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## Introduction

The use of plant parts or extracts, which can be used as rodenticides or as rodent repellents, is one of the main components of Ecologically-based rodent management (EBRM), which strives to control food losses in agriculture while reducing the application of controversial synthetic (chemical) rodenticides. The use of endemic plant species has additional value since EBRM substances can be sustainably produced locally, nevertheless, use of such measures is not widespread due to limited knowledge. Here we review plant species, endemic to Greece, the successful use of which as rodenticides or as rodent repellents been documented in the literature.

## Results

9 plant species were found to present EBRM significance of which 3 are rodenticides and 6 rodent repellents. Among rodenticides, *Urginea maritima* (Red Squill) contains the toxic agent scilliroside and has rodenticidal properties either in the form of the bulb extract or using it as a dried powder (Verbiscar et al., 1986). Also, *Nerium oleander* contains substances toxic agents oleandrin and nerine, which are cardiac glycosides (Akhtar et al., 2014). The consumption of leaves damaged heavily the liver and kidneys of the rats (Al-Yahya et al., 2000), while the extract from the leaves has adverse effects on significant hematological and histopathological parameters (Akhtar et al., 2014b). Finally, *Calendula aegyptiaca* flower extracts with ethanol, contain amounts of cardiac glycoside, flavonoides, saponins, tannins and triterpens, which have intense lethal properties to rats (Abou-Hashem, 2012). Among rodent repellents, the essential oils extracted from *Citrus bergamia* (bergamot), contain components such as limonene, linalol, and linalyl acetate, which have a repellent effect on rodents either using them alone or in combination with essential oils of *Thymus vulgaris* and *Lavandula angustifolia* (Jokić et al., 2017a). Furthermore, the essential oils extracted from *Pinus pinaster* resin (abietic acid), *Foeniculum vulgare*, and *Citrus bergamia* essential oils, prevent rodents from approaching the sprayed zones by promoting a repellent effect (Hansen et al., 2015), as well as the fermented juice of *Trifolium alexandrinum* sprayed on food and raw materials that we wish to protect (Kandil et al., 2021).

## Conclusions & Outlook

The results of this study highlight potential tools to be included in EBRM applications and will be used to further specify required active ingredient concentrations in greenhouse crop protection against rodents. Subsequent experiments are required to test promising Mediterranean plants under semi-natural and field conditions and optimally with further target rodents.



Figure 1. Overview of components Rodent Green Management.

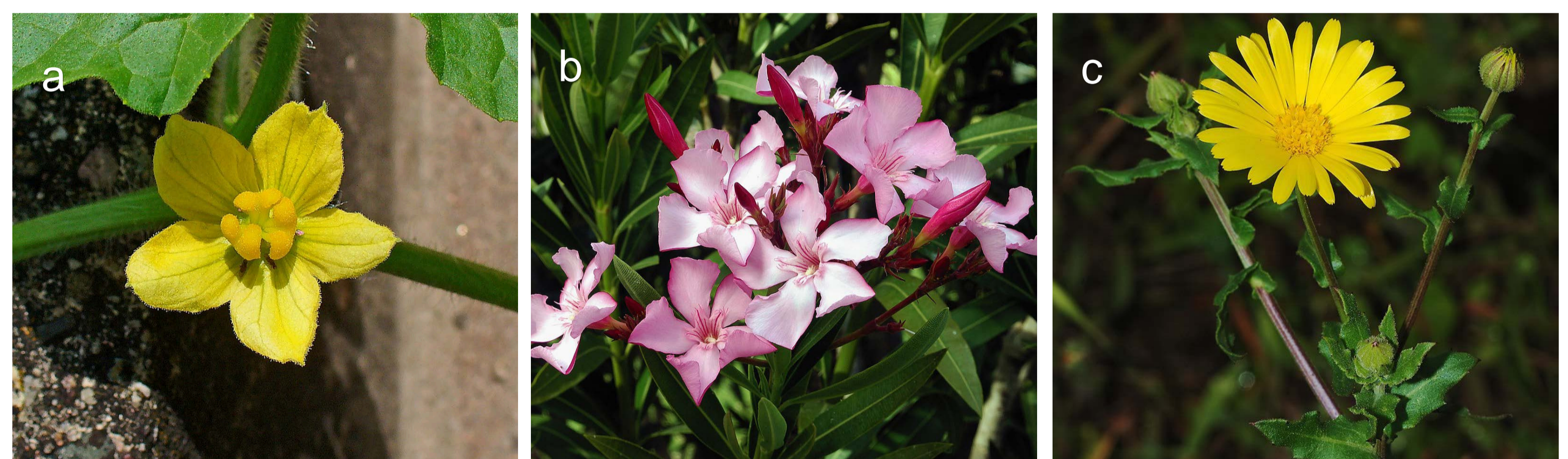


Figure 2. Parts and extracts of (a) *Citrullus colocynthis*, (b) *Nerium oleander*, and (c) *Calendula aegyptiaca* can be used as rodenticides.

Table 1. Species, part and method of extraction, and concentration in delivery method of potential rodenticides.

Species	Part and method	Concentration
<i>C. colocynthis</i>	Dried fruit powder extract	10% (w/w) in feed
<i>N. oleander</i>	Dried leaves powder extract	10% (w/w) in feed
<i>C. aegyptiaca</i>	Dried flower extract	10 ml/kg in feed

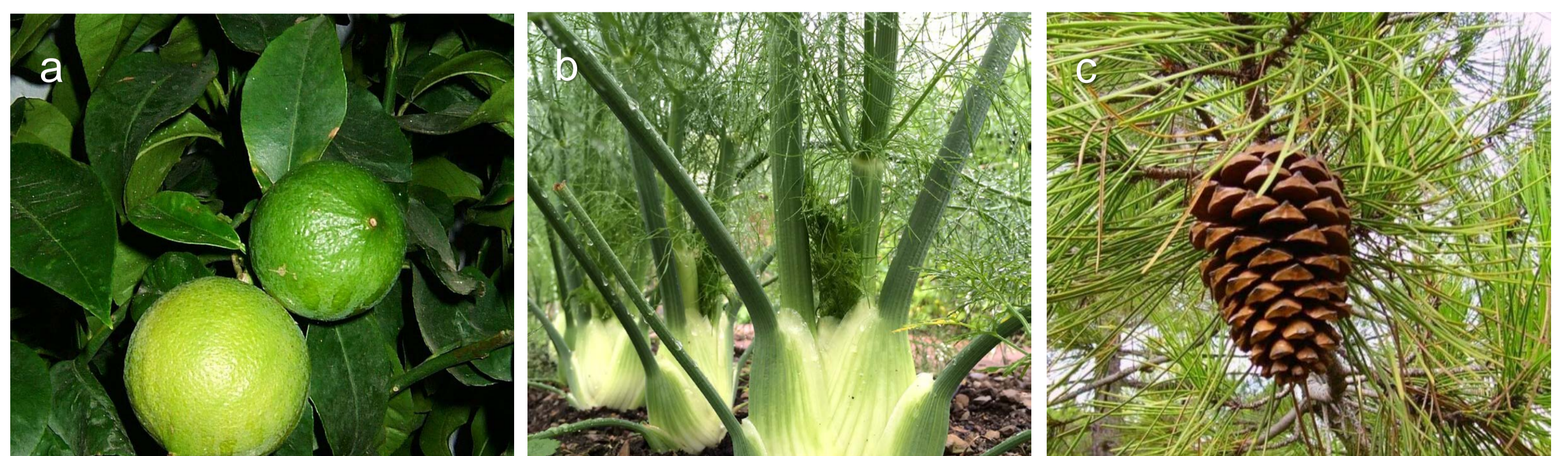


Figure 3. Parts and extracts of (a) *Citrus bergamia*, (b) *Piper nigrum*, and (c) *Pinus pinaster* can be used as rodent repellents.

Table 2. Species, part and method of extraction, and concentration in delivery method of potential as rodent repellents.

Species	Part and method	Concentration
<i>C. bergamia</i>	Essential oil in solvent	5/25 in ethanol
<i>F. vulgare</i>	Extract oil in solvent	4/10 in ethanol
<i>P. pinaster</i>	Abietic acid from resin in solvent	5% in chloroform