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Antignawing Activity of Plant Extracts against Mice

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Abstract : Methanol extracts of 54 plant species in 32 families were tested for their antignawing activities against mice by wire-dipping method. The activity varied with plant species. Potent antignawing activity was observed in extracts from roots of *Aucklandia lappa* (Compositae), barks of *Cinnamomum cassia* (Lauraceae), fruits of *Illicium verum* (Magnoliaeceae), fruits of *Piper nigrum* (Piperaceae), rhizomes of *Rheum officinale* (Polygonaceae), and leaves of *Pinus densiflora* (Pinaceae). As naturally occurring rodent repellents, these plant-derived materials could be useful as a preventive agent against various kinds of damage caused by rodents.(Received November 6, 1997; accepted January 6, 1998)

Introduction

Rodents are cosmopolitan in their distribution and approximately 1,800 species have been described. They cause great damage not only in agriculture and forestry, but significantly also contribute to the generation of serious problems for communication systems and structures as well as human health.[1,2] Current control of these rodent populations is primarily dependent upon continued or repeated applications of conventional rodenticides. Although many success has been achieved using rodenticides for control of rodents,[1,2] their extensive use for several decades has led to the development of resistance to rodenticides,[3,4] persistence of residues, adverse effects on non-target organisms and environmental problems, and human health hazards.[5-7] The decreasing efficacy and increasing concern over adverse effects of the earlier types of rodenticides have brought about the need for the development of new types of more safe and ecofriendly alternatives or alternative control methods without or with reduced use of conventional rodenticides.

Plants may be an alternative to currently used rodent control agents, because these constitute a rich source of bioactive chemicals and are biodegradable to nontoxic products.[8,9] Because for each rat killed with poison there are others in the area who survive, the most suitable alternative may be nonlethal rodenticides such as antifertile or repellent chemicals.[10-12] However, relatively little work has been carried out on repellents produced by plant-derived materials compared to other aspects of rodent control.

In the laboratory studies described herein, we assessed the repellent activity of methanol extracts from a total of 54 plant species against mice to search plant-derived materials for potentially useful products as commercial repellents or as lead compounds.

Materials and Methods

Animals

Four-week-old female ICR mice were purchased from Sam Yook Animal Co, Osan, Kyungi Province, Korea. Animals were allowed to acclimate to their new housing for at least one week prior to test. They were approximately five weeks of age (24~26 g) at the initiation of the study. They were randomly assigned to groups and housed, five per plastic cage, on aspen chip bedding under conditions of controlled temperature (25±1°C), 50~60% relative humidity, and a photoregime of 12:12 (L:D) h. Food (Sam Yook Animal Co.) and water were provided prior to and during the experiments.

Plants and sample preparation

A total of 54 plant species with strong bitterness or odor[13,14] were anecdotally selected (Table 1) because effectiveness of rodent repellents might depend partly on thermal irritant by contact and olfactory avoidance,[11,16] and taste aversion.[17,18] They were dried in an oven at 60°C for 2 d and finely pow-

Key words : rodent, mouse, antignawing activity, repellent, plant, wire-dipping method
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Table. 1. Plants tested

Plant species	Familiy	Tissue sampled[a]	Plant species	Familiy	Tissue sampled
Acer ginnala	Aceraceae	Fo	*Magnolia officinalis*		Co
Acer palmatum		Fo	*Magnolia liliflora*		Fl
Amaranthus mangostranus	Amaranathaceae	Fo	*Cudrania tricuspidata*	Moraceae	Fo
Angelica dahurica	Apiaceae	Ra	*Eugenia aromatica*	Myrtaceae	Ra
Ligusticum officinale		Rh	*Chionanthus retusa*	Oleaceae	Fo
Acorus calamus var. *angustatus*	Araceae	Rh	*Syringa reticulata*		Fo
Acorus gramineus		Rh	*Paeonia suffruticosa*		RC
Colocasia antiquorum var. *esculenta*		Fo	*Abies holophylla*	Pinaceae	Fo
			Abies koreana		Fo
Acanthopanax sessilifloru	Araliaceae	Fo	*Pinus densiflora*		Fo
Artemisia vulgaris	Asteraceae	Wp	*Piper nigrum*	Piperaceae	Fr
Boswellia carterii	Burseraceae	Wp	*Rheum officinale*	Polygonaceae	Rh
Cannabis sativa	Cannabinaceae	Se	*Lysimachia foenum-gaecum*	Primulaceae	He
Aucklandia lappa	Compositae	Ra	*Clematis mandshurica*	Ranunculaceae	Ra
Rhododendron mucronulatum	Ericaceae	Fo	*Rosa rugosa*	Rosaceae	Fo
Rhododendron schlippenbachii		Fo	*Chaenomeles sinensis*		Fr
Ricinus communis	Euphorbiceae	Fo	*Pourthiaea villosa*		Fo
Hierochloe odorata	Gramineae	He	*Evodia rutaecarpa*	Rutaceae	Fr
Sabina chinensis	Juniperaceae	Li	*Zanthoxylum piperitum*		Fr
Agastache rugosa	Labiatae	He	*Santalum album*	Santalaceae	Li
Schizonepeta tenuifolia		He	*Stemona japonica*	Stemonaceae	Ra
Thymus przewalskill		He	*Pterostyrax hispida*	Styracaceae	Fo
Cinnamomum camphora	Lauraceae	Li	*Styrax japonica*		Fo
Cinnamomum cassia		Co	*Aquillaria agallocha*	Thymelaeaceae	Li
Gleditsia horrida	Leguminosae	Fr	*Nardostachys chinensis*	Valerianaceae	Rh
Glycyrrhiza glabra		Ra	*Curcuma longa*	Zingiberaceae	Rh
Illicium verum	Magnoliaceae	Fr	*Kaempferia galanga*		Rh
Liriodendron tulipifera		Fo			

[a] Co, Cortex; Fl, Flos; Fo, Folium; Fr, Fructus; Li, Lignum; Ra, Radix; RC, Radicus Cortex; Rh, Rhizoma; and Se, Semen.

dered using a blender. Each sample (100 g) was extracted twice with 300 m*l* of methanol at room temperature and filtered (Toyo filter paper No. 2). The combined filtrate was concentrated *in vacuo* at 40°C, using a rotary vacuum evaporator.

Bioassay

We already eatablished the rapid and simple bioassay system for rodent repellents determined by wire-dipping method which is suitable for the measurement of repellent activity of compounds of synthetic or natural origin.[19] The antignawing activity of 54 plant samples against mice was examined by the wire-dipping method. The most important factor in the screening for repellent activity against rodents may be the starting concentration. A concentration of 5% ethanol solution (dried plant extract/ethanol, w/v) did not cause any problem with solubility and allows detection of minor active compounds.[19] Plastic-coated flexible electric wire was cut into 10-cm segments. The segments were dipped in the 5% ethanol solution of each plant sample for 3 min and allowed to dry. Control segments were prepared by dipping the cable in ethanol for 3 min. After evaporation in a draft for 30 min, ten segments treated with the test material, ten control segments and five female mice were placed in the same cage under the same conditions mentioned above. The mouse-induced damage state of the segments was observed 3 d after treatment. All treatments were replicated three times.

The antignawing activities (AA) of the plant samples used were determined and compared with those of controls. The antignawing value (AV) was calculated from the following two formulas, AVS = (the number of scars in each wire segment treated with test material/the number of scars in each wire segment treated with ethanol) × 100, and AVL = (the length gnawed in each wire segment treated with test material/the length gnawed in each wire segment treated with ethanol) × 100. The responses were classified as follows : strong AA +++, AVS and AVL <10%; moderate AA ++, AVS and AVL 10-30%; weak AA +, AVS and AVL 31-50%; and little or no AA -, AVS and AVL >50%.

Results and Discussion

Methanol extracts of 54 plant species were tested for the antignawing activity against mice by a wire-dipping method. The activity varied with plant species (Table 2). Of these, 31 samples exhibited antignawing activity. Strong antignawing activities were observed from crude extracts from roots of

Table 2. Antignawing activities of test materials against mice during 3-day test determined by wire-dipping method

Plant species[a]	Antignawing activity		Plant species[a]	Antignawing activity	
	AVS[b]	AVL[c]		AVS[b]	AVL[c]
A. gramineus	++[b]	+	*P. suffruticosa*	++	++
A. vulgaris	++	+	*P. densiflora*	++	++
B. carterii	++	+	*P. nigrum*	+++	+++
A. lappa	+++	+++	*R. officinale*	+++	++
D. camphora	-	+	*L. foenum-graecum*	++	-
H. odorata	++	+	*C. mandshurica*	++	+
A. rugosa	+	+	*C. sinensis*	++	+
S. tenuifolia	++	+	*E. rutaecarpa*	++	++
C. camphora	++	++	*Z. piperitum*	++	+
C. cassia	+++	+++	*S. album*	++	+
G. horrida	++	+	*S. japonica*	++	-
G. glabra	++	-	*A. agallocha*	+	++
P. santalinus	++	++	*A. dahurica*	++	-
I. verum	+++	+++	*L. officinale*	++	++
M. officinalis	++	-	*N. chinensis*	++	++
E. aromatica	++	++	*K. galanga*	++	++

[a] Plants showing antignawing activity are presented.

Aucklandia lappa (Compositae), barks of *Cinnamomum cassia* (Lauraceae), fruits of *Illicium verum* (Magnoliaeceae), fruits of *Piper nigrum* (Piperaceae), rhizomes of *Rheum officinale* (Polygonaceae), and leaves of *Pinus densiflora* (Pinaceae). Extracts from wood of *Sabina chinensis* (Juniperaceae), wood of *Cinnamomum camphora* (Lauraceae), roots of *Eugenia aromatica* (Myrtaceae), root barks of *Paeonia suffruticosa* (Ranunculaceae), fruits of *Evodia rutaecarpa* (Rutaceae), rhizomes of *Ligusticum officinale* (Umbelliferae), rhizomes of *Nardostachys chinensis* (Valerianaceae), and rhizomes of *Kaempferia galanga* (Zingiberaceae) showed moderate antignawing activities. Weak or no antignawing activities were produced from the other 40 plant samples. Jacobson[20] already pointed out that the most promising botanicals as sources of novel plant-based pesticides for use at the present (1989) and in the future are species of the families, Meliaceae, Rutaceae, Asteraceae, Annonaceae, Labiatae, and Canellaceae.

Rodent control is most commonly dependent upon repeated application of rodenticides. However, these comp onds have attendant problems.[7,11] Additionally, rodents exhibit shyness behavior after exposure to toxic chemicals and the shyness among rodents persists for 35 to 150 days.[21] These adverse effects and shyness to poisons call for alternative control agents such as repellents rather than attempts to kill the rodents.

Various compounds including alkaloids, phenolics, and terpenoids exist in plants and jointly or independently contribute to repellent activities.[9,22,23] They have no secondary hazards to animals, act in many ways on various rodent species, and may be applied to the cables, structures or agricultural products in the same way as other agricultural chemicals. In our study, extracts from *A. lappa, C. cassia, I. verum, P. nigrum, R. officinale,* and *P. densiflora* showing strong antignawing activities against mice confirm their superiority and usefulness as potent rodent control agents. These plant species might form a new source for managing rodents. Plant-derived repellent properties towards rodents were also reported in *Thujopsis dolabrata* var. *hondai*[19] and *A. absinthium.*[22]

In conclusion, some plant extracts described might be useful for developing new types of rodent repellents, or biorational management agents for controlling rodent populations.

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식물체 추출물의 생쥐에 대한 갉기억제활성

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초 록 : 32과 54종 식물체 메탄올 조추출물의 생쥐에 대한 갉기억제활성을 전선침지법으로 조사한 결과, 활성은 식물종에 따라 달리 나타났다. 국화과의 목향(*Aucklandia lappa*) 뿌리, 녹나무과의 계피(*Cinnamomum cassia*) 수피, 목련과의대회향 (*Illicium verum*) 과육, 후추과의 후추(*Piper nigrum*) 과육, 마디풀과의 대황(*Rheum officinale*) 근경 및 소나무과의 적송(*Pinus densiflora*) 잎의 메탄올 추출물이 강한 갉기억제활성을 나타내어, 천연물 유래의 설치류 기피제로서 이들 식물체 유래 물질들은 설치류에 의한 피해 예방제로서 유용할 것으로 기대되었다.

찾는말 : 설치류, 생쥐, 전선침지법, 갉기억제활성, 기피제, 식물
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