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(74) Agents: LEWIS, Mardi, L. et al.; Level 3, Spicers Build-
ing, 329 Durham Street, P.O. Box 2201, Christchurch (NZ).

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(71) Applicant (*for all designated States except US*): AGRE-
SEARCH LIMITED [NZ/NZ]; East Street, Ruakura
Campus, Hamilton (NZ).

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(72) Inventors; and

(75) Inventors/Applicants (*for US only*): DAY, Tim [NZ/NZ];
24 Comries Road, Hamilton (NZ). MATTHEWS, Lind-
say, Ross [NZ/NZ]; 31 Rosebanks Drive, Hamilton (NZ).

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(54) Title: A BIRD REPELLENT

(57) Abstract: A bird repellent composition containing a combination of anthraquinone and a visual cue; or anthraquinone and d-pulegone; or anthraquinone, a visual cue and d-pulegone is disclosed. The combinations have been found to produce a synergistic and unexpected effect of increased repellence to birds. One application is the area of pest control baits where the repellent composition is applied to the surface of the bait. Bird is less likely to be harmed by the toxins contained within the bait because they are repelled from the bait. A second application is for horticulture use, whereby the repellent composition is applied to the plant, fruit or ground around an orchard or vineyard thus repelling birds.

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A BIRD REPELLENT

TECHNICAL FIELD

The present invention relates to an animal repellent mixture. More specifically it relates to a
5 bird repellent mixture.

BACKGROUND ART

Poisonous baits are widely used in New Zealand to kill introduced mammalian pests. Effective
pest control operations have conservation benefits, including recovery of bird populations such as
10 the North Island robin *Petroica australis longipes* (Powlesland et al., 1999) and North Island
kokako *Callaeas cinerea* (Innes et al. 1999). It is generally assumed that the benefits of pest
control outweigh the risks to non-target species (Spurr, 1991).

Poison-based possum control causes some mortality of non-target species native bird species
(Spurr, 2000). Ground feeding birds, such as the robin, are particularly vulnerable to poisoning
15 (Brown, 1997; Powlesland et al. 1999; Empson and Miskelly, 1999). While there is currently no
evidence of long-term adverse impacts of poisoning on populations of non-target species that have
been adequately monitored, non-target mortality is a significant factor reducing the acceptability
of pest poisoning operations to the public (Fitzgerald et al. 2000). Further, the possibility remains
that there may be adverse effects on species that have not yet been assessed. By reducing non-
20 target bird mortality during pest control, populations may recover more quickly and successfully
and pest control practices may be considered to be more ethically sound.

Two main bait manipulations are currently used to deter birds from eating toxic substances (as
specified in the New Zealand Pesticides Act 1979): (1) all baits must be larger than 16mm, so

birds cannot readily manipulate them; and (2) all baits must be dyed green, a colour believed to be unattractive to birds (Caithness and Williams, 1971). Additionally, cinnamon oil is frequently added to bait as a further bird deterrent compound. Unfortunately, native birds still die during pest control operations that use large green dyed, cinnamon flavoured baits (Spurr, 2000).
5 Therefore, baits or bait additives are required that effectively repel non-target birds while remaining attractive to pest species such as brushtail possums *Trichosurus vulpecula* and rats *Rattus spp.*

Potential methods for reducing bait acceptability to birds include the use of less preferred bait types (e.g. gel; Morgan, 1999), less preferred bait colours (e.g. blue; Hartley et al, 1999,2000), or
10 bird repellent compounds (e.g. cinnamamide; Spurr and Porter, 1998). Each of these has its limitations. While gel baits appear to be unattractive to native birds (Morgan, 1999), to date they have not been used to control pests over the very large areas that can be effectively controlled with aerially sown baits. Additionally, some bait types (e.g. cereal) may pose greater risk to birds if the baits break up into edible sized pieces when birds feed on them. Blue dye is less attractive to
15 native birds than green (Hartley et al 1999,2000), and is accepted by pests (Day and Matthews, 1999), but is not a long lasting deterrent. Chemical repellents that have been tested to date are either too costly or have deleterious effects on bait consumption by target pests (e.g. cinnamamide; Spurr and Porter, 1998; Spurr et al 2001).

Repellents may be classified as either primary or secondary (Rogers, 1978). Primary repellents
20 invoke instantaneous rejection responses through sight, taste, smell and/or irritation and do not require learning to be effective (Clark, 1998). They are often more benign, and are less effective at promoting long-lasting avoidance responses than secondary repellent (Domjan, 1998). Secondary repellents act via an illness-induced learned avoidance of the food. The degree of avoidance depends on the strength of the unpleasant experience. However, potent secondary
25 repellents often have undesirable physiological and metabolic consequences (Sayre and Clark, 2001), and it may not be desirable to expose valued native species to such effects.

Combinations of repellent stimuli can be more effective for deterring birds than single repellents. Several researchers have found that methiocarb (a secondary repellent) is more effective when paired with either another chemical or a visual cue (e.g. Mason and Reidinger, 1983). Also, secondary repellents are effective at much lower concentrations when paired with aversive
5 primary repellents, such as tastes, odours or colours (Avery and Nelms, 1990; Avery and Mason, 1997; Nelms and Avery, 1997).

d-Pulegone (CAS No. 89-82-7) is a volatile compound (a type of peppermint) and acts as a primary repellent for birds via both volatile cues (odour) and by direct contact (taste) (Wager-Page and Mason, 1996). It has been shown to repel several bird species at a 1% w/w concentration,
10 including European starlings *Sturnus vulgaris* (Mason, 1990) and northern bobwhites *Colinus virginianus* (Mastrota and Mench, 1995). As d-pulegone repels birds without them having to ingest the food, the compound may be ideal for prevention of intake of poisonous baits. However, primary repellents often do not promote total or long lasting avoidance responses when they are used alone (Domjan, 1998). Wild brushtail possums and rats readily take carrot baits containing
15 d-pulegone (Day et al, 2000).

US patent no. 5,877,223 relates to the use of d-pulegone as a dog repellent. There is no mention in the '223 patent of using d-pulegone as a bird repellent.

Anthraquinone is a commercially available compound (CAS No. 84-65-1). This compound has been recognised as an effective avian feeding deterrent since the 1950's (Neff and Meanley, 1957;
20 GB1098687 and US 3,941,887). The repellent properties of anthraquinone have been rigorously evaluated with several bird species over recent years (e.g. Avery et al. 1998, 2001). Anthraquinone operates via conditioned taste aversion. Birds must taste anthraquinone-treated food, experience the post-ingestional effects, and thereby learn to avoid the treated food (Avery et al 1997). Baits treated with anthraquinone are readily eaten by possums, and wild rodents readily
25 take anthraquinone treated baits from bait stations (Day et al. 2000).

An alternative problem common in orchards and vineyards is the susceptibility of crops to bird

attack. Traditional methods of repelling birds from ripening fruit include bird scarers that make noise; physical barriers between the ripening fruit and the bird; and sprays of individual repellent materials.

It will be appreciated that the above methods have a tendency to be labour intensive and often
5 involve expensive capital costs. In addition, these methods alone are often not sufficient to deter birds from attacking ripening fruit.

It is an object of the invention to provide a bird repellent composition.

It is a further object of the invention to provide a repellent that can be used in pest control applications to repel birds.

10 It is a further object of the invention to provide a repellent that can be used in horticultural applications to repel birds.

It is a further object of the present invention to address the foregoing problems or at least to provide the public with a useful choice.

All references, including any patents or patent applications cited in this specification are hereby
15 incorporated by reference. No admission is made that any reference constitutes prior art. The discussion of the references states what their authors assert, and the applicant reserves the right to challenge the accuracy and pertinency of the cited documents. It will be clearly understood that, although a number of prior art publications are referred to herein, this reference does not constitute an admission that any of these documents form part of the common general
20 knowledge in the art, in New Zealand or in any other country.

It is acknowledged that the term 'comprise' may, under varying jurisdictions, be attributed with either an exclusive or an inclusive meaning. For the purpose of this specification, and unless otherwise noted, the term 'comprise' shall have an inclusive meaning - i.e. that it will be taken to mean an inclusion of not only the listed components it directly references, but also other non-

specified components or elements. This rationale will also be used when the term 'comprised' or 'comprising' is used in relation to one or more steps in a method or process.

Further aspects and advantages of the present invention will become apparent from the ensuing description which is given by way of example only.

5

DISCLOSURE OF INVENTION

According to one aspect of the present invention there is provided a bird repellent composition containing one of the following combinations: anthraquinone and a visual cue; anthraquinone and d-pulegone; anthraquinone, a visual cue and d-pulegone; characterised in that the combination produces a synergistic effect of repellence to birds.

The applicant has found that combinations of anthraquinone and either a visual cue, d-pulegone or all three compounds gives an unexpected improvement in repellence of birds. Traditional methods do not utilise these combinations and in fact teach away from these combinations.

Preferably, the visual cue used is novel to the bird to be repelled. In one embodiment, the visual cue is a blue or green dye with a lowered relative reflective wavelength in the range from 500 to 700 nm. It will be appreciated by those skilled in the art that other visual cues are also possible.

Preferably the bird repellent composition is in a form selected from the group consisting of: a liquid spray; a liquid dip; a gel; a paste; a solid powder. It will be appreciated that other forms of application are also possible e.g. an aerosol.

In preferred embodiments, the bird repellent composition as described above is applied to an environment or object by means selected from the group consisting of: dipping; spraying; dusting; and combinations thereof. It will be appreciated that a variety of other application methods are possible however the above means are simple, cost effective and easy to use.

In preferred embodiments, the bird repellent composition as described above is applied to any one of the group consisting of: the ground; a discrete area of ground; a plant; a portion of a plant; fruit; vegetable matter; a nut or nuts; bait and combinations thereof.

For specific horticulture applications, the composition as described above is applied to any one
5 of the group consisting of: ground in an orchard; ground in a vineyard; a grapevine; a fruit tree; fruit; vegetable matter; grapes; plant support structures; and combinations thereof.

As bird damage to horticultural crops is a significant problem, it is anticipated by the applicant that the bird repellent of the present invention will prove particularly advantageous for such uses.

10 Uses envisaged include application to the plant, fruit or ground of an orchard such as an apricot orchard. An alternative use is for vineyard applications where the composition is applied to the grapes, vines, support structures or ground of a vineyard to repel birds from ripening grapes.

It has been found by the applicant that the bird repellent composition remains effective as a bird repellent for a duration of at least 8 days. The length of time that the repellent remains
15 effective will however depend on the environment into which it is to be applied. By way of example, for wet and/or humid environments, the repellent will need to be reapplied more frequently than dry environments.

It is also the applicants understanding that the repellent of the present invention has a combination of both primary and secondary repellence. It has been found by the applicant that
20 the combination of a visual cue and/or olfactory stimulant primary repellents (novel colour (e.g. blue or green dye) and d-pulegone), and a secondary repellent compound (anthraquinone), give a synergistic effect beyond that expected e.g. more effective than, for example, the repellence observed from using either repellent alone.

It will be appreciated by those skilled in the art that the composition of the present invention
25 can be further combined with one or more excipients and/or carrier substances. Further

substances may include water, oils such as peanut oil and pennyroyal oil and other known substances to give further properties such as water resistance characteristics and longer-term stability.

Preferably the bird repellent composition substantially as described above has an anthraquinone concentration from 0.001% to 5% by weight. It has been found by the applicant that such concentrations of anthraquinone produce the desired repellence effect. Adding more anthraquinone is also possible depending on the environment and/or application for which the repellent composition is used. For example, wet environments may require more anthraquinone and ground spray applications can be stronger as other pest repellence may not be of concern whereas in bait applications, the bait must still be attractive to the pest and hence is a consideration. It will be appreciated that lower concentrations are useful to reduce the cost of the repellent composition and need only be included until the desired effect is achieved.

Preferably, where if d-pulegone is used, the d-pulegone concentration is from 0.001% to 2% by weight. Like anthraquinone, it has been found by the applicant that such concentrations of d-pulegone produce the desired repellence effect. Adding more d-pulegone is also possible for specific environments and/or applications. It will also be appreciated that lower concentrations are useful to reduce the cost of the repellent composition and need only be included until the desired effect is achieved.

According to a further aspect of the present invention, there is provided a bait including a bird repellent composition substantially as described above.

In preferred embodiments, the bird repellent composition is applied to the bait surface.

The composition of the present invention has been found to be particularly successful in bait applications. Birds tend to eat poisonous baits used in animal eradication projects for example against possums and rats in New Zealand forests. By repelling birds from the bait, the process of using such baits may become more acceptable to at least the public as fewer non-target

species (birds) will be harmed.

Preferred bait base material is selected from group consisting of: a cereal; a carrot; a dough. It will be appreciated by those skilled in the art that the bait base material is however primarily dependent on the pest to be attracted, so other bait materials may be used with the repellents.

- 5 Certain pests prefer certain base materials. It is the applicants finding however that the repellent composition of the present invention does not cause any effects (positive or negative) on the attractiveness / palatability of the bait to the pest.

In preferred embodiments, the pests on which the bait of the present invention is used are animals including possums and rats. Such pests cause significant damage to native flora and fauna at least in New Zealand and hence a number of bait programmes exist to catch and / or
10 kill possum and/or rat populations. Where such populations co-habit the same geographical area, the bait and bird repellent combination is particularly advantageous to use as it avoids non-target species (birds) being poisoned by the bait or hurt in animal traps.

According to yet a further aspect of the present invention, there is provided a method of
15 repelling birds from an environment or object including the steps of selecting the environment to which the repellent is to be applied, and applying the repellent substantially as described above to the environment or object.

According to yet a further aspect of the present invention, there is provided a method of repelling birds from bait including the step of applying a bird repellent composition
20 substantially as described above to the bait.

According to yet a further aspect of the present invention, there is provided the use of a bird repellent composition substantially as described above to repel birds from an environment or object, wherein the repellent is applied to the environment or object from which the birds are to be repelled.

25 According to yet a further aspect of the present invention, there is provided the use of a bird

repellent composition substantially as described above with a bait by applying the bird repellent composition to the bait.

It can be seen from the above description that there is provided a bird repellent composition, which is synergistic in nature to more effectively repel birds. The repellent can be applied as a spray or dip or other application method to an environment or object such as a plant or the ground around a plant, or on pest baits. By application to plants or the ground, the repellent composition is useful in horticultural applications whereby birds can be successfully repelled from, for example ripening fruit. In bait applications the birds are repelled from potentially toxic baits and/or traps that in themselves can harm the bird.

10

BRIEF DESCRIPTION OF THE DRAWINGS

Further aspects of the present invention will become apparent from the following description which is given by way of example only and with reference to the accompanying drawings in which:

15 Figure 1 Shows a possum-specific bait station used in accordance with the present invention as described in Example 1 and 2;

Figure 2: Shows a rat-specific bait station used in accordance with the present invention as described in Example 1 and 2;

Figure 3: Shows the peck frequency of standard versus repellent containing bait as described in Example 4;

20 Figure 4: Shows the peck frequency of standard versus repellent containing bait as described in Example 5;

Figure 5: Shows the peck frequency of standard versus repellent containing bait as

described in Example 6;

Figure 6: Shows the relatively repellence of different compositions on birds as described in Example 7;

5 Figure 7: Shows the relatively repellence of different compositions on birds as described in Example 7;

Figure 8: Shows the relatively repellence of different compositions on birds as described in Example 7;

Figure 9: Shows the relatively repellence of different compositions on birds as described in Example 8;

10 Figure 10: Shows the spectral reflectance profiles of the samples as described in Example 8, Experiment 1;

Figure 11: Shows the relatively repellence of different compositions on birds as described in Example 8;

15 Figure 12: Shows the spectral reflectance profiles of the samples as described in Example 8, Experiment 2;

Figure 13: Shows the relatively repellence of different compositions on birds as described in Example 9;

Figure 14: Shows the relatively repellence of different compositions on birds as described in Example 9; and

20 Figure 15: Shows the relatively repellence of different compositions on birds as described in Example 10.

BEST MODES FOR CARRYING OUT THE INVENTION

The invention is now further described with reference to experimental results obtained for various configurations of the present invention.

Three key studies are included below to show the effects of the invention embodiments on:

- 5 [I] The palatability of the repellent compounds of the present invention to possums and rats;
- [II] The repellence effect from bait treated with repellent compounds of the present invention on North Island robin and any effects attributable to the means with which the compounds are applied to the bait;
- 10 [III] The repellence effect from wheat treated with repellent compounds of the present invention on sparrows.

[I] The palatability of the repellent compounds of the present invention to possums and rats

- 15 To determine the palatability of baits to wild possums and wild rats, possum-specific bait stations and rat-specific bait stations were established in bush-pasture margin and forest habitats (see Figure 1 and Figure 2).

The possum-specific bait station (Figure 1) is mounted on an elevated wire stake 4 with bait 2 attached in a perforated bag 1 at top of wire 4. A plastic disc 3 is used to stop rodents (not shown) climbing wire 4 has plasticine (not shown) on it to record animal activity.

The rat-specific bait station (Figure 2) is an approximately 60mm diameter tube 6 with bait 2 placed in the centre and tube 6 is pinned to ground with holding stake 4. Plasticine 5 is added at either end of the tube 6 to record animal activity.

The bait stations (Figures 1 and 2) enable determination of the response of possums or rats to bait 2. Plasticine 5 is used to record the presence (e.g. footprints, claw marks, bite marks) and species of animal present at the bait station.

5 **Example 1 – The palatability of varying baits and varying bird repellent compounds on possums and rats**

In this example the repellence of neem (a known repellent), lime (a known repellent), anthraquinone and d-pulegone (compounds of the present invention) in cereal, carrot and paste baits are tested on wild possums and rats.

10 The following bait treatments are compared:

- standard (solution of dye + water + 0.1% cinnamon oil)
- cinnamamide (solution of dye + water + 0.5% cinnamamide)
- neem (solution of dye + water + 2% neem oil)
- lime (solution of dye + water + 2% agricultural lime)
- 15 • anthraquinone (solution of dye + water + 0.75% anthraquinone formulation)
- d-pulegone (solution of dye + water + 1% d-pulegone)
- salt (solution of dye + water + salt (10% of total bait weight))

All quantities are given in percent by weight.

Treatments are applied to the cereal and carrot bait surface at a rate of 10% of total bait weight.

20 The treatments are applied to the paste bait by mixing the solution through the bait, again at a rate of 10% of total bait weight.

Cinnamamide is used as a positive control, as cinnamamide is a known bird repellent. Salt baits are used as a negative control, as food containing high salt concentrations is known to be unpalatable to possums.

The treatments are placed on the bait stations as described above and possum and rat activity measured.

1.1 Possums

Fewer cereal bait stations were touched at first exposure than carrot or paste bait stations, but there was no difference in the proportion of bait stations left untouched in subsequent exposures (Table 1). There was also no difference between the three bait types when encountered at first or subsequent exposures (Table 1).

Treatment	Untouched		Eaten	
	First Exposure	Subsequent	First Exposure	Subsequent
Cereal	0.68	0.33	0.66	0.95
Carrot	0.33	0.28	0.75	0.94
Paste	0.40	0.31	0.79	0.94

Table 1: Proportion of bait stations from each bait type left untouched or with bait eaten when encountered at first and subsequent exposures by wild possums.

The proportion of bait stations left untouched did not differ between bait treatments at first or subsequent exposures (Table 2). The proportion of baits eaten when encountered was significantly lower for salt baits than for standard bait, but the proportion of other bait treatments eaten did not differ from standard bait at first or subsequent exposures (Table 2).

Treatment	Untouched		Eaten	
	First Exposure	Subsequent	First Exposure	Subsequent
Standard	0.58	0.33	0.80	0.98
Cinnamamide	0.55	0.29	0.71	0.95
Neem	0.48	0.32	0.81	0.94
Lime	0.45	0.22	0.71	0.95
Anthraquinone	0.67	0.35	0.80	1.00
d-pulegone	0.52	0.30	0.87	0.98
Salt	0.37	0.29	0.30	0.38

Table 2: Proportion of bait stations from each bait treatment left untouched or with bait eaten when encountered at first and subsequent exposures by wild possums.

There was no difference in possum feeding behaviour (e.g. time spent feeding on bait 2,
5 number of attempts to open bait bag 1) between the repellent treated and the control or positive control baits 2.

1.2 Rats

The results found for rats are shown in Table 3 below.

Treatment	Untouched		Eaten	
	First Exposure	Subsequent	First Exposure	Subsequent
Cereal	0.62	0.35	0.96	0.99
Carrot	0.89	0.60	0.00	0.60
Paste	0.71	0.65	0.25	0.53

10 **Table 3:** Proportion of bait stations from each bait type left untouched, or eaten when

encountered at first and subsequent exposures by wild rats.

When rats encountered bait stations they readily ate cereal baits at first exposure, but ate significantly fewer carrot or paste baits (Table 3). There were no significant differences
 5 between the bait treatments eaten at first exposure, (Table 3) except for salt (negative control) which were not eaten. In subsequent exposures, cereal baits were eaten more readily than carrot or paste baits (Table 4).

Treatment	Untouched		Eaten	
	First Exposure	Subsequent	First Exposure	Subsequent
Standard	0.65	0.50	0.44	0.73
Cinnamamide	0.77	0.66	0.67	0.70
Neem	0.78	0.56	0.67	0.63
Lime	0.78	0.61	0.80	0.61
Anthraquinone	0.64	0.57	1.00	0.65
d-pulegone	0.63	0.55	0.70	0.75
Salt	0.86	0.72	0.00	0.16

10 **Table 4:** Proportion of bait stations from each bait treatment left untouched, or eaten when encountered at first and subsequent exposures by wild rats.

Example 2: The palatability of different combinations of bird repellent compounds to wild possums and rats

15 The following bait treatments were compared (only carrot baits are compared):

- standard (solution of dye + water + 0.1% cinnamon oil)
- anthraquinone 1 (solution of dye + water + 1% anthraquinone formulation)
- anthraquinone 2 (solution of dye + water + 2% anthraquinone formulation)
- d-pulegone 1 (solution of dye + water + 1% d-pulegone)
- 5 • d-pulegone 2 (solution of dye + water + 2% d-pulegone)
- combination 1 (solution of dye + water + 1% anthraquinone formulation + 1% d-pulegone)
- combination 2 (solution of dye + water + 2% anthraquinone formulation + 2% d-pulegone)
- 10 • salt (solution of dye + water + salt (10% of total bait weight))

All quantities given in percent by weight and all bait treatment, bait station set-up and subsequent measurement are as described in Example 1.

2.1 Possums

- 15 There was no significant difference between the bait treatments in the proportion of baits left untouched at first exposure (Table 5). The proportion of baits eaten did not differ between treatments at first exposure, but in subsequent exposures salt baits (negative control) were eaten less (Table 5). All baits were generally either mostly eaten or completely eaten after several exposures.

Treatment	Untouched		Eaten	
	First Exposure	Subsequent	First Exposure	Subsequent
Standard	0.73	0.64	0.67	0.83
Anthraquinone 1	0.36	0.52	0.57	0.94
Anthraquinone 2	0.55	0.45	1.00	0.83
d-pulegone 1	0.82	0.58	1.00	1.00
d-pulegone 2	0.64	0.55	1.00	1.00
Combination 1	0.45	0.39	1.00	1.00
Combination 2	0.73	0.64	1.00	0.92
Salt	0.82	0.30*	1.00	0.43*

Table 5: Proportion of bait stations from each bait treatment left untouched or eaten when encountered at first and subsequent exposures by wild possums.

2.2 Rats

The results found for rats are shown in Table 6 below.

Treatment	Untouched		Eaten	
	First Exposure	Subsequent	First Exposure	Subsequent
Standard	0.50	0.53	0.25	0.80
Anthraquinone 1	0.82	0.46	0.50	0.85
Anthraquinone 2	0.82	0.48	0.50	0.81
d-pulegone 1	0.50	0.66	0.80	0.82
d-pulegone 2	0.60	0.37	0.50	0.82
Combination 1	0.56	0.41	0.50	0.76
Combination 2	0.64	0.60	0.50	0.83
Salt	0.18	0.50	0.22	0.33*

Table 6: Proportion of bait stations from each bait treatment left untouched, or eaten when encountered at first and subsequent exposures by wild rats.

- 5 On first exposure all treatments were eaten more readily than the standard. The combination of anthraquinone and d-pulegone had a similar palatability to other treatments, (Table 6).

Example 3: The kill effect of rat baits treated with bird repellent compounds

The repellent efficacy for rat poisons was further checked.

- 10 In the experiment, rats are offered toxic carrot baits containing 0.15% sodium monoflouroacetate (the toxin) and combinations of repellents (or a control bait).

The repellents used on the toxin containing baits were as follows:

- Control baits – green dye and cinnamon oil (non repellent standard baits used for pest

control in NZ);

- Blue dye and anthraquinone 1%;
- Blue dye and anthraquinone 1% with 1% peanut oil.
- Blue dye and anthraquinone 1% + 0.1% peanut oil

5 All quantities are given in weight percent.

The results found were as shown in Table 7 below:

Bait type	Fate of rat		
	Dead	Unwell	Recovered
Blue dye and anthraquinone 1%	6	2	1
Blue dye, anthraquinone 1% and 1% peanut	5	3	1
Blue dye, anthraquinone 1% and 0.1% peanut	9	0	0
Control	9	0	0

Table 7: Rat trial results

10 The results found were that the use of blue dye, anthraquinone and/or different peanut oil combinations gave no significant difference in the number of rats killed compared to other treatments.

Therefore, the repellent compounds of the invention do not impact on the kill effects of repellent treated bait to the pest.

[III] The repellence effect from bait treated with repellent compounds on North Island robins

The repellent compounds effect on robins is compared. Evidence from poisoning operations
5 suggests that North Island robins, *Petroica australis longipes* eat cereal or carrot baits (or bait fragments known as 'chaff').

**Example 4: The repellence effect on North Island robins from bait treated with blue dye,
anthraquinone and combinations of these compounds compared to standard repellent
10 compounds**

This experiment investigates whether the addition of a novel visual cue and a secondary repellent (anthraquinone) to baits influences the feeding behaviour of wild robins.

Robins were trained to approach observers within their territory and were offered repellent-treated (blue colour + anthraquinone) and standard (green colour + cinnamon oil, as used for
15 pest control operations in New Zealand) dough baits over four consecutive days on a test arena on a forest floor.

Blue dye is used as the novel visual cue as this is known to have the least repellent effect from prior art experiments. By proving an effect with blue dye, it can be assumed that similar deterrent effects can also be attained using visual cues that are known to have a greater
20 repellent effect on birds.

Both choice and no-choice tests were used to record the feeding behaviour of robins towards the baits.

The results are shown below in Tables 8 and 9:

	Peck frequency (mean $\pm$ SE)	
Factor	Standard	Repellent
Bait type x season		
Winter	5.5 $\pm$ 1.5	1.0 $\pm$ 0.4
Summer	2.5 $\pm$ 0.9	0.5 $\pm$ 0.2
Bait type x robin class		
Male	3.3 $\pm$ 1.0	0.4 $\pm$ 0.2
Female	3.7 $\pm$ 1.7	0.7 $\pm$ 0.4
Juvenile	4.7 $\pm$ 3.0	1.6 $\pm$ 1.3
Bait type x test type		
Choice test	3.8 $\pm$ 0.9	0.4 $\pm$ 0.2
No-choice test	4.0 $\pm$ 2.2	1.3 $\pm$ 0.9

Table 8: Adjusted mean number of pecks ($\pm$ SE) by robins directed at standard or repellent bait, summarised by season and robin class.

Season and trial type	N (birds)	Standard	Repellent
Summer choice test	22	10	2
Winter choice test	20	26	2
Winter no-choice test	14	18	9
Total	56	54	13

- 5 **Table 9:** Total number of standard and repellent baits removed from the test arena by robins during winter and summer choice tests and the winter no-choice test.

The end result of the baits removed (eaten, dropped unknown) is described in Table 10 below.

	Standard	Repellent
Eaten	10	1
Dropped	3	5
Unknown	41	7
Total	54	13

Table 10: Total number of standard and repellent baits that were eaten, dropped or taken out of sight (unknown result) by robins when they removed baits from the test arena.

- 5 Further results are also shown in Figure 3, which shows the adjusted mean number of pecks ($\pm$ SE) by robins directed at standard or repellent baits over 4 days of exposure.

Robins were found to peck at standard baits more frequently than repellent baits, with the frequency of pecking at repellent baits declining over the four days.

- Choice and no-choice tests produced similar levels of pecking response towards both bait
10 types.

The results demonstrate that, relative to standard baits, the combination of blue dye and anthraquinone effectively deters most robins from feeding, with evidence of learned avoidance.

- 15 **Example 5: The repellence effect on North Island robins from bait treated with d-pulegone and anthraquinone compounds compared to standard repellent compounds**

In this example the repellence of robins to dough baits treated with a repellent consisting of anthraquinone and d-pulegone is compared.

A test arena, consisting of a 0.5m x 0.5m area scraped clear of leaf litter was used. Robins were offered a choice between two types of green-dyed dough bait in the test arena.

Two bait treatments sprayed onto the dough bait surface were used:

- Standard (green dough bait coated with a solution of water + 0.1% cinnamon oil)
- 5 • Repellent (green dough bait coated with a solution of water + 2% anthraquinone formulation + 2% d-pulegone).

All quantities given in percent by weight.

At first exposure, all robins came to the test arena and pecked at one or both of the bait types.

Robins pecked at standard baits more frequently than they pecked at repellent baits (Figure 4).

- 10 The frequency of pecking repellent treated baits reduced over subsequent exposures indicating both primary and secondary repellence effects.

The feeding behaviour of robins towards baits differed. Robins removed standard baits from the arena more frequently than they removed repellent baits (Table 11) and they tended to eat standard baits when they removed them. In contrast, they did not eat repellent treated baits

- 15 when they removed them from the arena (Table 11).

Fate of bait	Standard	Repellent
Eaten	16	0
Dropped	0	8
Unknown	16	12
Total	32	20

Table 11: Number of baits removed from the test arena by robins during all exposures to baits and fate of the baits when removed (eaten, dropped or unknown).

In summary it was found that bait treated with d-pulegone and anthraquinone was significantly less preferred than standard repellent treatment. In addition, where bait was removed from the test arena, bait treated with d-pulegone and anthraquinone was less likely to be subsequently eaten compared to standard treatments which were often eaten.

Example 6: The influence of application method is determined

The same method was used as in Example 5, except the treatments were applied to the bait by dipping into treatment solutions rather than spraying in Example 5.

At first exposure, all robins came onto the test arena. Robins that pecked at baits pecked at standard baits more frequently than they pecked at repellent baits during first and subsequent exposures (Figure 5). Pecking at repellent treated baits reduced over the subsequent exposures.

Robins removed standard baits from the arena more frequently than they removed repellent baits (Table 12). They also tended to eat standard baits when they removed them. Robins did not eat repellent treated baits when removed from the arena (Table 12).

Fate of bait	Standard	Repellent
Eaten	7	0
Dropped	2	6
Unknown	19	7
Total	28	13

Table 12: Number of baits removed from the test arena by robins during all exposures to baits and fate of the baits when removed (eaten, dropped or unknown).

As in Example 5, bait treated with d-pulegone and anthraquinone was significantly less preferred than standard repellent treatment and were also less likely to be subsequently eaten compared to standard treatments. In addition no influences are noted between different methods of application i.e. spraying on the repellent compounds versus dipping.

[III] The repellence effect on sparrows of various repellent compounds applied to wheat

Example 7: Repellence effect on sparrows from differing levels of anthraquinone, d-pulegone, blue dye and combinations of these compounds applied to wheat.

Wild sparrow tests were used to determine the effect of the individual repellency compared with the combination repellency.

On sparrow feed tables, sparrows were offered a choice between control wheat and three doses of repellent treated wheat.

Dose response studies showed that an anthraquinone formulation reduced the amount of wheat eaten by sparrows on days 3 and 4 of presentation relative to control wheat (Figure 6).

Similarly, dose response studies showed that d-Pulegone also reduced the quantity of wheat eaten by sparrows on days 1, 3 and 4 (Figure 7).

When the anthraquinone formulation and d-pulegone were combined the wheat consumption of sparrows was significantly lower than when anthraquinone and d-pulegone are used alone as repellents (Figure 8). Similarly, for a combination of blue dye and anthraquinone the combined effect is were significantly more than anthraquinone alone.

In summary, an unexpected and synergistic effect is noted on bird repellency for combinations of either blue dye and anthraquinone or d-pulegone and anthraquinone.

Example 8: Repellence effect on sparrows from differing levels of anthraquinone compound in combination with other compounds when applied to wheat.

The feeding behaviour of free-ranging house sparrows (*Passer domesticus*) presented wheat treated with anthraquinone paired with either a novel visual cue (blue dye), cinnamon oil (containing primarily olfactory cues), or d-pulegone (containing olfactory and taste cues), was recorded, to determine the suitability of repellent combinations for preventing non-target birds from consuming pesticides or other harmful substances.

Eight independent populations of house sparrows, were trained to eat plain hulled wheat from four identical food trays on feed tables.

8.1 Experiment 1

In Experiment 1, sparrows were presented, for 4-day periods, with a choice between plain wheat, anthraquinone treated wheat, and two of the remaining repellent combinations (anthraquinone and cinnamon oil, anthraquinone and blue dye, anthraquinone and d-pulegone (at 0.5% wt or 2.0% wt concentrations)) until all sparrow populations had been exposed to each repellent.

The results are shown in Figure 9 which shows the mean ($\pm$ SED) daily percentage of wheat eaten over the 4-day test periods in Experiment 1 by house sparrows offered a choice between plain wheat, anthraquinone treated wheat and two of the other wheat treatments: anthraquinone and cinnamon oil (novel odour), anthraquinone and blue dye (novel colour), anthraquinone and 0.5% wt d-pulegone, or anthraquinone and 2% wt d-pulegone.

The consumption of plain wheat and anthraquinone treated wheat was compared to the

consumption of the repellent combinations every 24 hr.

Plain wheat was almost always fully consumed at each table each day; over the same timeframe, anthraquinone significantly reduced wheat consumption, to 54% of that offered. Addition of cinnamon oil to wheat with anthraquinone did not further reduce consumption
5 (41%), but when anthraquinone was paired with either blue dye or d-pulegone, repellency was enhanced.

The combinations of anthraquinone and 2% wt d-pulegone or anthraquinone and blue dye elicited the most effective avoidance responses (14.6% and 9.6% consumption, respectively).

A further analysis was completed to determine the spectral reflectance profiles (wavelength)
10 for each of the samples of Experiment 1. The results are shown in Figure 10. In particular, the blue dyed samples had a lowered relative reflectance wavelength in the range from 500 to 700 nm.

8.2 Experiment 2

In Experiment 2, the same populations and food tables were used to compare the consumption
15 of plain wheat to that of wheat treated with either anthraquinone and blue dye, blue dye alone, or green dye alone on each table. An 8-day time period was used to determine repellency levels over a longer timeframe than had been examined in Experiment 1.

The results are shown Figure 10 which shows the mean ($\pm$ SED) daily percentage of wheat eaten over the 8-day test period in Experiment 2 by house sparrows offered a choice between
20 plain wheat and three types of treated wheat: green dye, blue dye or anthraquinone and blue dye in combination.

While sparrows ate all plain wheat that was offered every day, they initially avoided all three treated wheat types. Over time, sparrows progressively consumed more green and blue dyed wheat each day, eating significantly more of these treatments than anthraquinone and blue dye

by day 5.

Overall, green dyed wheat was consumed more readily (47.5%) than blue dyed wheat (35.3%) or anthraquinone and blue dyed wheat (14.7%).

Colour alone did not provide a long-lasting avoidance response in sparrows.

- 5 The data found clearly demonstrates the potential of combining anthraquinone with additional visual, olfactory or taste cues for modifying the feeding behaviour of birds.

Like Experiment 1, a further analysis was completed to determine the spectral reflectance profiles (wavelength) for each of the samples of Experiment 2. The results are shown in Figure 12. Both the blue and green dyed samples of Experiment 2 had a lowered relative
10 reflectance wavelength in the range from 500 to 700 nm.

Example 9: Repellence effect on sparrows from differing concentrations of anthraquinone compound in combination with blue dye and/or d-pulegone when applied to wheat.

- 15 Effective repellent concentration ranges and combinations – the effect of blue dye and anthraquinone is investigated as well as in combination with d-pulegone.

Similar methodology is used to that discussed in Example 8 above.

The results found are shown in Figures 11 and 12.

In the first experiment blue dye and anthraquinone is found to be less effective at 0.75% wt
20 concentration than at an anthraquinone concentration of 2% wt for house sparrows, although both concentrations have a repellent effect.

In the second experiment, it can be seen that blue dye and anthraquinone are effective at a 1%

wt concentration or more of anthraquinone.

Also, the combination of blue dye and a 1% wt concentration of anthraquinone as well as a 0.5% wt concentration of d-pulegone is also an effective repellent for sparrows

- 5 **Example 10: Repellence effect on sparrows from differing concentrations of anthraquinone compound in combination with blue dye are further mixed with known excipients to determine if any unexpected effects found.**

The same methodology as Example 8 is used except further excipients are used including peanut oil (at 1% wt and 0.1% wt concentration) and pennyroyal oil (0.5% wt concentration).

- 10 The results are shown in Figure 13.

No significant differences in repellence were noted between compositions containing excipients and those not containing excipients.

Summary of Examples

- 15 The examples above show that the combination of anthraquinone and either blue dye or d-pulegone or all three compounds have a significantly increased effect on repellency of birds.

Further, Examples 1 and 2 show that there is no loss in palatability to pests such as possums and rats, an important factor when using the repellent in a toxic pest control bait.

- 20 Aspects of the present invention have been described by way of example only and it should be appreciated that modifications and additions may be made thereto without departing from the scope thereof as defined in the appended claims.

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WHAT WE CLAIM IS:

1. A bird repellent composition containing one of the following combinations: anthraquinone and a visual cue; anthraquinone and d-pulegone; anthraquinone, a visual cue, and d-pulegone; characterised in that the combination produces a synergistic effect of repellence to birds.
2. The bird repellent composition as claimed in claim 1 wherein the visual cue is novel to the bird to be repelled.
3. The bird repellent as claimed in either claim 1 or claim 2 wherein the visual cue is a blue or green dye with a lowered relative reflective wavelength in the range from 500 to 700 nm.
4. The bird repellent composition as claimed in any one of claims 1 to 3 wherein the composition is in a form selected from the group consisting of: a liquid spray; a liquid dip; a gel; a paste; a solid powder.
5. The bird repellent composition as claimed any one of claims 1 to 3 wherein the repellent composition is applied to an environment or object by means selected from the group consisting of: dipping; spraying; dusting; and combinations thereof.
6. The bird repellent composition as claimed in any one of the above claims wherein the composition is applied to one of the group consisting of: the ground; a discrete area of ground; a plant; a portion of a plant; fruit; a nut or nuts; bait; and combinations thereof.
7. The bird repellent composition as claimed in any one of the above claims wherein the composition is applied to one of the group consisting of: ground in an orchard; ground in a vineyard; a grapevine; a fruit tree; fruit; vegetable matter; grapes; plant support structure; and combinations thereof.

8. The bird repellent composition as claimed in any one of the above claims wherein the duration of repellent effect is for at least 8 days.
9. The bird repellent composition as claimed in any one of the above claims wherein the repellency effect is a combination of both primary and secondary repellence.
10. The bird repellent composition as claimed in any one of the above claims wherein the composition is further combined with one or more excipients and/or carrier substances.
11. The bird repellent composition as claimed in any one of the above claims wherein the anthraquinone concentration is from 0.001% to 5% by weight.
12. The bird repellent composition as claimed in any one of the above claims where, if d-pulegone is used, the d-pulegone concentration is from 0.001% to 2% by weight.
13. A bait including a bird repellent composition as claimed in any one of claims 1 to 12.
14. The bait as claimed in claim 13 wherein the bird repellent composition is applied to the bait surface.
15. The bait as claimed in claim 13 or 14 wherein the base bait material is selected from group consisting of: a cereal, a carrot, a dough.
16. The bait as claimed in any one of claims 13 to 15 wherein the bait is for attracting a pest animal.
17. The bait as claimed in claim 16 wherein the pest animal is a possum or rat.
18. A method of repelling birds from an environment including the steps of selecting the environment or object to which the repellent is to be applied and applying the repellent as claimed in any one of claims 1 to 12, to the environment or object.
19. A method of repelling birds from bait including the step of applying a bird repellent

composition as claimed in any one of claims 1 to 12 to the bait.

20. A bird repellent composition as claimed in any one of claims 1 to 12 substantially as hereinbefore described with reference to the drawings and examples.
21. A bait including a bird repellent composition as claimed in any one of claims 13 to 17 substantially as hereinbefore described with reference to the drawings and examples.
22. A method as claimed in any one of claims 18 or 19 substantially as hereinbefore described with reference to the drawings and examples.

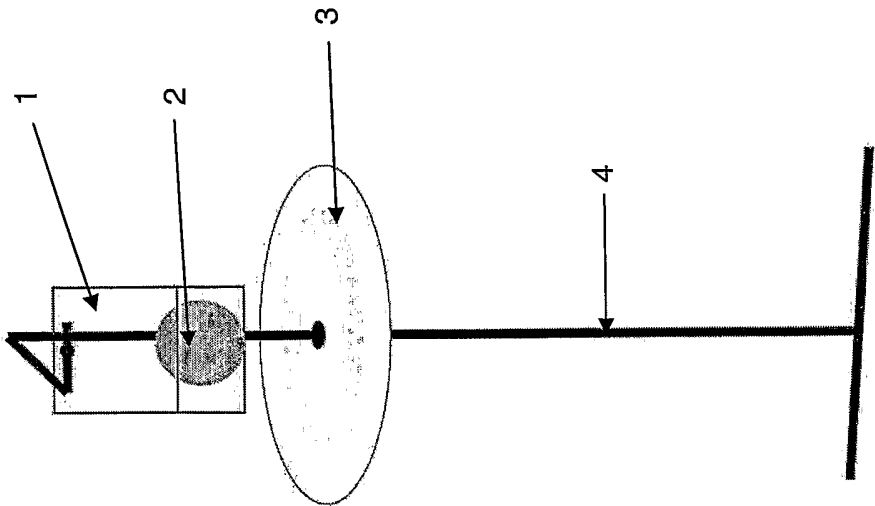


FIGURE 1

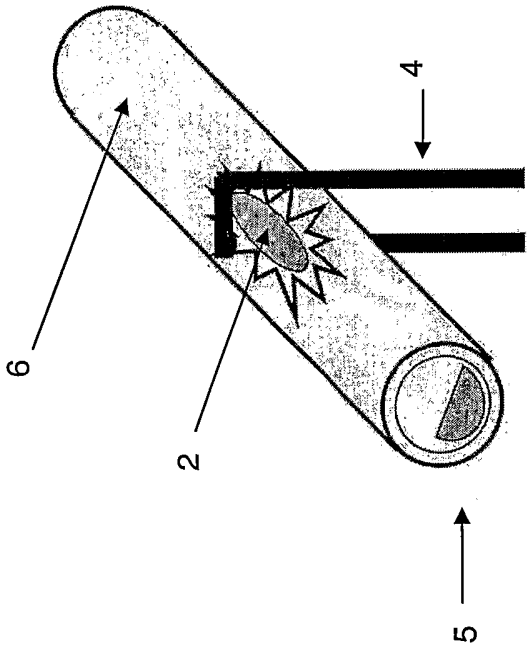


FIGURE 2

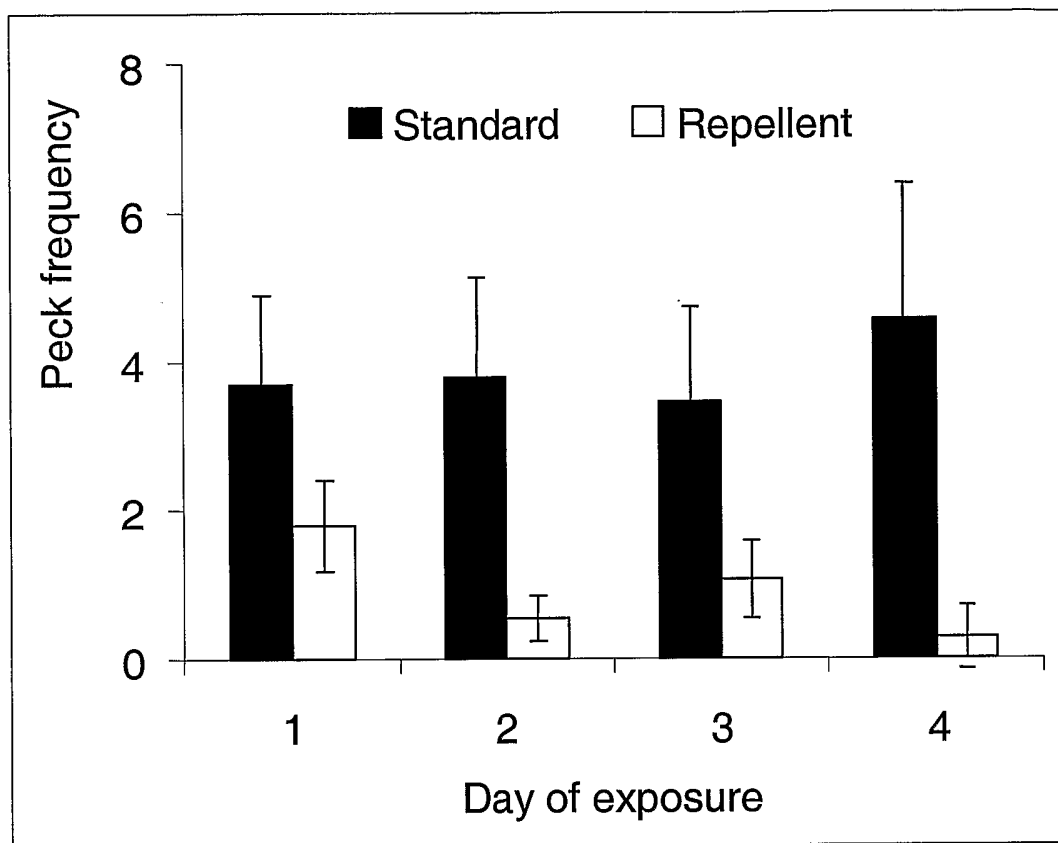


FIGURE 3

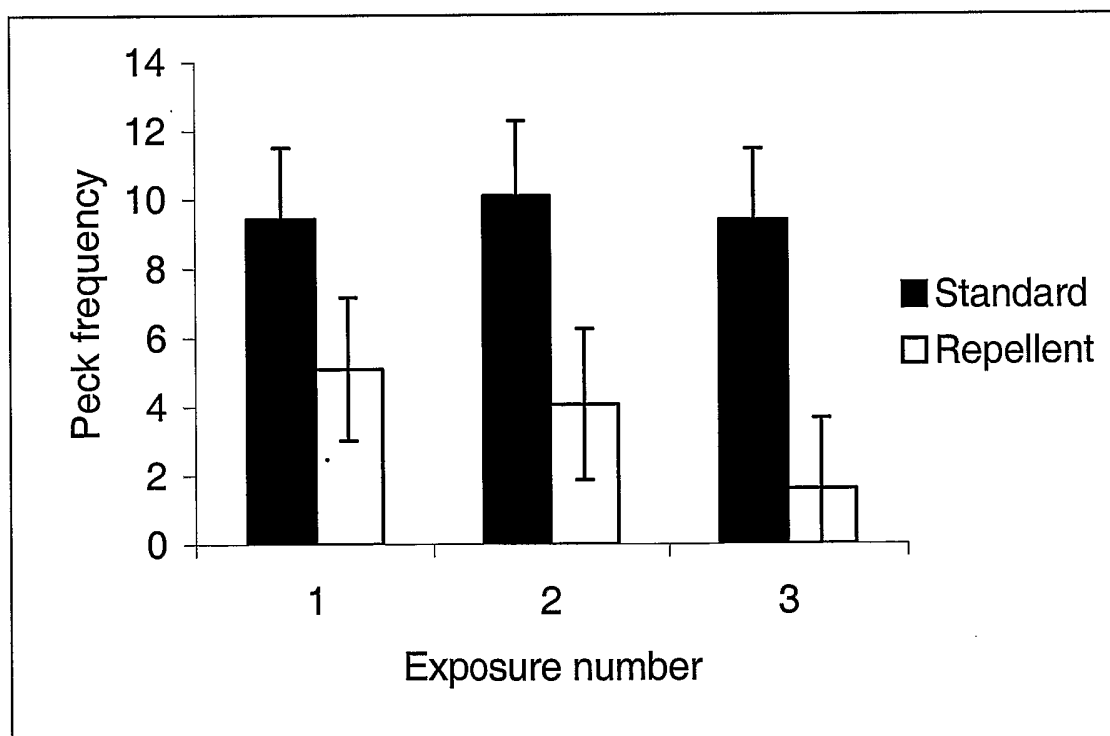


FIGURE 4

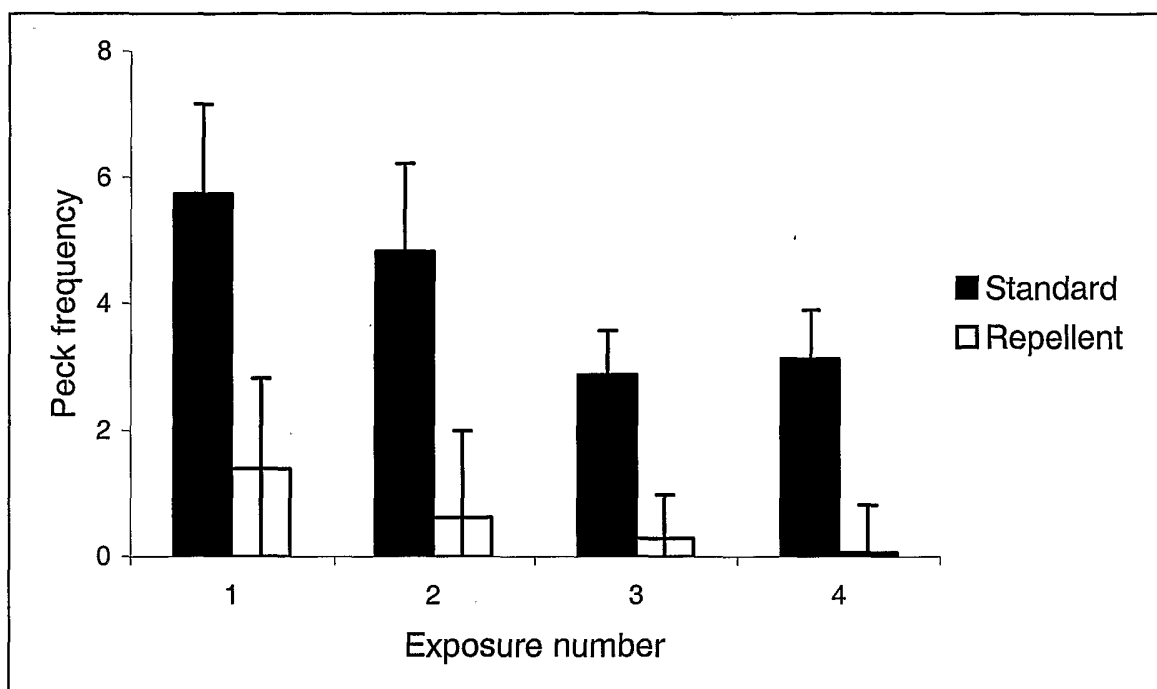


FIGURE 5

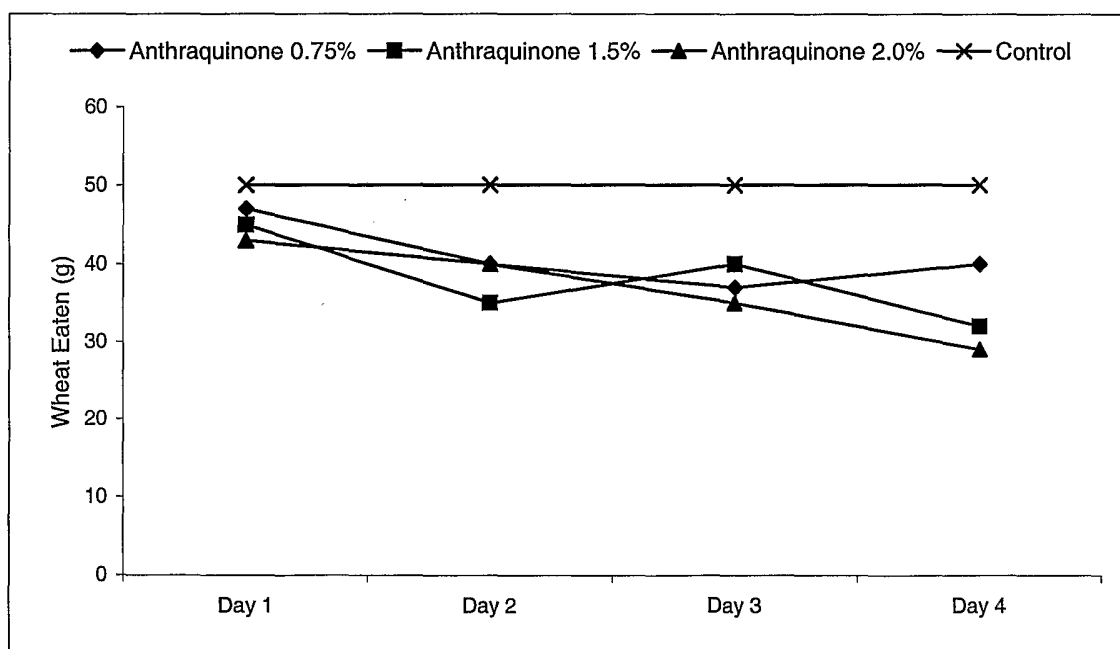


FIGURE 6

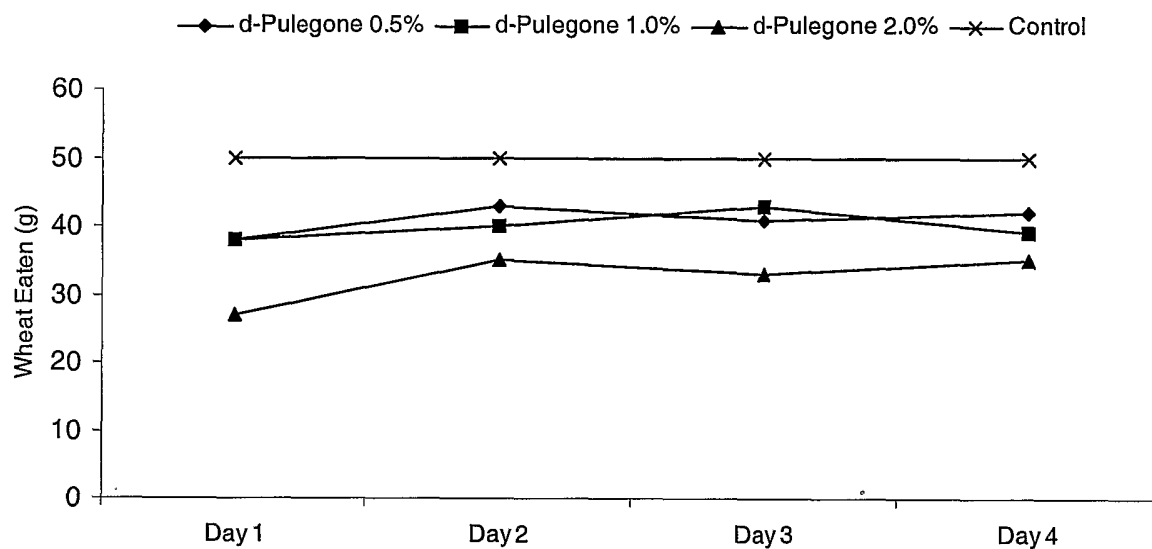


FIGURE 7

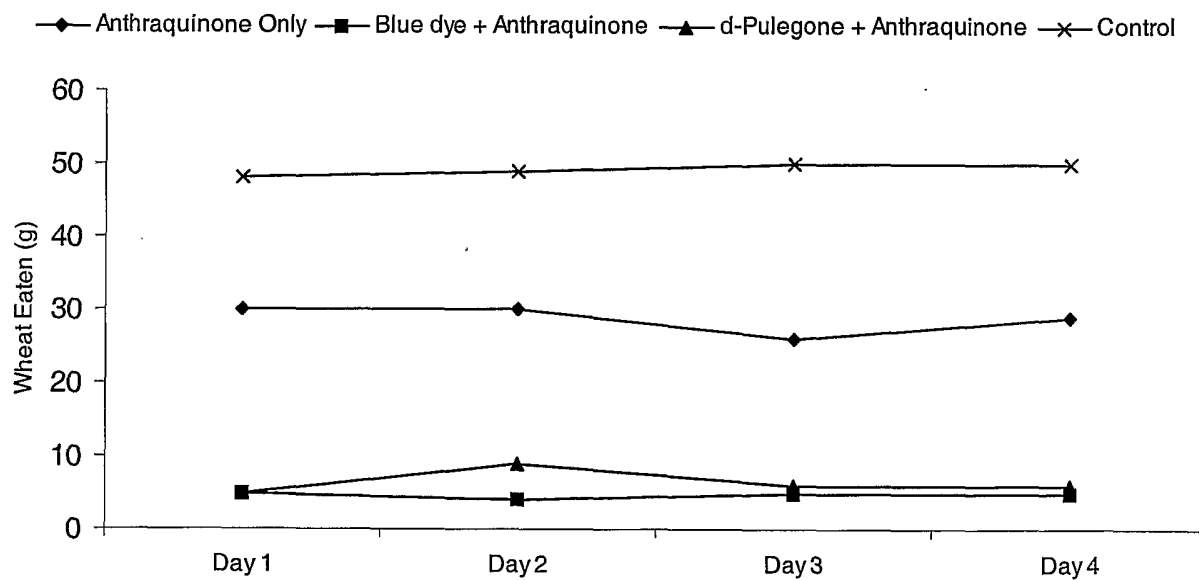


FIGURE 8

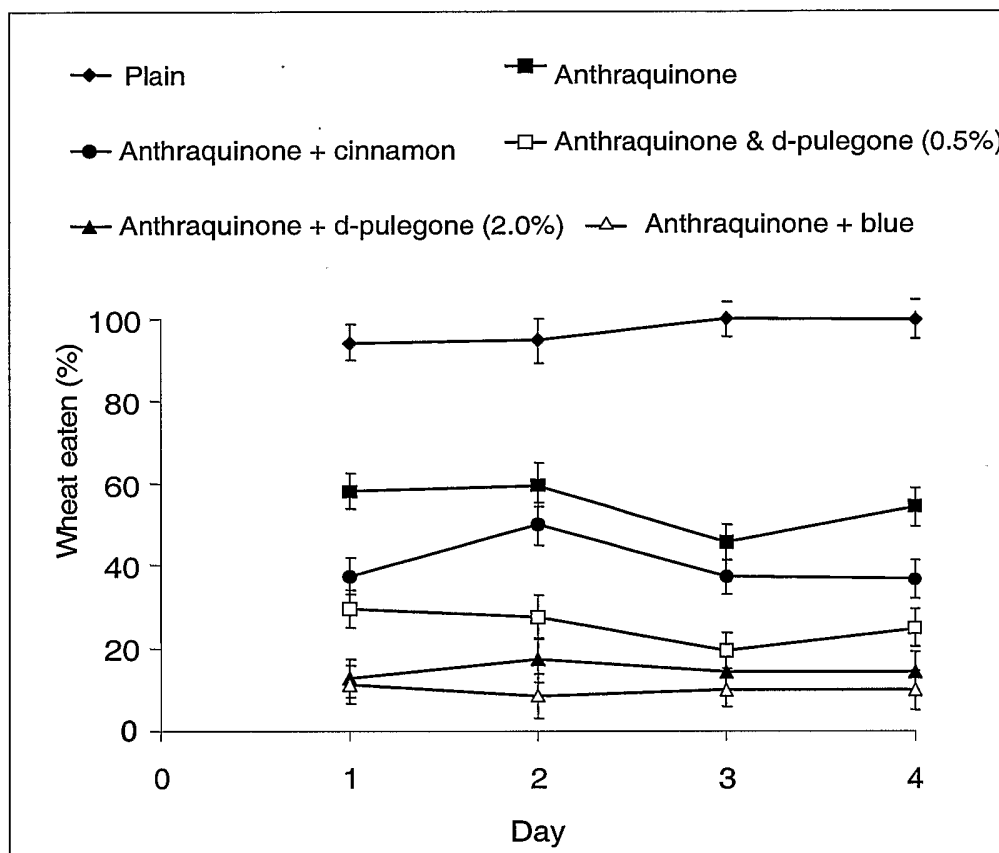


FIGURE 9

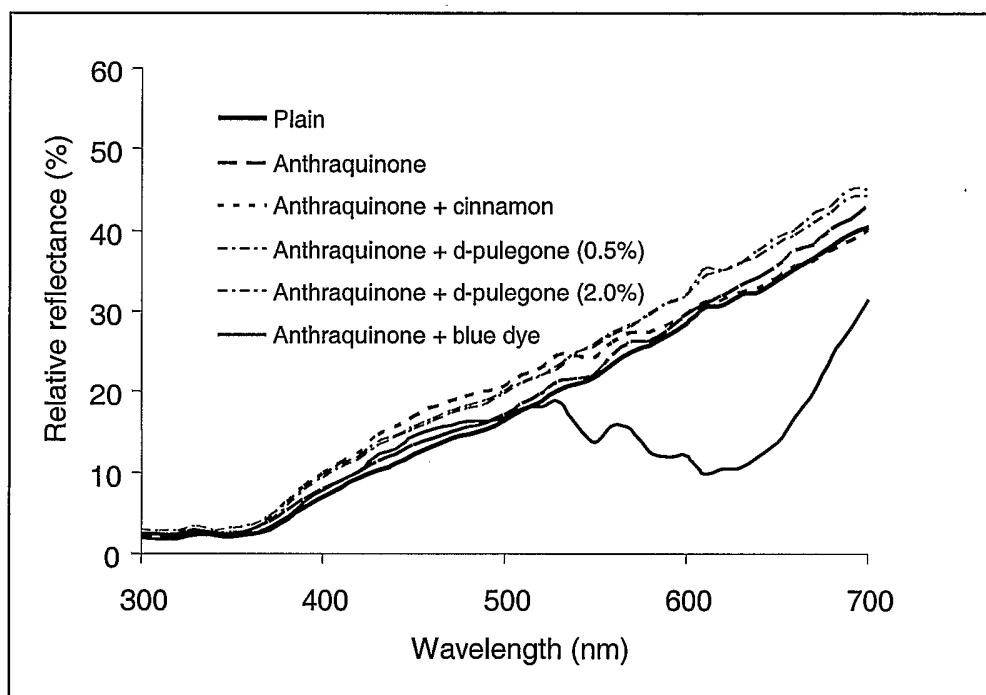


FIGURE 10

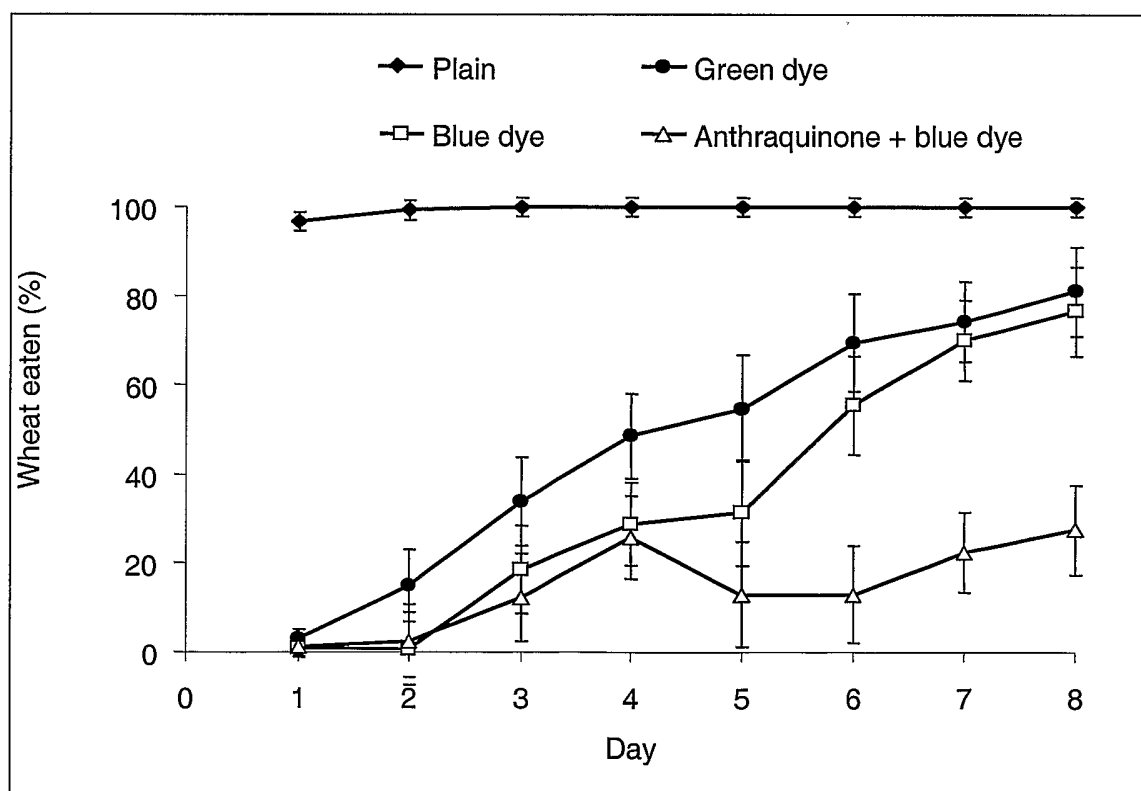


FIGURE 11

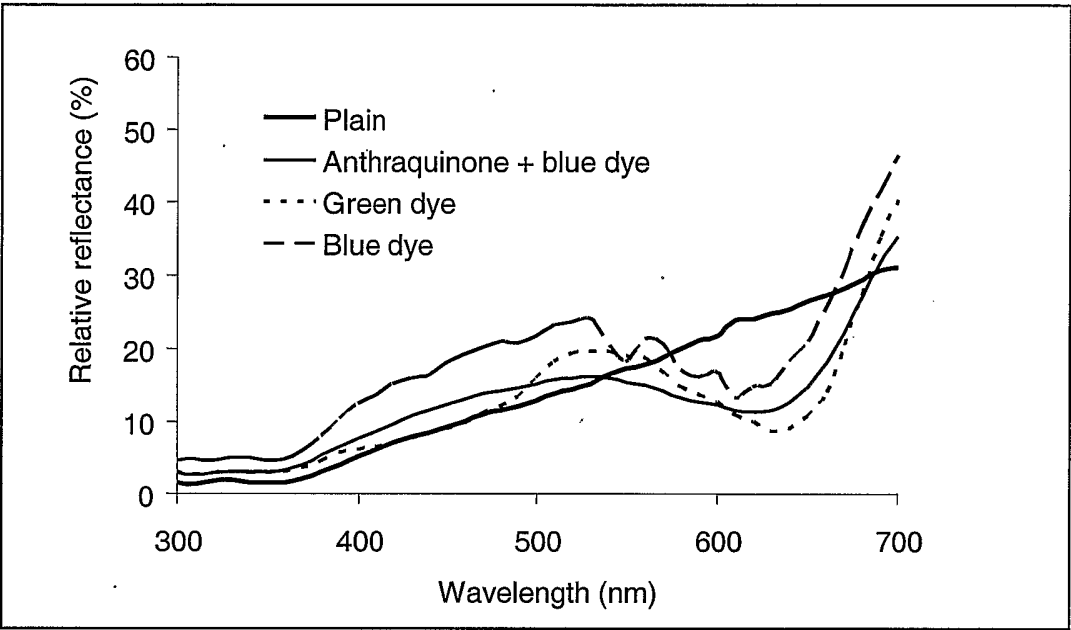


FIGURE 12

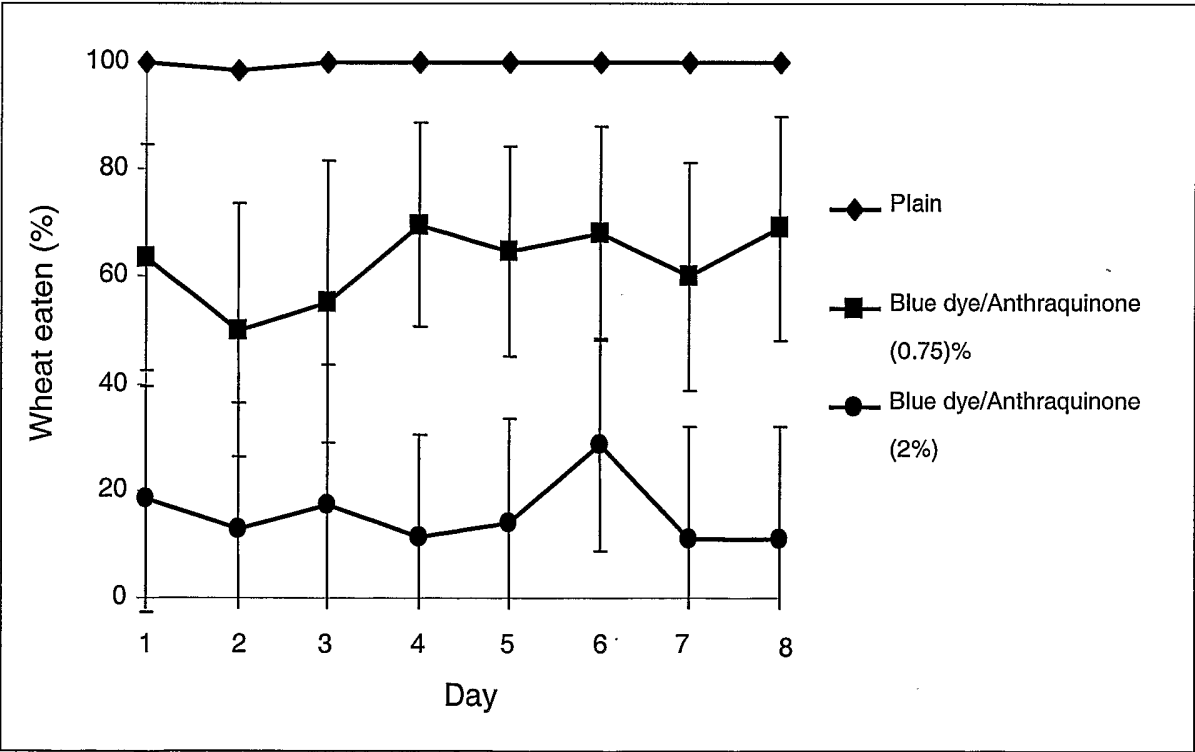


FIGURE 13

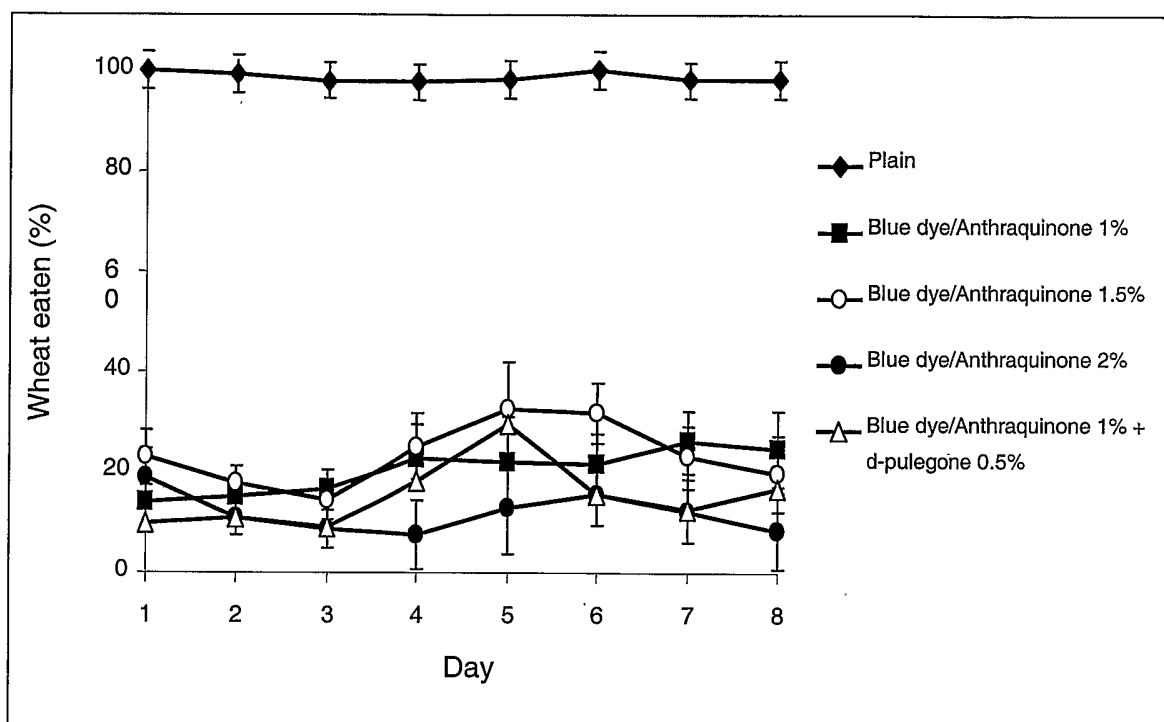


FIGURE 14

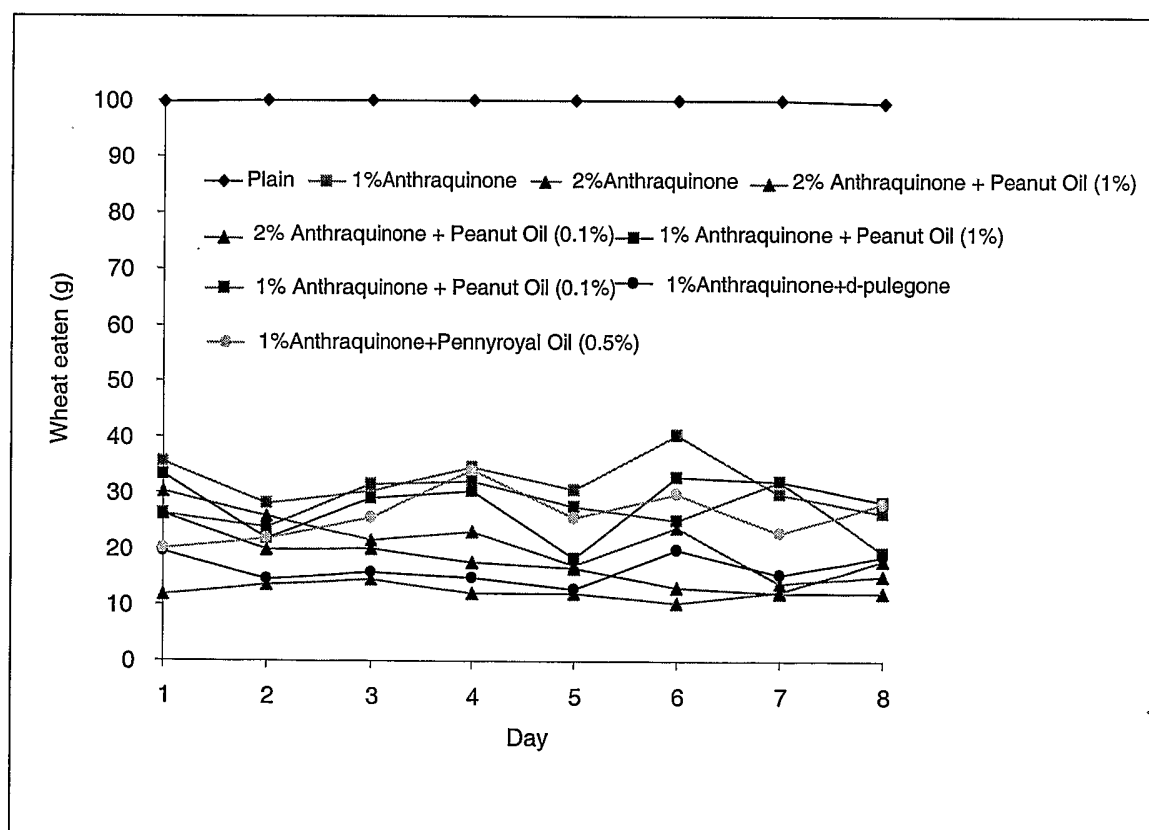


FIGURE 15

INTERNATIONAL SEARCH REPORT

International application No.

PCT/NZ03/00127

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. ⁷: A01M 29/00, A01N 25/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPAT (World Patents); CAPLUS (Chemical Abstracts); AGRICOLA (National Agricultural Library, USA);
keywords: bird, avian, anthraquinone, pulegone, chemical registry numbers.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,Y	GB 1601226 A (FISONS LIMITED) 28 October 1981; see page 1 column 1, line 21, page 3, examples 1 and 2 in particular.	1-11, 13-16, 18-19
X,Y	US 5885604 A (BALLINGER) 23 March 1999; see column 1, line 19, line 57, column 3, line 6 in particular.	1-11, 13-16, 18-19
X,Y	WO 01/78510 A1 (DCV INC.) 25 October 2001; see page 4, lines 25-28, page 5, line 32, page 10, line 25 in particular.	1-19

☒ Further documents are listed in the continuation of Box C

☒ See patent family annex

* Special categories of cited documents:	
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
15 September 2003

Date of mailing of the international search report
24 SEP 2003

Name and mailing address of the ISA/AU
AUSTRALIAN PATENT OFFICE
PO BOX 200, WODEN ACT 2606, AUSTRALIA
E-mail address: pct@ipaustalia.gov.au
Facsimile No. (02) 6285 3929

Authorized officer

DAVID HENNESSY
Telephone No : (02) 6283 2255

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ03/00127

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4888173 A (MASON ET AL.) 19 December 1989; see columns 1-4 in particular.	
A	US 5877223 A (MASON ET AL.) 2 March 1999; see column 2 line 60- column 5, line 18 in particular.	
Y	ENVIRONMENTAL TOXICOLOGY AND CHEMISTRY, vol. 14 no. 4, 631-638; Mastrola, F.N. and Mench, J.A. (1995) Evaluation of taste repellents with northern bobwhites for deterring ingestion of granular pesticides; see the abstract in particular.	1-19
Y	ARCH. ENVIRONM. CONTAM. TOXICOL., vol. 12, 355-382; Schafer, E.W. et al. (1983) The acute oral toxicity, repellency, and hazard potential of 998 chemicals to one or more species of wild or domestic birds; see table 2, pages 360, 361 (CAS registry no.s 84651, 89827) in particular.	1-19
A	CURRENT PRACTICES IN SEQUENTIAL USE OF POSSUM BAIT, Department of Conservation (New Zealand), Technical Series 22, R.J Henderson, C.E. O'Connor and D.R. Morgan (1999). See the whole document.	
A	THE NEW ZEALAND JOURNAL OF AGRICULTURE, vol. 122 (6), 38-43; Caithness, T.A. and Williams, G.R. (1971) Protecting birds from poisoned baits. See the whole document.	
A	COUNTERPEST, vol. 6, 13, 15; Udy, P.B (1981) Baits, birds and field operations. See the whole article.	
A	J. WILDL. MANAGE., vol. 54(1), 130-135; Mason, J.R. (1990) Evaluation of d-pulegone as an avian repellent; see the whole article.	
A	NEW ZEALAND JOURNAL OF ECOLOGY, vol. 17, no. 1, 13-18; Spurr, E.B. (1993) Feeding by captive rare birds on baits used in poisoning operations for control of brushtail possums; see the whole article.	

INTERNATIONAL SEARCH REPORT

International application No.

PCT/NZ03/00127

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report				Patent Family Member			
GB	1601226	NONE					
US	5885604	AU	24418/97	WO	9737540	US	6328986
		CA	2407126	BR	200110294		
WO	200178510	AU	200145981	BR	200110294	CA	2407126
		US	6328986				
US	4888173	CA	1012017	US	3918408		
US	5877223	NONE					
END OF ANNEX							