Title: FORMULATIONS FOR VERTEBRATE PEST CONTROL

Abstract: Formulations for vertebrate pest control comprising microencapsulated alkali metal salts of nitrite are disclosed.
FORMULATIONS FOR VERTEBRATE PEST CONTROL

FIELD OF INVENTION

The invention relates to improved formulations of alkali metal salts of nitrite for use as vertebrate pest control agents. In particular, the invention relates to improved formulations of sodium nitrite for use in the control of feral pigs.

BACKGROUND ART

When present in large numbers feral pigs adversely impact ecosystems causing extensive damage to agricultural and conservation land. In addition, feral pigs are susceptible to tuberculosis and may act as a vector of this disease (Fletcher et al, 1990).

Hunting, shooting, fencing and trapping are inadequate methods for the control of populations of feral pigs in remote areas, or areas which are difficult to access. However, feral pigs are also difficult to poison, partly because of their large size.

Larger doses of a toxic agent are needed for the control of feral pigs than are needed for the control of smaller vertebrate pests. Poisoned baits are therefore employed to encourage the ingestion of larger doses by the target animal.

The use of poisoned baits has become a widely accepted method for the control of feral pigs in rural communities (O’Brien et al, 1986; Choquenot et al, 1996). For example, gelatin capsules containing powdered sodium monofluoracetate (1080) may be inserted into suitable bait, e.g. apples, potatoes or meat (O’Brien et al 1986), and left for the target animal to consume.

The use of 1080 for the control of feral pigs has a number of limitations. The handling of 1080 presents risks to users (Eason, 1989). Despite the use of baits, doses consumed by the target animal may be inadequate. Furthermore, the dose-response relationship for 1080 in feral pigs is inconsistent.
The use of known alternatives to 1080, such as warfarin and yellow phosphorus (sold as CSSP), either does not overcome these limitations, or raises additional concerns related to animal welfare (Sharpe and Saunders, 2004; Cowled and O'Connor, 2004) or residues (Eason and Henderson, 1991).

Winks et al (1950) have reported the toxicity to pigs of sodium nitrite following the heavy mortality of pigs fed on soup prepared by cooking beef and offal in well water.

Hoorens and Thoonen (1961) have also reported the poisoning of pigs attributed to nitrite intoxication caused by drinking water from wells containing blue-green algae and from silos with a high amount of nitrite.

More recently Staples et al (2008) have disclosed nitrite salts as toxic agents for use in the control of feral pigs. In an example the toxic agent is presented in the form of a poisoned bait comprising a shaped, solid carrier material with the toxic agent distributed throughout the carrier material.

It is an object of the present invention to provide an improved formulation of nitrite salts particularly suited for use in the control of vertebrate pests and the preparation of poisoned baits or to at least provide a useful choice.

**STATEMENT OF INVENTION**

In a **first** aspect the invention provides a vertebrate pest control product comprising a microencapsulated alkali metal salt of nitrite.

Preferably, the alkali metal salt of nitrite is sodium nitrite.

Preferably, the ratio (w/w) of encapsulating material to alkali metal salt of nitrite is in the range 0.05 to 0.5. More preferably, the ratio (w/w) of encapsulating material to alkali metal salt of nitrite is 1:9.

Preferably, the encapsulating material is selected from the group consisting of: enteric coating material and lipophilic
coating material. More preferably, the encapsulating material is a water insoluble, digestible substance. Most preferably, the water insoluble, digestible substance is zein.

Preferably, the encapsulating material includes one or more organoleptic compounds. More preferably, the encapsulating material includes one or more organoleptic compounds selected to promote the palatability to the vertebrate pest of the microencapsulated alkali metal salt of nitrite.

Preferably, the vertebrate pest control product is in the form of pellets of the microencapsulated alkali metal salt of nitrite.

Preferably, the vertebrate pest is selected from the group consisting of: feral pigs, possums and rats.

In an embodiment of the first aspect the invention provides a vertebrate pest control product comprising microencapsulated sodium nitrite where the encapsulating material is zein at 10% (w/w) of the microencapsulated sodium nitrite.

In a second aspect the invention provides the use of a microencapsulated alkali metal salt of nitrite in the preparation of poisoned bait for the control of a vertebrate pest.

Preferably, the alkali metal salt of nitrite is sodium nitrite.

Preferably, the ratio (w/w) of encapsulating material to alkali metal salt of nitrite is in the range 0.05 to 0.5. More preferably, the ratio (w/w) of encapsulating material to alkali metal salt of nitrite is 1:9.

Preferably, the encapsulating material is selected from the group consisting of: enteric coating material and lipophilic coating material. More preferably, the encapsulating material is a water insoluble, digestible substance. Most preferably, the water insoluble, digestible substance is zein.
Preferably, the encapsulating material includes one or more organoleptic compounds. More preferably, the encapsulating material includes one or more organoleptic compounds selected to promote the palatability to the vertebrate pest of the microencapsulated alkali metal salt of nitrite.

Preferably, the vertebrate pest is selected from the group consisting of: feral pigs, possums and rats.

Preferably, the ratio (w/w) of microencapsulated alkali metal salt of nitrite to bait used in the preparation of the poisoned bait is at least 0.025. More preferably, the ratio (w/w) of microencapsulated alkali metal salt of nitrite to bait used in the preparation of the poisoned bait is at least 0.05.

In a third aspect the invention provides a microencapsulated alkali metal salt of nitrite manufactured for use in the preparation of the vertebrate pest control product of the first aspect.

In the description and claims of this specification the following acronyms, terms and phrases are intended to have the meaning indicated:

"Digestible" means, with reference to the encapsulating material, becoming friable or soluble in the conditions of the stomach.

"Microencapsulated" means, with reference to a toxic agent, that the formulation of the toxic agent is in a granular or powdered form and comprises particles of the toxic agent coated with an encapsulating material.

"Pellets" means, with reference to the form of the vertebrate pest control product, solid bodies prepared by compacting a dry mix of the microencapsulated alkali metal salt of nitrite with or without the addition of binders. In this context the term "pellets" is used synonymously with the terms "slugs", "tablets", etc.
"Rodenticide" means a vertebrate pest control product for use in rodent control.

"Vertebrate pest control product" means a formulation of a toxic agent packaged and identified for use in vertebrate pest control.

"Water insoluble" means, with reference to a substance, that the substance is substantially insoluble in water at neutral pH at 25 °C, remaining impervious to water when applied as a coating.

The term "feral" is used synonymously with the term "wild".

The term "pig" is used synonymously with the terms "boar", "hog", "swine", "sow", etc.

The terms "first", "second", "third", etc. used with reference to elements, features or integers of the subject matter defined in the Statement of Invention and Claims, or when used with reference to alternative embodiments of the invention are not intended to imply an order of preference.

Exemplary embodiments of the invention will now be described in detail with reference to the Figures of the accompanying drawings pages.

**BRIEF DESCRIPTION OF FIGURES**

**Figure 1.** Mean time to death for pigs fed bait containing different presentations of microencapsulated sodium nitrite (Study 2, Table 4).

**DETAILED DESCRIPTION**

A formulation of microencapsulated sodium nitrite has been developed. This formulation is distinguished from the formulation described by Staples et al (2008) where the sodium nitrite is distributed throughout a carrier material.

Without wishing to be bound by theory it is believed the formulation of sodium nitrite in a microencapsulated form promotes ingestion of the toxic agent (sodium nitrite) at a
sufficient rate and in a sufficient dose to promote a rapid increase in methemoglobin levels.

A rapid increase in methemoglobin levels is required for death of the target animal to occur. It is contemplated that the rate of ingestion and subsequent absorption may be further enhanced by formulation of the microencapsulated sodium nitrite in a suitably flavoured carrier material and co-administration with an agent (proton pump inhibitor) to reduce the acidity of the stomach.

The microencapsulation of food ingredients is a well established technology (Vistrup, 2001). Known methods are readily adaptable to the preparation of microencapsulated sodium nitrite.

The invention resides in a formulation of sodium nitrite that mitigates the adverse palatability of the toxic agent and consequential feeding deterrence and promotes rapid and sufficient ingestion of the toxic agent by the vertebrate pest to ensure a rapid and lethal increase in methemoglobin levels.

The formulation of microencapsulated sodium nitrite may be prepared by a number of methods, including fluid bed drying. A preferred encapsulant for use in the preparation of the formulation is the major storage protein of corn, zein.

In its pure form the encapsulant is odourless, tasteless, hard, water insoluble and edible with accepted use in processed food and pharmaceuticals being classified as Generally Recognised As Safe (GRAS) by the US Food and Drug Administration (USFDA).

Selection of zein as the encapsulant is particularly advantageous in the preparation of microencapsulated sodium nitrite and the use of the formulations for vertebrate pest control. Due to the small particle size of the sodium nitrite used in the preparation it can be difficult to achieve complete coverage of each particle as required to mitigate the adverse palatability of the sodium nitrite and consequential feeding deterreants that might otherwise arise.
Once ingested the encapsulant is required to be capable of being rapidly broken down in the stomach of the target vertebrate pest. However, the encapsulant must also be water insoluble to enable its incorporation into a range of baits routinely employed in vertebrate pest management.

The use of zein as an encapsulant was found to be particularly suitable for use as an encapsulant in the context of preparing formulations for invertebrate pest control.

**PREPARATION OF MICROENCAPSULATED SODIUM NITRITE**

Ten parts by weight of a coating mixture consisting of 10% (w/w) zein, 10% (w/w) water and 80% (w/w) alcohol is prepared. Nine parts by weight of technical grade sodium nitrite is placed in a spray mixing bowl.

The coating mixture is sprayed onto the technical grade sodium nitrite with the application of air heated to a temperature of approximately 50 °C. Flash evaporation of the solvent provides the microencapsulated sodium nitrite (90% (w/w) sodium nitrite).

**PIG STUDIES**

Initial experiments with baits containing technical grade sodium nitrite in cereal paste were unsuccessful as the taste of the poison deterred pigs from eating bait. None of a group of six pigs presented with poisoned bait ate sufficient material to be killed. One animal, a pig which ate the most material, was severely affected, but recovered.

In a first trial the formulation was found to be palatable, effective and humane, with thirteen out of fifteen pigs (87%) killed quickly. The two survivors did not eat a lethal dose, with one being a reluctant feeder, even of non-toxic material, and the second being sub-lethally dosed after spilling the bait and the bolus of the toxin. When these two animals are excluded a 100% kill rate was achieved.
In a second trial data on the effect of omeprazole (a proton pump inhibitor) as a potential synergist was also gathered. Omeprazole addition to the bait had a slight, but not significant, effect on the toxicity of microencapsulated sodium nitrite and the subsequent time to death.

The formulation of microencapsulated sodium nitrite presents a number of advantages. Firstly, the feeding deterrence observed with formulations where sodium nitrite is distributed throughout a carrier material is avoided. Secondly, the need to include a proton pump inhibitor to reduce degradation of the toxic agent in the stomach is negated.

**Trials**

For Study 1 twelve pigs were placed in two large pens and fed on a grain based diet with water *ad libitum*. Pigs were acclimatised for approximately one week before the trial began and were lightly fasted on the day before the trial. For Study 2 fifteen pigs were used with the same husbandry conditions.

Sodium nitrite was presented as technical grade sodium nitrite (NaNO₂) with a cereal paste bait 213 FERASEED™ (Connovation Limited) or microencapsulated sodium nitrite with a cereal paste bait designated 213 (Connovation Limited). Dose levels were chosen based on earlier work (Cowled et al, 2008).

**Study 1 - Technical grade sodium nitrite**

The twelve pigs for this study were divided into four groups of three. Each pig received 150 gm of formulation. The following formulations were tested:

1. Technical grade sodium nitrite as a bolus in bait (bolus); and
2. Technical grade sodium nitrite mixed throughout bait (mixed).

There were two control groups and two test groups. The first control group received the bait alone and the second control
group received the bait plus the carrier material. The first test group received technical grade sodium nitrite and carrier material as a bolus in the bait. The second test group received technical grade sodium nitrite and carrier material mixed throughout the bait.

Bait consumption was assessed and compared with and without technical grade sodium nitrite and the effect of the poison determined (Table 1).

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Dosage mg/kg</th>
<th>Number of pigs</th>
</tr>
</thead>
<tbody>
<tr>
<td>First control</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Second control</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Bolus</td>
<td>350</td>
<td>3</td>
</tr>
<tr>
<td>Mixed</td>
<td>350</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 1. Summary of pig treatment with technical grade sodium nitrite including delivery method, dosage and number of pigs.

**Study 2 - Microencapsulated sodium nitrite**

Microencapsulated sodium nitrite was prepared consisting of 80% (w/w) and 20% (w/w) encapsulating material.

The fifteen pigs for this study were divided into seven groups. Each pig received 150 gm of bait. The following formulations were tested:

1. Microencapsulated sodium nitrite as a bolus in bait (bolus); and
2. Microencapsulated sodium nitrite mixed throughout bait (mixed).

No non-toxic control group was included, as most pigs immediately ate the bait regardless of the presence of the toxin.

**Results**

The results from both trials are summarised below. In Study 1 sodium nitrite was ineffective.
**Study 1 - Technical grade sodium nitrite**

Baits containing technical grade sodium nitrite were ineffective.

The lack of efficacy was attributed to taste deterring the pigs from eating the formulation (Table 3). The control bait without toxin was readily eaten. The carrier had a deterrent effect which was further exacerbated by the presence of sodium nitrite when it was spread through the bait. None of a group of six pigs presented with a formulation comprising technical grade sodium nitrite was killed.

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Dosage mg/kg</th>
<th>Number of pigs*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed</td>
<td>300</td>
<td>3</td>
</tr>
<tr>
<td>Mixed</td>
<td>300 + omeprazole</td>
<td>3</td>
</tr>
<tr>
<td>Mixed</td>
<td>350</td>
<td>2</td>
</tr>
<tr>
<td>Mixed</td>
<td>400</td>
<td>2</td>
</tr>
<tr>
<td>Bolus</td>
<td>215</td>
<td>1</td>
</tr>
<tr>
<td>Bolus</td>
<td>350</td>
<td>1</td>
</tr>
<tr>
<td>Bolus</td>
<td>400</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2. Summary of pig treatment with microencapsulated sodium nitrite including delivery method, dosage and number of pigs (* 2 pigs did not eat a full dose and are not included).

**Study 2 - Microencapsulated sodium nitrite**

Baits containing microencapsulated sodium nitrite were palatable, effective and humane.

As indicated in Table 4 and in Figure 1 the results obtained with microencapsulated sodium nitrite as a bolus (2.6g pellets of compressed microencapsulated sodium nitrite) or mixed through the bait both demonstrate linear decreases in time to death with increasing dose.

The presentation as a bolus significantly reduced time to death in those animals receiving a lethal dose. However, delivery was more unreliable, with one pig partly spilling and leaving up to half the dose uneaten and surviving. This was not the case for
the presentation mixed through the bait which was consistently eaten.

<table>
<thead>
<tr>
<th>Group</th>
<th>Bait type</th>
<th>Bait remaining (g)</th>
<th>Amount eaten (g)</th>
<th>Average eaten per group (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>First control</td>
<td>0</td>
<td>170</td>
<td>170</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>170</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>170</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Second control</td>
<td>47</td>
<td>123</td>
<td>74.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>107</td>
<td>63</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>113</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Bolus</td>
<td>134</td>
<td>26</td>
<td>67.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>59</td>
<td>111</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>114</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Mixed</td>
<td>154</td>
<td>16</td>
<td>28.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>113</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>157</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Bait consumption by individual pigs eating toxic and nontoxic bait.

The microencapsulated sodium nitrite was accepted by all test animals, with no aversion evident. The onset of symptoms was delayed for approximately 1 hour after the baits had been eaten. This was attributed to the delayed absorption of the active agent in the duodenum. Symptoms of methaemoglobinemia ensued shortly thereafter, including loss of colour, lethargy and death.

Data on omeprazole as a potential synergist was also gathered in these trials. Omeprazole was administered at a dose of 40 mg, a dose known to increase gastric pH in pigs (Friendship et al, 2000). Comparison of a dose of sodium nitrite with and without omeprazole showed that omeprazole slightly but not significantly reduced the time to death (One-way ANOVA; F₁,₄=4.7; P=0.1).

Two results are not shown in Table 4 and Figure 1. A female that was fed a 350 mg/kg bolus dose only consumed half the pellets (~170 mg/kg) and survived. A male, that would not eat the cereal
paste bait, was alternatively fed 350 mg/kg with 150 g of pig pellets. Although this animal showed clear signs of toxicosis it also survived. It is, however, uncertain exactly what the final dose was that this animal received.

<table>
<thead>
<tr>
<th>Dose (mg/kg)</th>
<th>300</th>
<th>300</th>
<th>350</th>
<th>400</th>
<th>215</th>
<th>350</th>
<th>400</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentation</td>
<td>mixed</td>
<td>mixed + omeprazole</td>
<td>mixed</td>
<td>mixed</td>
<td>bolus</td>
<td>bolus</td>
<td>bolus</td>
</tr>
<tr>
<td>Individual times to death (min)</td>
<td>307</td>
<td>291</td>
<td>200</td>
<td>127</td>
<td>198</td>
<td>101</td>
<td>88</td>
</tr>
<tr>
<td>Mean time to death (min)</td>
<td>293</td>
<td>232</td>
<td>200</td>
<td>132</td>
<td>340</td>
<td>272</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>313</td>
<td>265</td>
<td>200</td>
<td>130</td>
<td>198</td>
<td>101</td>
<td>88</td>
</tr>
<tr>
<td>24</td>
<td>30</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Dose, type of delivery and individual and mean time to death for sodium nitrite in pigs

In summary 13 out of 15 pigs (87%) were quickly killed. Two survivors did not eat a lethal dose. One was a reluctant feeder, even of non-toxic material, and the second was sub-lethally dosed after spilling bait and a bolus of the toxin. When the reluctant feeder and the animal that split its dose are excluded a 100% kill rate was achieved.

The results suggest that microencapsulated sodium nitrite is a humane and effective toxic agent for the control of feral pigs.

**Simulated Field Trial**

**Materials**

**Preparation of toxic bait**

A non-toxic cereal paste bait designated 213 FERAFEED™ (Connovation Limited) containing microencapsulated sodium nitrite was prepared immediately prior to pen trials.

Microencapsulated sodium nitrite was determined by assay to comprise circa 80 % (w/w) sodium nitrite. Twenty five grammes (25 g) of the microencapsulated sodium nitrite was mixed with 225 g of 213 FERAFEED™.
Pre-feeding and Exposure to Bait Station

Nine domestic pigs (large white) weighing approximately 35 kg each were housed together in an enclosure with access to food and water ad libitum. Half of the enclosure could be closed to form two smaller enclosures.

Two prototype bait stations were placed in one of the smaller enclosures. Six balls of bait weighing approximately 250 gms were placed in each bait station each day. The lids of the bait stations were wired open on the first night. The pigs were allowed into the enclosure in groups of three and pigs fed readily from the bait stations.

On night two the bait station lids were closed. Pigs rapidly learned how to open the bait stations to access the non-toxic bait. Pre-feeding out of the bait stations was continued for nine days.

Toxic Baiting

Pigs were fasted for 24 hours and sorted into groups of three before entering the enclosure with the bait stations. Eight balls of toxic bait prepared as described above were placed in the bait stations (four in each station) for Group One. Six balls of baits were placed in the bait stations (three in each station) for Groups Two and Three.

A veterinarian was present for the observation period.

Results

Seven of the nine pigs consumed their food quickly and there appeared to be little aversion. Two of the pigs ate smaller amounts with one of the pigs being very timid and moving away from the bait when others approached.

Eight of the nine pigs died between 39 and 101 minutes. Average time to onset of symptoms was 19.44 minutes, average duration of symptoms was 42.13 minutes and average time to death was 59.5 minutes.
One pig survived.

All deaths were unremarkable and the following symptoms were observed in order: pale nose extremities, vomiting, blue tongues, lethargy, ataxia, slight tremors, collapse and death.

The observations are summarised in Table 6.

Microencapsulated sodium nitrite was found to be an effective and humane poison for killing pigs in this study. Pigs easily learnt how to open the bait stations and fed readily on the toxic baits.

Most pigs fed more quickly when feeding as a mob and challenged by others and one refrained from eating by moving away when challenged by other pigs. At least six of the pigs ate more than twice a lethal dose.

Times to death were relatively rapid compared with conventional vertebrate pesticides, but comparable with those reported for sodium nitrite in possums (Hix et al, 2010) and for other toxins inducing methaemaglobinaemia (Littin et al, 2010; Eason et al 2010a, b and c).

From the behavioural observations made after the pigs had consumed the toxin it seems possible that physical activity following bait consumption may enhance the toxic effects of the microencapsulated sodium nitrite.

**POSSUM STUDIES**

Preliminary feeding studies provided a kill rate of 20 or 28 possums with doses of 50 to 750 mg/Kg indicating an LD₅₀ around 120 mg/Kg.

**RAT STUDIES**

The efficacy of microencapsulated sodium nitrite (80% (w/w) sodium nitrite and 20% (w/w) encapsulating material) when used in the preparation of poisoned baits (213) was evaluated. Three groups of caged rats were permitted to feed on poisoned bait
containing microencapsulated sodium nitrite at ratios (w/w) of 1:10 (Group 1), 1:20 (Group 2) and 1:40 (Group 3). The results of these feeding trials are recorded in Table 5.

Effective (lethal) doses were ingested in the bait comprising 10% (w/w) sodium nitrite (NaNO₂). The lethal dose (LD₁₀₀) was indicated to be in the range 170 to 410 mg/Kg. It was observed that tentative or prolonged feeders were less susceptible to ingestion of the poisoned bait.

Although the invention has been described by way of exemplary embodiments it should be appreciated that variations and modifications may be made without departing from the scope of the invention.

Where known equivalents exist to specific features, such equivalents are incorporated as if specifically referred to in this specification.

In particular, although the invention has been described with reference to the use of sodium nitrite as the toxic agent it will be recognised that formulations of other toxic salts of nitrite could be developed for use in accordance with the third aspect of the invention
<table>
<thead>
<tr>
<th>Group</th>
<th>SN %</th>
<th>Rat</th>
<th>Rat</th>
<th>Quantity of bait ingested (g)</th>
<th>Quantity of NaNO₂ ingested (mg)</th>
<th>Rat weight (Kg)</th>
<th>Dose (mg/kg)</th>
<th>Death (D) or survival (S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10.0%</td>
<td>1F</td>
<td>1</td>
<td>0.814</td>
<td>81.40</td>
<td>0.281</td>
<td>289.6797</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>10.0%</td>
<td>2F</td>
<td>2</td>
<td>0.688</td>
<td>68.80</td>
<td>0.395</td>
<td>174.1772</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>10.0%</td>
<td>3M</td>
<td>3</td>
<td>1.577</td>
<td>157.70</td>
<td>0.506</td>
<td>311.6601</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>10.0%</td>
<td>4M</td>
<td>4</td>
<td>2.754</td>
<td>275.40</td>
<td>0.676</td>
<td>407.3964</td>
<td>D</td>
</tr>
<tr>
<td>2</td>
<td>5.0%</td>
<td>1F</td>
<td>5</td>
<td>0.981</td>
<td>49.05</td>
<td>0.258</td>
<td>190.1163</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>5.0%</td>
<td>2F</td>
<td>6</td>
<td>1.832</td>
<td>91.60</td>
<td>0.290</td>
<td>315.8621</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>5.0%</td>
<td>3M</td>
<td>7</td>
<td>2.220</td>
<td>111.00</td>
<td>0.537</td>
<td>206.7039</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>5.0%</td>
<td>4M</td>
<td>8</td>
<td>2.209</td>
<td>110.45</td>
<td>0.476</td>
<td>232.0378</td>
<td>S</td>
</tr>
<tr>
<td>3</td>
<td>2.5%</td>
<td>1F</td>
<td>9</td>
<td>11.796</td>
<td>294.90</td>
<td>0.329</td>
<td>896.3526</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>2.5%</td>
<td>2F</td>
<td>10</td>
<td>6.078</td>
<td>151.95</td>
<td>0.335</td>
<td>453.5821</td>
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<td>3M</td>
<td>11</td>
<td>12.122</td>
<td>303.05</td>
<td>0.258</td>
<td>1174.612</td>
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<td>2.5%</td>
<td>4M</td>
<td>12</td>
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<td>245.55</td>
<td>0.273</td>
<td>899.4505</td>
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Table 5.
<table>
<thead>
<tr>
<th>Outcome</th>
<th>Weight (Kg)</th>
<th>Baits</th>
<th>Total (g)</th>
<th>Eaten (g)</th>
<th>Time to onset of symptoms (mins)</th>
<th>Time from first symptoms until death (mins)</th>
<th>Time to death (mins)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 (3 pigs)</td>
<td>Survival</td>
<td>-</td>
<td></td>
<td></td>
<td>36</td>
<td>-</td>
<td>-</td>
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<td>Death</td>
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<td>8 x 250g</td>
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<td>670</td>
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<td>68</td>
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<td>Death</td>
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<td></td>
<td></td>
<td>26</td>
<td>30</td>
<td>56</td>
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<tr>
<td>Group 2 (3 pigs)</td>
<td>Death</td>
<td>35.4</td>
<td></td>
<td></td>
<td>10</td>
<td>32</td>
<td>42</td>
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<td>Death</td>
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<td>6 x 250g</td>
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<td>1,500</td>
<td>15</td>
<td>39</td>
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<tr>
<td></td>
<td>Death</td>
<td>36.6</td>
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<td>10</td>
<td>38</td>
<td>48</td>
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<tr>
<td>Group 3 (3 pigs)</td>
<td>Death</td>
<td>26.4</td>
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<td>76</td>
<td>101</td>
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<td>1,500</td>
<td>14</td>
<td>29</td>
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<tr>
<td></td>
<td>Death</td>
<td>32.8</td>
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<td></td>
<td>14</td>
<td>25</td>
<td>39</td>
</tr>
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Table 6.
REFERENCES


Couch and Bunyea (1939) Toxicity of potassium cyanide for swine Veterinary Medicine 34, 620-623


Hoorens and Thoonen (1961) Nitrite poisoning in pigs Vlaams Diergeneesk. Tijdschr. 30, 204-10


CLAIMS

1) A vertebrate pest control product comprising a microencapsulated alkali metal salt of nitrite.

2) The vertebrate pest control product of claim 1 where the alkali metal salt of nitrite is sodium nitrite.

3) The vertebrate pest control product of claim 1 or claim 2 where the ratio (w/w) of encapsulating material to alkali metal salt of nitrite is in the range 0.05 to 0.5.

4) The vertebrate pest control product of claim 1 or claim 2 where the ratio (w/w) of encapsulating material to alkali metal salt of nitrite is 1:9.

5) The vertebrate pest control product of any one of claims 1 to 4 where the encapsulating material is selected from the group consisting of: enteric coating material and lipophilic coating material.

6) The vertebrate pest control product of any one of claims 1 to 5 where the encapsulating material is a water insoluble, digestible substance.

7) The vertebrate pest control product of claim 6 where the water insoluble, digestible substance is zein.

8) The vertebrate pest control product of any one of claims 1 to 7 where the encapsulating material includes one or more organoleptic compounds.

9) The vertebrate pest control product of claim 8 where the encapsulating material includes one or more organoleptic compounds selected to promote the palatability to the vertebrate pest of the microencapsulated alkali metal salt of nitrite.
10) The vertebrate pest control product of any one of claims 1 to 9 where the vertebrate pest control product is in the form of pellets of the microencapsulated alkali metal salt of nitrite.

11) The vertebrate pest control product of any one of claims 1 to 10 where the vertebrate pest is selected from the group consisting of: feral pigs, possums and rats.

12) The vertebrate pest control product of claim 11 where the vertebrate pest is feral pigs.

13) A **vertebrate pest control product** comprising microencapsulated sodium nitrite where the encapsulating material is zein at 10% (w/w) of the microencapsulated sodium nitrite.

14) The **use** of a microencapsulated alkali metal salt of nitrite in the preparation of poisoned bait for the control of a vertebrate pest.

15) The use of claim 14 where the alkali metal salt of nitrite is sodium nitrite.

16) The use of claim 14 or 15 where the ratio (w/w) of encapsulating material to alkali metal salt of nitrite is in the range 0.05 to 0.5.

17) The use of claim 16 where the ratio (w/w) of encapsulating material to alkali metal salt of nitrite is 1:9.

18) The use of any one of claims 14 to 17 where the encapsulating material is selected from the group consisting of: enteric coating material and lipophilic coating material.
19) The use of any one of claims 14 to 18 where the encapsulating material is a water insoluble, digestible substance.

20) The use of claim 19 where the water insoluble, digestible substance is zein.

21) The use of any one of claims 14 to 20 where the encapsulating material includes one or more organoleptic compounds.

22) The use of claim 21 where the encapsulating material includes one or more organoleptic compounds selected to promote the palatability to the vertebrate pest of the microencapsulated alkali metal salt of nitrite.

23) The use of any one of claims 14 to 22 where the vertebrate pest is selected from the group consisting of: feral pigs, possums and rats.

24) The use of claim 23 where the vertebrate pest is feral pigs.

25) A microencapsulated alkali metal salt of nitrite for use in the preparation of the vertebrate pest control product of any one of claims 1 to 13.