

A BIOASSAY TO EVALUATE NATIVE PLANT EXTRACTS AS SLUG FEEDING DETERRENTS

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Grey field slugs (*Deroceras reticulatum* Müller) can cause severe damage to direct-drilled pasture species during establishment (Ferguson and Barratt 1983), and in cropping systems (Barratt *et al.* 1989). Currently, the most effective form of chemical control is methiocarb incorporated into extruded bran pellets (Mesurol 2% Bait). However, this method of slug control is expensive, environmentally unacceptable to some growers, and only partially effective. The ultimate objective of the work described here is to identify compounds from New Zealand plants and fungi that could be developed as natural slug feeding deterrents to be applied to, or around agricultural and horticultural plants. The approach taken is to screen a large number of extracts in a simple, rapid laboratory bioassay. Extracts with feeding deterrent activity will then be fractionated, directed by the same bioassay, to give the pure active compounds.

Plant collections were made under the supervision of botanical experts, and voucher specimens are held in the Plant Extracts Research Unit. Samples were air-dried and ground, then 5 g subsamples were extracted with 50 ml rectified spirits (95% ethanol/5% water) by shaking overnight. After filtration the extracts were stored at -15° C. For the slug assay, 5 ml extract samples were dried under vacuum then suspended in 5 ml water containing a surfactant (0.025% Citowett).

Cabbage plants (*Brassica oleracea* var. *capitata* cv. Yates 'Gourmet') were grown from seed in standardised conditions in a glasshouse to the 4-5 true leaf stage. Discs were cut from the leaves of the cabbage plants with a 20 mm diam. punch. For each treatment the discs were dipped into the plant extract solution for 1-2 s, left until dry, and then placed in 85 mm diameter Petri dishes, with eight discs per dish. Each treatment was replicated ten times since analysis of preliminary bioassay results indicated that, in bioassays with similar variability, the probability of detecting a 20% difference between treatments using a 5% probability test was almost 100% with ten replicates. Untreated discs were dipped in water plus surfactant (0.025% Citowett). Copper sulphate solution (10% weight/volume), which is known to almost completely deter slug feeding, was used as a standard control treatment to assist comparisons between experiments.

Slugs collected from the field were pre-fed on cabbage leaves for 24 h, then held without food for 24 h immediately prior to a bioassay. Five slugs were added to each dish, placed in an incubator in darkness at 12°C, and allowed to feed on the discs for 24 h. The slugs were then removed, and the remaining cabbage discs were oven-dried overnight then weighed. Control discs were from dishes which had no slugs added. The percentage reduction in feeding was $100 \times [(\text{mean weight of untreated discs with slugs} - \text{mean weight of treated discs with slugs}) / (\text{mean weight of untreated discs without slugs} - \text{mean weight of untreated discs with slugs})]$.

This bioassay, with up to 15 treatments (including controls), can be set up, run and results obtained within a six working day period by one person.

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TABLE 1: Effect of extracts of selected plant species used in bioassays for slug feeding deterrent activity.

Species	Taxonomic group	Plant accession no.	% Reduction in feeding
<i>Artemisia absinthium</i> (wormwood)	Angiospermae: Asteraceae	920504-01	19.8
<i>Coriaria arborea</i> (tutu)	Angiospermae: Coriariaceae	92102822	87.5
<i>Euphorbia pepplus</i> (milkweed)	Angiospermae: Euphorbiaceae	911002-01	64.8
<i>Nicotinia tabacum</i> (tobacco)	Angiospermae: Solanaceae	911001-01	25.8
<i>Agathis australis</i> (kauri)	Gymnospermae: Araucariaceae	921007-01	18.6
<i>Phyllocladus aspleniifolius</i> var <i>alpinus</i> (mountain celery pine)	Gymnospermae: Podocarpaceae	920929-15	3.8
<i>Russula</i> species	Basidiomycetes (fungus)	930218-15	11.4
<i>Weraroa erythrocephala</i>	Ascomycetes (fungus)	930218-01	13.4
<i>Lepidozia</i> species	Bryophyta: Hepaticae (liverwort)	921028-11	2.8
<i>Schistochila nobilis</i> (liverwort)	Bryophyta: Hepaticae (liverwort)	921028-08	-1.9

Extracts from over fifty species of plants and fungi have been screened in this bioassay. Results for ten of these extracts are given in Table 1. Extracts from three non-native plants were tested: two *Euphorbia* species have been reported to be toxic to aquatic molluscs (Singh and Agarwal 1990); our extract of *E. pepplus* showed anti-feedant activity; *Nicotinia tabacum* and *Artemisia absinthium* are both known to be generally toxic (Anon. 1989); our extracts showed antifeedant activity. Our extract of the leaves of the native angiosperm *Coriaria arborea* showed strong feeding deterrence. Tutu leaves contain the poison tutin (Brooker *et al.* 1987) and may be the active slug antifeedant. Extracts from two fungi had slight activity, as did the extract of leaves of *Agathis australis*. The extracts of the two liverwort species shown in Table 1 were not active, although molluscicidal activity has been reported for lunularic acid, a common liverwort component (Wurzel *et al.* 1990).

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