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Creating aversion to toxic plants in ewe lambs: The example of *Ferula communis*

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SUMMARY – The circum-Mediterranean perennial *Ferula communis* (giant fennel) contains anticoagulant constituents. The value of conditioned feed aversion (CFA) – building up temporal contiguity between ingestion of the plant and post-ingestive malaise in order to elicit rejection at later encounters – as a means to minimize intake of *F. communis* was investigated. Because most casualties are ewe-lambs, within 30 days of being turned out, the first objective was to achieve CFA for 30 days. In experiment 1, six weaned lambs (15 kg BW), which had been accustomed to *F. communis* for 1 week, were averted to *F. communis* by administering orally two doses of 266 mg LiCl/kg BW at 5-day intervals at the time of *F. communis* meals. Six lambs served as unaverted controls. The aversion persisted for 31 days. The lambs were then turned out to pasture on a *F. communis*-infested artificially-constructed paddock divided into two plots differing in standing biomass of Italian ryegrass. Averted and unaverted grazed separately. Averted lambs consumed 28% less *F. communis*. Lambs consumed more *F. communis*, and CFA was more effective, when pasture standing biomass was low (1060 kg DM/ha), compared with medium (2070 kg DM/ha). In experiment 2, CFA against *F. communis* was implemented in lambs (28 kg BW) by using two administrations of 143 mg LiCl/kg BW. Time spent foraging on *F. communis* was in the range of 0-0.015 min/h (not significantly different from nil) in averted, and 0.15-0.24 min/h in unaverted lambs, respectively ($P = 0.002$). Disappearance rate was greater when grazing was by unaverted than by averted lambs (0.29 and 0.15 g/min, $P = 0.01$). The aversion persisted for 31 days after LiCl treatment, and observations were then discontinued. The problem of *F. communis* poisoning in grazing ewe-lambs may be alleviated by using CFA.

Key words: Sheep, poisonous plants, *Ferula communis*, conditioned food aversion.

RESUME – "Apparition de l'aversion aux plantes toxiques chez les agnelles : Exemples de *Ferula communis*". La grande férule (*F. communis*), une plante méditerranéenne pérenne, contient des anticoagulants. On a analysé la possibilité d'utiliser l'aversion alimentaire conditionnée (AAC), la contiguïté temporelle entre l'ingestion de la plante et un malaise post-alimentaire comme moyen de limiter l'ingestion de *F. communis* chez les agnelles. Comme les empoisonnements d'agnelles se produisent au cours de leur premier mois au pâturage, le premier objectif était d'établir une persistance de AAC de 30 jours. Dans l'essai 1, l'AAC a été induite chez 6 agnelles sevrées (PV 15 kg), habituées à *F. communis* depuis une semaine, en les dosant 2 fois au pistolet drogueur, à intervalle de 5 jours, au LiCl (266 mg/kg PV) au moment des repas de *F. communis*. Six agnelles servaient de contrôle. L'AAC a persisté 31 jours, après les agnelles ont été mises au pâturage sur deux prés de Raygrass italien infestés artificiellement de *F. communis*, dont la biomasse initiale était différente. Les groupes expérimentaux pâturaient séparément. Les agnelles du groupe AAC ont consommé 28% moins de *F. communis*. Les agnelles ont ingéré plus de *F. communis*, et l'aversion a été plus nette quand la biomasse initiale était faible (1060 kg MS/ha) plutôt que moyenne (2070 kg MS/ha). Dans l'essai 2, on a induit l'AAC à *F. communis* chez des agnelles de 28 kg de PV par 2 doses de LiCl (143 mg/kg PV). Les agnelles du groupe AAC et du groupe contrôle ont passé 0-0,015 et 0,15-0,24 min/h à consommer *F. communis*, respectivement ($P = 0,002$). Le taux de disparition de *F. communis* des prés a été plus élevé pour les agnelles AAC (0,29 et 0,15 g/min, $P = 0,01$). L'aversion a persisté 31 j, puis l'essai a été interrompu. Le problème des empoisonnements à *F. communis* peut probablement être évité par l'aversion alimentaire conditionnée.

Mots-clés : Ovin, plantes toxiques, *Ferula communis*, aversion alimentaire conditionnée.

Introduction

The circum-Mediterranean perennial *Ferula communis* (giant fennel) is known to contain

anticoagulant constituents in healthy, fresh plant material. Mortality can affect 5% of the flock. In regions where *F. communis* is widespread, shepherds will defer grazing and alternate grazing in infested and non-infested paddocks as a means to prevent poisoning, which results in sub-exploitation of pasture (Shlosberg and Egyed, 1985). Creating conditioned feed aversion (CFA) against a plant is achieved by building up temporal contiguity between ingestion of the plant and post-ingestive malaise, in order to elicit rejection at later encounters (Ralphs, 1992). LiCl, when administered at 266 mg/kg BW, causes post-ingestive malaise and is harmless to lambs (Egber *et al.*, 1999).

The aim of the project was to assess the value of CFA as a means of preventing lambs from consuming *F. communis*. Most casualties are ewe-lambs, at the onset of the grazing season, within 30 days of being turned out, probably because at that time herbaceous vegetation is scarce, whereas *F. communis* is prominent and lush. Therefore, the objective of this study was to achieve CFA to *F. communis* for at least 30 days.

Materials and methods

Experiment 1

Lambs were housed in individual cages and fed a basic diet of chopped oat hay and concentrate containing 16% CP. Six weaned lambs, which had been accustomed to *F. communis* for one week, were averted to it by administering 266 mg LiCl/kg BW, using a de-worming pistol (d 0); the procedure was repeated on d 5. Six lambs served as unaverted controls and four lambs were averted to vetch hay. Aversion to *F. communis* and vetch hay was evaluated on days 5, 8, 12, 15, 20, 24 and 29. The CFA procedure was evaluated as effective, if the intake of forage in the averted group did not significantly differ from nil (termed absolute aversion), or significantly differed from the controls (termed relative aversion). Effect of CFA on the intake of basic diet was also recorded. On day 31, lambs were turned out to pasture on a *F. communis*-infested artificially-constructed paddock consisting mainly of Italian ryegrass (*Lolium multiflorum* Lam.). Freshly cut bunches of *F. communis* were clamped to 9 poles at 10 m intervals and identified by letters (Fig. 1). The paddock was divided into two plots, A and B, differing in standing biomass, viz. 2070 and 1060 kg DM/ha, respectively. Averted lambs grazed separately from unaverted counterparts. Groups grazed alternatively on each plot. Effectiveness of CFA was evaluated on days 35-41 of experiment, using the weight change of *F. communis* over 180-210 minutes of grazing. Effectiveness of CFA for individual lambs was evaluated by recording number of individual visits to and feeding encounters with *F. communis*.



Fig. 1. Disposition of *Ferula communis* bunches in a ryegrass meadow divided into two plots A and B: each square represents a 350 g bunch of *Ferula communis*. Distance between bunches was approximately 10 m.

Experiment 2

Six lambs were averted to *F. communis*, using doses of 143 mg LiCl/kg BW and six lambs served as controls. Immediately after the CFA procedure, lambs grazed the *F. communis*-infested artificially-constructed paddock. Standing biomass was similar in both plots (approx. 5 tons of DM/ha). Effectiveness of CFA was evaluated group-wise and lamb-wise on days 12, 13, 15, 23, 24, 29, 31, as in experiment 1.

Statistics

The weight change of *F. communis* bunches after grazing was analyzed using a bi-factorial design with CFA (yes/no) and plot as main effects. The effects of CFA and position of the bunch in the field on the number of feeding encounters with *F. communis* was analyzed separately for each plot, using a repeated measurement procedure with lamb (CFA treatment) as error term.

Results and discussion

Absolute aversion to vetch hay persisted for 16 days, supporting previous finding (Egber *et al.*, 1999), while full recovery of intake was recorded on day 24 (Fig. 2).

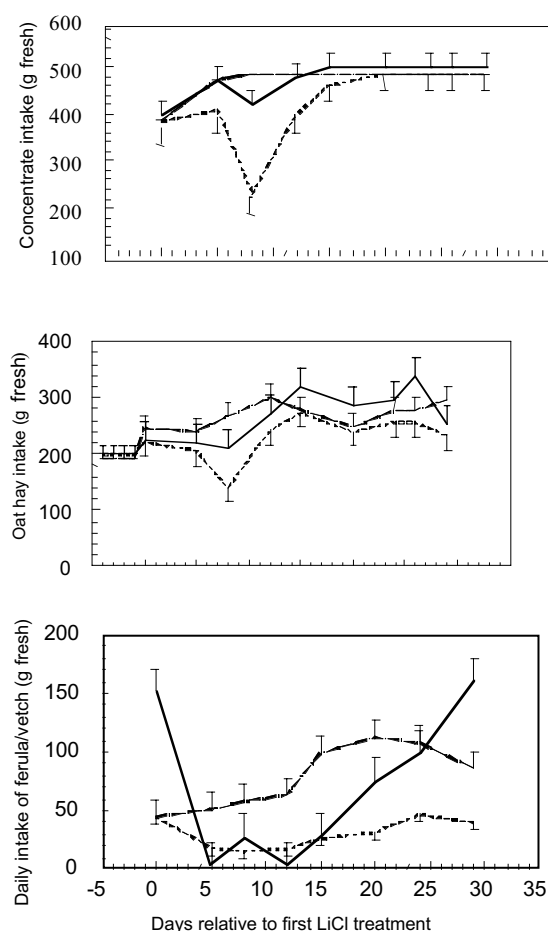


Fig. 2. The daily intake (g, fresh) of concentrates (top), oat hay (middle), and vetch hay or *Ferula communis* (bottom) in lambs subjected to conditioned food aversion to *F. communis* (---), vetch hay (·) or not subjected to aversion (·). On test days, lambs averted to vetch hay were offered vetch hay, whereas lambs averted to *F. communis* were offered *F. communis*.

A transient decrease in concentrate and oat hay intake was recorded in lambs averted to *F. communis* after the second dose of LiCl. Because no impairment of the basic diet intake was noted in older lambs by duToit *et al.* (1991), it can be assumed that lambs in the present study were not familiar enough to the basic diet before CFA, and safety status of feeds was not well established. The total intake of *F. communis* decreased significantly and plateaued at 40 g/d through d 31 in averted lambs with no recovery of intake, whereas it tended to increase in controls. When grazed on the *F. communis*-infested paddock, averted lambs consumed 28% less *F. communis* than counterparts. Relative

aversion persisted 46 days after first LiCl administration. Lambs consumed more *F. communis*, and CFA was more effective, when pasture standing biomass was low (1060 kg DM/ha), compared with medium (2070 kg DM/ha). Plot x CFA interaction on *F. communis* disappearance was significant (Table 1).

Table 1. Disappearance of *Ferula communis* bunches [g/min/lamb, fresh; average (\pm SE)] from plots A and B used in experiment 1 (days 35-41 after CFA): lambs had been submitted to conditioned feed aversion (CFA) or not (CON)

Plot A†		Plot B††		Main effects (P<)		
CFA	CON	CFA	CON	Plot	CFA	Plot x CFA
0.16 (0.010)	0.25 (0.014)	0.11 (0.014)	0.14 (0.014)	0.0001	0.0001	0.03

†2070 kg DM/ha.

††1060 kg DM/ha.

In experiment 2, no difference was found between groups in the frequency of visits to *F. communis* (Fig. 3). Visits to *F. communis* were 50% more frequent in plot B than in plot A. Average time spent by lambs foraging on *F. communis* was in the range of 0-0.015 min/h (not significantly different from nil) in averted, and 0.15-0.24 min/h in unaverted lambs, respectively ($P = 0.002$). Consequently, the rate of disappearance of *F. communis* was greater when the paddock was grazed by unaverted than by averted lambs (0.29 and 0.15 g/min, $P = 0.01$). Rate of disappearance was 50% greater from *F. communis* clamped to poles along the boundary between plots, inferring that lambs from experimental groups were willing to socially interact. The practical meaning of this finding is that, in order to be effective, CFA has to be implemented in all animals in the flock. Aversion persisted for 31 days after LiCl treatment, and observations were then discontinued that lambs from experimental groups were willing to socially interact. The practical meaning of this finding is that, in order to be effective, CFA has to be implemented in all animals in the flock. Aversion persisted for 31 days after LiCl treatment, and observations were then discontinued.

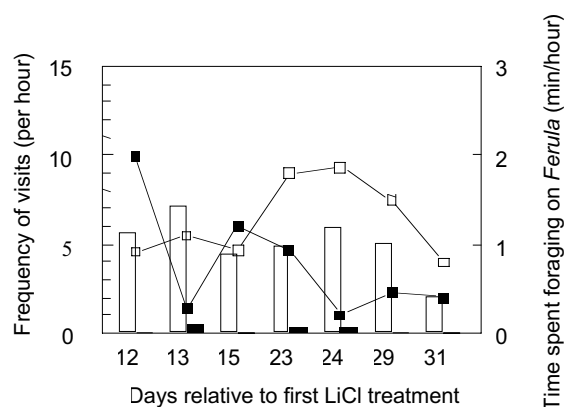


Fig. 3. The frequency of visits (lines, per hour) and time spent foraging on *F. communis* (bars, min/hour) in lambs averted (filled bars and squares) or non averted (open bars and squares) to *F. communis* in experiment 2.

Values for *F. communis* disappearance were similar within experiments. If lambs were grazed every day on the *F. communis*-infested paddock, calculated intake by unaverted lambs was high enough to endanger them (Shlosberg and Egyed, 1985), whereas averted lambs consumed safe amounts of the poisonous plant.

Conclusion

We conclude that CFA to poisonous forage species is feasible in grazing ewe-lambs. The present study with *F. communis* and the preliminary study with vetch hay (Egber *et al.*, 1999) indicate that: (i) CFA is repeatable and dose-dependent; (ii) LiCl is safe at levels < 266 mg/kg BW and may be hazardous at higher levels; (iii) CFA must be initiated after the weaning growth-check is over, when lambs are familiar with basic feeds, in order to prevent impaired appetite; (iv) CFA persistency is inversely related to palatability; and (v) the quality of aversion depends on pasture quality and availability.

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