed.

2 There are minor variations in the isotopic composition of compounds within a plant which may have been preferentially taken up by the sheep.

We conclude that animal tissue which is laid down chronologically (such as wool) can be used to monitor the relative intakes of sub-tropical and tropical grasses.

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