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Black Currant (*Ribes nigrum*) as a Living Volatile Organic Compound-Mediated Deterrent against Wild Boar (*Sus scrofa*): A Novel Hypothesis, Mechanistic Rationale, and Proposed Research Programme

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Abstract

Wild boar cause severe agricultural and ecological damage across Europe and beyond, yet effective non-lethal deterrent strategies remain elusive. Scent-based repellent trials have consistently failed, a result attributed to rapid habituation and chemical degradation of applied preparations—a conclusion valid for extracts but never tested against living aromatic plants. This paper aims to identify a foundational methodological gap in the botanical deterrence literature and advance the first formal hypothesis that a living, constitutively aromatic perennial shrub can function as a self-sustaining olfactory deterrent against *Sus scrofa*. Through a systematic literature review conducted in May 2026 across Google Scholar, Web of Science, and CAB Abstracts, no published study was identified in which a living, metabolically active plant was used as the experimental deterrent source. All existing trials used processed, extracted, or non-living material. Drawing on published VOC chemistry, field-documented mammalian avoidance data, and recent molecular evidence that plant VOCs activate TRPA1—a conserved mammalian aversion ion channel confirmed in *Sus scrofa*—a mechanistic rationale and structured five-study experimental programme are presented. This paper represents the first formal scientific proposal that living aromatic plants constitute an untested and potentially highly effective class of mammalian deterrent, and the first hypothesis linking *Ribes nigrum* specifically to *Sus scrofa* deterrence via the TRPA1 mechanism.

Keywords

Olfactory Deterrence, Living Plant Defence, TRPA1, Herbivore Repellent, Herbivore-Induced Plant Volatiles, HIPV, Plant Chemical Ecology, Pest Management

1. Introduction

Wild boar (*Sus scrofa* Linnaeus, 1758) represents one of the most ecologically and economically damaging large terrestrial mammals on Earth. Native to Europe and Asia, *Sus scrofa* has been introduced—through deliberate release, escape from captivity, and illegal translocation—to North America, Australia, and numerous island ecosystems, where it causes severe damage to agriculture, native plant communities, wetlands, ground-nesting bird populations, and native vertebrate fauna. In Europe, where the species is native, populations have expanded dramatically since the 1980s as a consequence of reduced hunting pressure, agricultural intensification providing high-energy food resources, and a series of mild winters. This expansion has progressively brought *Sus scrofa* into conflict with peri-urban gardens, smallholdings, and commercial farmland across northern and central Europe, including Sweden, where the population is currently estimated at over 300,000 individuals and continues to expand northward.

A variety of non-lethal deterrent strategies have been evaluated against *Sus scrofa*, including electric fencing, acoustic devices, light deterrents, and—of particular relevance to the present proposal—olfactory and gustatory repellents. Interest in scent-based approaches is motivated in part by the species' exceptionally developed olfactory system: *Sus scrofa* has been reported to detect human scent at distances exceeding 500 metres, and olfaction is its primary means of locating food, detecting predators, and navigating its environment. This acute chemosensory capacity could, in principle, be exploited by a sufficiently potent and persistent olfactory deterrent.

In practice, published trials of botanical olfactory preparations have returned largely negative results. Plant VOCs have been shown to activate TRPA1, a conserved mammalian aversion ion channel [1], establishing a plausible neurological basis for olfactory deterrence—yet no trial has exploited this mechanism using a living plant source [2] [3]. The most rigorous evaluations—Schlageter and Haag-Wackernagel (2012) [2] [3]—found no significant damage reduction and no measurable area avoidance using both commercial odour preparations and gustatory repellents. A broader review by Massei *et al.* (2021) [4] concluded that commercially available olfactory and gustatory repellents have proven ineffective in European field conditions. These results have shaped a prevailing consensus against the viability of botanical scent-based deterrence. A broader review of mammalian herbivore repellent mechanisms by Kimball and Taylor (2010) [5] identifies four modes of action—neophobia, irritation, conditioned aversion, and flavour modification—and notes that only preparations delivering genuine physiological consequences sustain long-term avoidance. A living plant delivering continuous, constitutive, and HIPV-upregulated VOC emission may satisfy this criterion in ways that extracted preparations cannot.

Here, we identify a critical and previously unremarked gap that fundamentally limits the conclusions this literature can support: every trial to date has used a processed, extracted, or non-living botanical material as the olfactory source. No study has tested whether a living, growing, metabolically active aromatic plant—continuously biosynthesising and emitting its full VOC complement from all plant parts, with output that intensifies over successive growing seasons—can deter *Sus scrofa*. We propose that *Ribes nigrum* L. (black currant) represents an ideal and compelling first candidate for such a study, and present the rationale, mechanistic framework, and experimental programme to test this hypothesis.

2. Background

2.1. The Published Repellent Literature and Its Limitations

The most frequently cited evaluations of olfactory repellents against *Sus scrofa* in Europe share a common experimental design: a commercially available or homemade preparation is applied to field boundaries or directly to crop surfaces, and subsequent boar activity or damage is monitored relative to untreated controls. Schlageter and Haag-Wackernagel (2012) [2] tested the commercial preparation Wildschwein-Stopp®—an industrially processed olfactory deterrent—and found no significant reduction in field damage and no detectable area avoidance. The same authors (2012) [3] evaluated a gustatory repellent applied to clover, meadow, and wheat plots with equivalent negative results. Broader reviews of the literature [4] have reached similarly discouraging conclusions, noting additionally that even transiently effective preparations are typically rendered ineffective within two to three days as animals habituate or as rainfall and UV exposure degrade the active compounds.

A notable and underappreciated outlier is the finding reported by Rao *et al.* (2019), cited in Mohamedfarook *et al.* (2025) [6], that a mixture of castor oil, ginger, and garlic achieved up to 95% deterrence efficacy against wild boar in crop field trials. This result directly contradicts the prevailing consensus and warrants attention: the three components of the effective mixture—castor oil, ginger, and garlic—all share a common characteristic of chemically rich, complex VOC profiles dominated by terpenes and sulfur-containing or phenylpropanoid volatiles. This is precisely the chemical character of *Ribes nigrum*. Critically, this study also used pressed or extracted botanical preparations—not living plants.

The universal use of non-living botanical sources in deterrence trials is never acknowledged, justified, or controlled for in the literature. It is treated as an unremarkable methodological default. We argue it is neither unremarkable nor methodologically neutral, and that it may be the principal reason the field has underestimated the deterrent potential of aromatic plants.

2.2. The TRPA1 Mechanism: Molecular Support for Plant VOC Deterrence

A landmark study published in *Communications Biology* (Cai *et al*., 2025) [1] provided the first molecular-level characterisation of how plant VOCs produce mammalian herbivore aversion. Studying the order *Piperales*—particularly *Houttuynia cordata Thunb.* (fish mint), a constitutively and intensely aromatic perennial herb—the authors demonstrated that plant VOCs activate TRPA1 (transient receptor potential ankyrin 1), a sensory ion channel in mammalian trigeminal and dorsal root ganglia responsible for detecting noxious chemical stimuli and mediating avoidance behaviour. TRPA1 activation was confirmed in mice, cattle (*Bos taurus*), and goats (*Capra hircus*) through *in vitro* electrophysiology and *in vivo* behavioural assays. Critically, avoidance was absent in TRPA1-knockout mice, confirming channel specificity. The primary active compound, houttuynin, was shown to activate TRPA1 by binding conserved cysteine residues—residues identified as present and functionally conserved across herbivorous mammal species, indicating that the plant exploits an evolutionarily conserved olfactory vulnerability shared throughout the mammalian herbivore class.

TRPA1 is present and well-characterised in *Sus scrofa*; porcine TRPA1 has been studied extensively in the context of nociception and chemosensory biology. These findings [1] therefore provide a specific, testable, and mechanistically grounded basis for predicting that VOC-rich aromatic plants—including *Ribes nigrum*—may activate TRPA1 in wild boar and thereby produce olfactory aversion. Notably, this study used extracted and isolated compounds rather than the living plant, leaving the *in situ* deterrent potential of VOC-producing organisms in field conditions entirely untested. The olfactory misinformation framework of Finnerty *et al.* (2024) [7] further demonstrates that plant VOC profiles can provide mammalian browsing refuge at field scale using artificial VOC preparations—strengthening the case that living plants emitting these profiles directly may be even more effective. Similarly, VOC studies using *H. cordata* against insect pests (Zeng *et al*., 2025) [8] have employed extracted rather than living material, leaving the living-organism question open.

2.3. Literature Search Methodology

A systematic search of the peer-reviewed literature was conducted in May 2026 using Google Scholar, Web of Science, and CAB Abstracts. Search terms used included: "*Ribes*" + "deterrent" + "mammal"; "living plant" + "olfactory" + "deterrent"; "volatile organic compound" + "barrier" + "mammal"; "black currant" + "pest deterrent"; "botanical repellent" + "wild boar"; and "*Sus scrofa*" + "olfactory". No published study was identified in which a living, metabolically active aromatic plant was used as the experimental VOC source in a controlled herbivore deterrence trial. All identified studies used processed, extracted, or otherwise non-living plant material. The recent work of Finnerty *et al.* (2024) [7]—demonstrating that artificial VOC extracts of unpalatable plant species provide associational browsing refuge to palatable plants from mammalian herbivores—represents the closest the literature has come to testing plant VOC-mediated deterrence at field scale, yet even this study used artificial odour preparations rather than the living plant organism itself.

3. The Hypothesis

As shown in Table 1, we advance the following primary hypothesis: Living *Ribes nigrum* plants deter *Sus scrofa* through the continuous, constitutive, and herbivore-inducible emission of a complex volatile organic compound (VOC) profile from all plant parts—leaves, stems, buds, and berries—throughout the growing season. This deterrence operates via TRPA1-mediated olfactory aversion and/or conditioned avoidance learning, and increases in intensity as the plant matures and total VOC-emitting biomass expands over successive growing seasons.

Three testable subsidiary predictions follow:

Table 1. Summary of the three testable subsidiary predictions of the living *Ribes nigrum* deterrence hypothesis.

Prediction	Summary	Key Measurement
P1 (Behavioural)	Living *Ribes nigrum* reduces rooting activity, proximity time, and crop damage vs. controls.	Boar activity rates; damage survey scores; camera-trap proximity data
P2 (Temporal)	Deterrent effect intensifies over successive growing seasons as plant biomass and VOC output expand.	Year-on-year boar avoidance vs. plant age and leaf area index
P3 (Living vs. *R. nigrum* extract)	Living *R. nigrum* deters more effectively than its equivalent solvent extraction applied to an inert substrate.	Behavioural comparison: living plant/extract/untreated control

4. Rationale: Why *Ribes nigrum*

4.1. Volatile Chemistry

Ribes nigrum is distinguished among cultivated fruiting shrubs by the intensity, persistence, and whole-plant distribution of its aromatic emissions. The characteristic pungent, resinous scent is generated by a rich blend of volatile organic compounds biosynthesised in glandular trichomes distributed across the leaf lamina, petioles, young stems, and buds. GC-MS analysis of *R. nigrum* bud essential oil has identified 19 monoterpenes, 20 sesquiterpenes, 12 carbonyl compounds, 11 esters, and 34 alcohols [9]. The principal compound classes include monoterpenes (sabinene, terpinolene, β-myrcene, γ-terpinene), sesquiterpenes, sulfur-containing volatiles including thiols and polysulfides, and phenylpropanoid-derived compounds. These emissions are constitutive—produced continuously without the need for damage or disturbance. Headspace analyses of intact leaves and berries confirm that monoterpene hydrocarbons and oxygenated monoterpenes are the dominant volatile classes in constitutive emissions [10]. A mature *Ribes nigrum* hedge functions as a perimeter of uninterrupted chemical signal, not an isolated point source.

4.2. Documented Mammalian Aversion in Field Conditions

Multiple independent horticultural sources consistently classify *Ribes nigrum* as deer-resistant in field conditions. Reich (2015) [11] notes that black currant is exceptional among garden fruiting plants in being reliably avoided by deer, and additionally observes that domestic poultry and wild bird species rarely consume the berries—a pattern of broad-spectrum avoidance inconsistent with simple palatability preference and more consistent with olfactory deterrence. Hilty's Illinois Wildflowers database [12] notes that the closely related wild black currant (*R. americanum* Michx.) lacks the physical spines that protect many other *Ribes* species from large herbivores, suggesting that chemical deterrence, not mechanical defence, is the mechanism responsible for the genus's herbivore resistance.

While deer (*Cervidae*) and wild boar (*Suidae*) differ in feeding strategy—deer are primarily browsers, boar are primarily rooters and ground-foragers—both are large-bodied mammals with acute olfactory systems operating in shared habitat. The consistent field-documented avoidance of living *Ribes nigrum* by deer is the most directly relevant observational evidence available that the plant's VOC profile is aversive to large mammalian herbivores under naturalistic conditions.

4.3. The Self-Amplifying Deterrent Mechanism

Displayed in **Figure 1** below, a central feature distinguishing the *Ribes nigrum* deterrence hypothesis from all previously tested approaches is the temporal trajectory of the proposed deterrent source. Applied repellent preparations degrade continuously from the moment of application, losing chemical potency through volatilisation, UV photodegradation, rainfall dissolution, and microbial breakdown. By contrast, a living perennial *Ribes nigrum* shrub increases its VOC-emitting surface area—and therefore its total VOC output—with every growing season. A three-year specimen has substantially more leaf area and budding tissue than a first-year cutting; a mature five- to ten-year hedge substantially more still. The deterrent barrier, if effective, thus intensifies rather than degrades over time. This represents a deterrent architecture with no precedent in the published repellent literature.

4.4. Herbivore-Induced VOC Upregulation

Living aromatic plants under herbivore pressure upregulate VOC emission through the HIPV response, mediated by jasmonic acid (JA) and related wound-signalling cascades [13]-[15]. This inducible response produces VOC blends often qualitatively distinct from constitutive emissions and specifically shaped by evolutionary pressure to repel further herbivory. The HIPV capacity of *Ribes nigrum* has not been formally characterised, but the genus is a member of the order *Saxifragales* and possesses the glandular trichome architecture associated with robust induced volatile responses. Should *Sus scrofa* investigate or partially disturb a *Ribes nigrum* plant, the plant's induced response may amplify rather than attenuate the deterrent signal—an adaptive feedback loop entirely absent from any preparation-based deterrent.

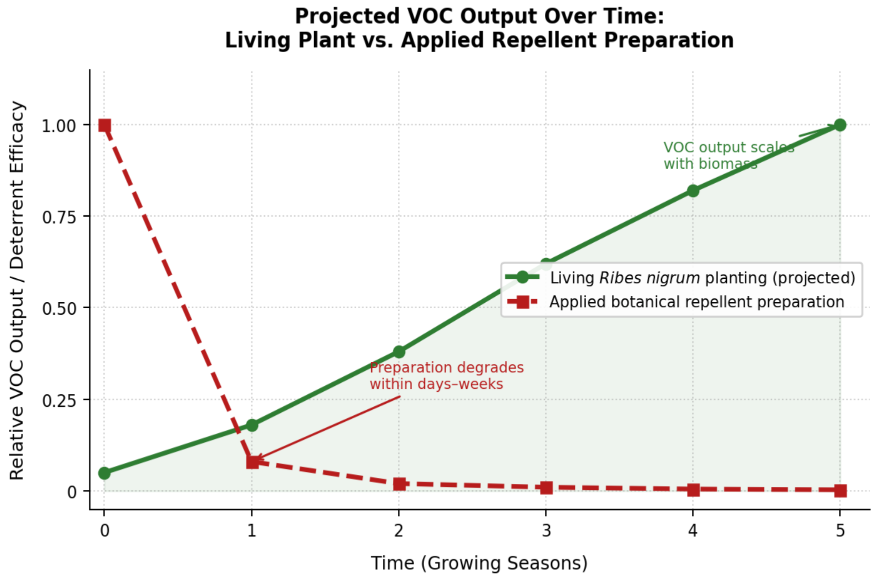

Figure 1. Projected relative VOC output over five growing seasons for a living *Ribes nigrum* planting compared with a single application of an extracted botanical repellent preparation. Living plant output scales with above-ground biomass accumulation over successive growing seasons; extracted preparation output declines from the moment of application due to volatilisation, UV photodegradation, and rainfall dissolution. Values are projected/conceptual and based on documented biomass-scaling of plant VOC emission and published repellent degradation timelines.

4.5. Geographic and Practical Accessibility

Ribes nigrum is native to and widely cultivated across northern and central Europe—precisely the geographic range in which *Sus scrofa* populations are currently expanding most rapidly [16] and causing the greatest agricultural damage. The plant is frost-hardy to approximately −30˚C, making it suitable for cultivation throughout Sweden and the broader Scandinavian range. Established specimens already exist in gardens, allotments, and smallholdings throughout the boar's expanding range, making the hypothesis directly testable through retrospective camera-trap and damage survey studies without the need for purpose-established experimental plots.

5. The Research Gap

As of May 2026, no published peer-reviewed study has examined any living aromatic plant as a deterrent against *Sus scrofa*—or, to the author's knowledge, against any large herbivorous mammal in a controlled field or enclosure setting. The entirety of the botanical repellent literature for wild boar is constructed on applied preparations: commercially produced sprays, fermented or pressed botanical mixtures, extracted oils, and synthesised isolated compounds. This methodological uniformity has never been remarked upon, acknowledged as a limitation, or presented as a research gap in any review known to the author.

The gap is compounded in the specific case of *Ribes nigrum* by three converging factors. First, the plant's consistent field-documented avoidance by deer and other large mammals—a pattern reported independently across multiple horticultural traditions and geographic contexts—has generated no formal scientific inquiry. Second, its widespread cultivation throughout the zone of boar expansion in Europe makes it both ecologically relevant and experimentally accessible at negligible cost. Third, the 2025 TRPA1 finding [1] provides, for the first time, a specific and testable molecular mechanism through which its constitutive VOC profile could produce the observed mammalian aversion. The olfactory misinformation work of Finnerty *et al.* (2024) [7] further validates the concept that plant VOC profiles can provide functionally meaningful browsing protection to mammals at field scale.

An entire living organism—constitutively aromatic from all plant parts, documented to repel large mammalian herbivores in field conditions, continuously and increasingly productive in its deterrent chemistry, and now mechanistically grounded in the TRPA1 ion channel literature—has been entirely overlooked by the science most urgently concerned with non-lethal wild boar management.

6. Proposed Research Programme

As summarized in **Table 2**, the following five-study programme is proposed to test the hypothesis and its subsidiary predictions in a progressive sequence from observational field evidence to mechanistic characterization.

Table 2. Summary of the proposed five-study research programme: design, prediction tested, and primary resource requirements.

Study	Design	Prediction Tested	Key Resource
1—Field survey	Camera traps and damage surveys at existing *R. nigrum* plantings vs. matched controls; two growing seasons minimum.	P1 (behavioural deterrence)	Camera traps; landowner permissions
2—Enclosure trial	Captive *Sus scrofa*; living *R. nigrum* vs. scent-neutral shrub; three plant age classes (1-, 3-, 5-year).	P1, P2 (temporal intensification)	Captive *Sus scrofa* facility
3—Living vs. extract	Captive *Sus scrofa*; living plant/*R. nigrum* extract/untreated control; three-way comparison.	P3 (living vs. extracted)	Captive facility; solvent extraction
4—VOC profiling + TRPA1	GC-MS headspace (live, extract, induced); porcine TRPA1 *in vitro* screening of *R. nigrum* VOC fractions.	P3 (mechanism)	GC-MS; TRPA1 expression system
5—Longitudinal VOC	Annual SPME headspace sampling + biomass measurements across ≥3 seasons; *R. nigrum* cohort.	P2 (biomass scaling)	SPME; established plants

7. Conclusions

Ribes nigrum represents a compelling and entirely overlooked candidate for non-lethal *Sus scrofa* deterrence, combining a constitutive whole-plant VOC profile, independently documented mammalian avoidance in field conditions, and a self-amplifying deterrent output that increases rather than degrades over successive growing seasons.

The TRPA1 ion channel mechanism, now confirmed in large herbivorous mammals, provides the first molecularly grounded basis for predicting that its aromatic emissions may produce olfactory aversion in wild boar—a prediction that remains entirely untested.

The prevailing consensus that botanical scent deterrents are ineffective applies to extracted preparations only; no published study could be found to have evaluated a living aromatic plant as a deterrent source, and this methodological gap has silently constrained the field's conclusions.

The five-study research programme proposed here is designed to test this overlooked category of deterrent directly and may substantially revise current understanding of both wild boar management and the broader deterrent potential of the plant kingdom.

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Author Contributions

C.D.: Conceptualisation, hypothesis formulation, literature review, manuscript preparation.

Data Availability

No experimental data were generated or analysed in this study. This manuscript constitutes a hypothesis paper and research proposal.

Ethics Statement

No animal or human subjects research was conducted in preparation of this manuscript. Proposed Study 2 and Study 3 would require institutional animal ethics approval prior to commencement.

AI Use Disclosure

During the preparation of this work, the author used Claude/Sonnet 4.6 in order to format the research into an acceptable version for publication/peer-review. The author also used Google Scholar in order to locate existing literature relevant to the manuscript. After using these tools/services, the author reviewed and edited the content as needed and took full responsibility for the content of the publication.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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