The intake and preference by sheep for three poplar cultivars

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Abstract

Poplar (*Populus* spp.) leaves are used as sheep fodder but sheep preference and intake of different poplar cultivars has not been researched. The preference and intake by sheep when fed three different poplar cultivars (cv. Argyle, Kawa, and Eridano – in order from least possum resistant to most) were measured. There were two experiments. In the preference experiment six sheep were separately penned and fed a different pair of poplar cultivars each day of the three-day experiment. In the intake experiment the six sheep were fed a different poplar cultivar each day for three days. Sheep preferred cv. Argyle and Kawa to Eridano with no significant difference in preference between cv. Argyle and Kawa. Intake levels for the three cultivars followed the same pattern (with the intake of cv. Argyle and Kawa nearly two times that of cv. Eridano). Cultivar choice is an important factor in the selection of poplars for use as a fodder for sheep. It is suggested that preference and intake levels by sheep for the three cultivars were linked to their salacin levels. The intake results suggest that sheep can feed at above-maintenance levels on cv. Argyle or Kawa. Intake levels for cv. Argyle (1.4 kgDM/day) and cv. Kawa (1.3 kg DM/day) were significantly above the maintenance feeding level (0.75 kg DM/day). Cv. Eridano (0.7 kgDM/day) was just below the maintenance feed level. Hence, the use of cv. Eridano as a fodder crop may result in partial feed-aversion and below-maintenance consumption.

Additional key words: *Eridano, Kawa, Argyle, salacin*

Introduction

Over the last one hundred and fifty years poplars (*Populus* spp.) and willows (*Salix* spp.) have been planted in New Zealand as a soil control measure and also as windbreaks, woodlots, and for amenity reasons. The poplar plantings have focused on providing shelter and hillside erosion control, with any timber or fodder benefits being supplementary (Reid and Wilson, 1985). More recently, these plantings have been identified as a potential fodder resource. Poplar and willow trees planted primarily for control of soil erosion and shelter from wind have the potential to provide emergency stock fodder during summer and autumn droughts. They can also be incorporated into the fodder cycles with regrowth being cropped regularly (Smith, 1992).

The identification of drought-tolerant feed sources has become a critical issue for the pastoral sector, reinforced by the two recent East Coast droughts. Up to now very little formal research has been carried out on the feeding patterns of sheep when fed poplars, either nationally or internationally. The information available is predominantly either anecdotal or based on experiments involving other animals (e.g., possum).

The objectives of the research were to: 1) measure the feeding preference characteristics of sheep when fed combinations of two of three poplar cultivars and 2) measure the total dry matter intake by sheep when fed one of three poplar cultivars to quantify a measure of individual cultivar acceptability.

Experimental and Discussion

The experiments were conducted concurrently over a two-week period from 8 March 1999 to 22 March 1999 in the Animal Physiology Unit (APU) at Massey University, Palmerston North. APU pens can accommodate two feed bins and a water container, allowing comparison of two feeds.

Eight mixed age Romney ewes of 55kg (± 2kg) were sourced from the Massey University flock on 8 March. From the 8 - 15 March the sheep were fed a mix of poplar leaves and lucerne chaff, with the proportion of poplar leaves increasing to 100% by the 12 March. From the 12 – 15 March the sheep were solely fed poplar leaves. The period from the 8 - 15 acclimatised the sheep to the change in diet and environment. The two sheep slowest to settle were removed from the experiment, leaving six sheep for the experimental phase.

From 12–15 March visual and crude weight analyses were made of the maximum daily gross consumption of poplar leaves by each sheep. This provided a good approximation of the amount of leaf matter that needed to be harvested each day to ensure that there was always sufficient feed for each sheep to be at *ad lib* levels of feeding. Initially, twice the maximum intake was harvested. Due to a shortage of poplar fodder the experimental period was set at three days for each experiment.

The poplar cultivars used were *Poplus deltoides* x *P. nigra* cv. Argyle (A), *P. deltoides* x *P. yunnanensis* cv. Kawa (K) and *P. deltoides x maximowiczii* cv. Eridano (E). The leaves were hand-stripped daily from the fodder-bank at the Hort+Research Aokautere nursery, bagged, weighed and transported to the APU. As the leaves of cv. Eridano were much larger than the leaves of the other cultivars they were manually guillotined to a size similar to those of the other two cultivars to ensure that there was no selection based on fodder size or ease of consumption.

On 15 March the three-day preference experiment formally began. Each of the six sheep were fed a combination of two of the three cultivars, one combination a day for three days (Table 1).

After the morning harvest of leaves the bags were accurately weighed to obtain a fresh weight in kilograms (e.g., 5 kg, 7.5 kg, 9 kg). A sub-sample was taken from each bag and the dry matter (DM) determined after being dried in a forced draught at 80°C. The sheep feed bins were then filled. Unused leaves remained in the bags and were stored in the APU cool store at 5°C to minimise weight-loss. The bins were topped up in the evening and again in the morning to ensure ad-lib feeding conditions. Water was refreshed daily and the experimental area hosed thoroughly. At the conclusion of the 24hr period the uneaten leaves were weighed and the residual DM calculated. This allowed total intake (DM and fresh weight) to be determined for each cultivar.

Table 1. Preference experiment; popular cultivar feed combinations and sequence.

Sheep No.	15/03/99	16/03/99	17/03/99
Sheep 1	Kawa	Kawa	Eridano
	Argyle	Eridano	Argyle
Sheep 2	Kawa	Kawa	Eridano
	Argyle	Eridano	Argyle
Sheep 3	Kawa	Eridano	Kawa
	Eridano	Argyle	Argyle
Sheep 4	Kawa	Eridano	Kawa
	Eridano	Argyle	Argyle
Sheep 5	Eridano	Kawa	Kawa
	Argyle	Argyle	Eridano
Sheep 6	Eridano	Kawa	Kawa
	Argyle	Argyle	Eridano

The intake experiment commenced on the 18 March and finished on the 20 March. The methodology and the sheep were the same as for the preference experiment, except each sheep had only one poplar cultivar to feed on each day (Table 2).

For the preference experiment intake/sheep/day for each poplar cultivar in the presence of another cultivar was analysed using a Bradley-Terry choice model (Agresti, 1990). The model assumes that each cultivar has an 'attractiveness' value, and that when a sheep is confronted with the choice between K and A (for example), the proportion of the amount of K eaten is:

Table 2. Intake experiment; popular cultivar feed sequence.

Sheep No.	18/03/99	19/03/99	20/03/99
Sheep 1	Kawa	Eridano	Argyle
Sheep 2	Kawa	Eridano	Argyle
Sheep 3	Eridano	Argyle	Kawa
Sheep 4	Eridano	Argyle	Kawa
Sheep 5	Argyle	Kawa	Eridano
Sheep 6	Argyle	Kawa	Eridano

Attractiveness of K/(Attractiveness of K + Attractiveness of A)

Thus, the amount of K eaten when a sheep had a choice of K and A is:

Sheep appetite x Attractiveness of K /(Attractiveness of K + Attractiveness of A)

Taking logs of both sides of this equation produces a linear model that can be analysed using ANOVA (for instance, Proc GLM in SAS):

log(amount of K eaten) = log(sheep appetite) + log(Attractiveness of K) - log(Attractiveness of K + Attractiveness of A)

Assuming the sheep appetites can be modelled as block effects of individual sheep and day, this becomes:

log(amount of K eaten) = log(sheep effect) + log(day effect) + log(Attractiveness of K) + log(effect of K, A pair)

This produced estimates for the log(Attractiveness) of each cultivar. Cv. Kawawas used as the reference cultivar; its coefficient was set at zero and the other coefficients were calculated relative to it.

For the intake experiment intakes/sheep/day for each poplar cultivar were analysed by ANOVA using proc GLM, with three treatments (K, A, E) and blocking for sheep (because sheep may eat differing amounts) and day (because there might have been environmental differences between days - this was unlikely to be significant due to the experiment being carried out indoors). The Tukey LSD test was used to determine if significant differences occurred between treatments. Normality was tested for as there was no prior experience in this area and the distribution could have been skewed.

When sheep were offered cv. Argyle and Kawa in the preference experiment, they ate similar amounts of both cultivars. But when they were offered either cv. Argyle and Eridano, or Kawa and Eridano, cv. Eridano was less acceptable than the other cultivar, constituting only 10-11% of the mean daily intake per sheep (Table 3). This pattern was confirmed by the estimated coefficients (Table 4). The coefficient for cv. Argyle (i.e., the estimate of the log of its Attractiveness rating) was not significantly different from cv. Kawa, meaning that the two cultivars were not significantly different in terms of Attractiveness. The coefficient for cv. Eridano, however, was significantly lower than that for either cv. Argyle or Kawa, meaning that its Attractiveness was also significantly lower.

Table 3. Intake (g DM/sheep/day) of each poplar cultivar when offered *ad lib* diets of pairs of cultivars.

	Cultivar Pair		
	Kawa/Argyle	Kawa/Eridano	Argyle/Eridano
Intake	546 / 628	880 / 98	976 / 121
SEM	73.6 / 165.4	98.9 / 76.9	156.4 / 51.0

Table 4. Feed preference by sheep for a poplar cultivar when given the choice of two cultivars, using the Terry-Bradley binary choice model. Preference was relative to cv. Kawa.

Poplar cultivar	Coefficient Estimate	Std Error of Estimate	Pr > T
Argyle	-0.0450	0.1157	0.7009
Kawa	0.0000		
Eridano	-0.8200	0.1157	0.0001

When sheep were fed one poplar cultivar *ad lib* as the sole diet their intakes per day of Argyle and Kawa were similar (Table 5). However, intake per day of cv. Eridano was significantly less than that of cv. Kawa and

Argyle (Table 5). The mean daily intake of cv. Eridano by sheep was 51 and 55%, respectively, of that of cv. Argyle and Kawa (Table 5).

Table 5. Intake per sheep for each poplar cultivar when fed *ad lib* as the sole diet to sheep.

Poplar cultivar	Mean Intake (g DM/sheep/day)
Argyle	1408
Kawa	1305
Eridano	718
LSD $_{(p<0.05)}$	196
SEM	85.0

The preference experiment showed that sheep preferred cv. Argyle and Kawa to cv. Eridano with no significant difference in preference between cv. Argyle and Kawa. Similarly, intake by sheep of the three cultivars showed the intake of cv. Argyle and Kawa was approximately two times that of cv. Eridano. These results suggest that the cultivar used is important when poplars are planted for use as sheep fodder, and particularly if poplar is the sole diet for a period.

Edwards (1978) suggested that the salacin content of poplar leaves is related to possum preference. The order of possum preference, from most preferred to least preferred, for the poplar cultivars used in this study was cv. Argyle, Kawa, Eridano (L. Fung, pers comm 2000) which is similar to the preference order shown by the sheep. It is proposed that the salacin levels of the three poplar cultivars influenced the preference and intake levels by sheep.

More research is needed along the continuum of intake levels among the three cultivars to define what impact differing levels of secondary compounds have on intake. The level of secondary compounds that provides the highest possible possum deterrence without restricting sheep intake needs definition. Also, whether salacin is the sole secondary compound affecting sheep preference, or whether other secondary compounds such as condensed tannins, known to be present in poplar, affect preference is unknown.

The results demonstrate that sheep can feed at above maintenance levels and on cv. Argyle or Kawa. Intake rates per sheep for cv. Argyle (1.4 kg DM/day) and cv. Kawa (1.3 kg DM/day) were significantly above the 0.75 kg DM/day maintenance feeding level proposed by Hodgson (1990). Cv. Eridano (0.7 kg DM/day) was below the maintenance feed level. Hence, the use of cv. Eridano for a fodder crop may result in partial feed-aversion and below maintenance consumption. However, anecdotal observations (P. Kemp, pers. comm. 2000) suggest that cattle do not exhibit preference for different poplar clones.

The nutritive value of fresh poplar leaves harvested in mid March is adequate for livestock growth. Guevara-Escobar (1999) found fresh *Populus deltoides* leaves had a dry matter digestibility of 75 % and an energy value of 11.5 MJ kg/DM. Annual leaf production from a stand of 38 trees/ha of mature *Populus deltoides* was 3.1 t/ha^{-1}.

Due to the experimental conditions (inside, picked leaves in bins), the leaves were more accessible than in the field, and sheep were not eating stems which are of lower nutritive value than leaves. Therefore, it is possible that the magnitude of the intake of poplar by sheep in the experiments could be different to that in the field. The issue of how the poplar leaves and branches are made available to the sheep is important, but was beyond the scope of this study. However, whether poplar is made available by thinning, pruning, or coppicing trees will affect the accessibility of the leaves.

Conclusion

Choice of poplar cultivar by farmers planning a poplar fodder resource for sheep should be carefully assessed because a poorly preferred cultivar could decrease sheep performance. If there is a significant possum problem in the farm area cv. Kawa type cultivars would be preferable in that they were less preferred by possums, but still readily consumed by sheep. Cv. Eridano is not recommended as fodder for sheep.

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