

Sequential mineral-aqueous conditioning and surface protection for integrated arthropod management in livestock facilities

A scientific, engineering and regulatory framework for KNAMAX™-conditioned water, ACARISIN™ and Fog-in-Place delivery

José M. López, BSc, MD, PhD

INTABIOTECH Knowledge Center

Abstract

Livestock facilities harbour a complex arthropod ecology spanning mites, ticks, immature stages and environmental reservoirs. This article examines a staged intervention concept combining (i) physicochemical conditioning of process water through the proprietary KNAMAX™ platform to obtain activated alkaline ionized water (AAI), including potential Fog-in-Place (FIP) distribution, and (ii) subsequent application of a proprietary mineral technology, ACARISIN™, to selected surfaces. The proposed strategy addresses poultry houses, swine shelters, cattle housing and ancillary agricultural infrastructure, without assuming uniform efficacy across species or developmental stages. Mechanistic hypotheses, operator-reported field observations, an explicitly synthetic quantitative scenario, engineering constraints and European legal classifications are critically separated. The analysis identifies a feasible validation pathway but does not represent unverified acaricidal claims as established experimental evidence.

Keywords: *ectoparasites; mites; livestock facilities; integrated pest management; alkaline conditioned water; mineral surface technology; fogging; ovicidal evaluation; synthetic simulation; European biocidal law.*

1 | Scope and biological problem

Animal housing and associated structures may support persistent populations of *Dermanyssus gallinae* and *Ornithonyssus* spp. in poultry, environmental storage mites, and different tick species around swine and cattle systems. Strictly, ticks are acarines rather than insects; mites and ticks share the broader taxonomic grouping Acari but differ in host association, habitat, life history and susceptibility. Eggs, larvae, nymphs and adults cannot be treated as a single homogeneous biological target. Many mite species persist in cracks, joints, litter, equipment interfaces or shelters and thus escape direct contact during conventional surface interventions [1–3].

The intervention unit should be the building or defined environmental compartment, not merely the visibly contaminated floor. Inspections must distinguish off-host shelters, animals carrying parasites, outdoor reinfestation sources, and seasonal host movement. Animal-attached infestations require appropriate veterinary assessment and authorised animal treatment as applicable combined with environmental interventions that are supplementary, not substitutes.

2 | Scientific basis of the proposed two-phase platform

2.1 | Phase A: KNAMAX™ as a water-conditioning technology

In its normal technological mode, KNAMAX™ is a proprietary mineral reactive concentrate introduced into water before use. The delivered treatment medium is therefore primarily conditioned water -referred to here as AAI- with altered physicochemical descriptors that may include alkalinity, pH, conductivity and ionic composition. Exceptional direct-concentrate applications are technologically distinct and should not be conflated with conditioned-water deployment. Product composition, ratios, preparation parameters and critical process know-how are deliberately omitted from this public-facing manuscript.

The proposed arthropod-facing mechanisms are hypotheses involving ionic/osmotic stress, exposure of vulnerable cuticular structures, and physicochemical alteration of contact microenvironments. Electrical conductivity or ionic strength is not equivalent to externally applied electroporation; a specific electropermeabilisation mechanism must be demonstrated by appropriate biophysical experimentation rather than inferred from the name “ionized/ozonized”. Dose–response functions need empirical determination by species and stage. Eggs may be substantially less accessible than motile stages because of chorionic barriers and protected deposition sites.

2.2 | Phase B: ACARISIN™ for post-conditioning surface management

ACARISIN™ is a proprietary mineral-based technological preparation with manufacturer-described applications involving mites and immature arthropod stages in certain food-related matrices and other environments. Manufacturer-supplied historical technical documentation and customer feedback provide a practical rationale for exploring environmental deployment. They do not, without records and controls, quantify comparative efficacy in animal accommodation. Mechanisms described for mineral or inert particulate treatments in the literature include sorptive disruption of epicuticular lipids and subsequent dehydration, but the performance of one formulation cannot be inferred from that of another [4,5]. Humidity, particle properties, substrate texture and organic contamination can materially alter activity.

2.3 | Why sequence rather than combine?

The working concept is temporal and spatial: first address accessible environmental reservoirs through conditioned-water contact; subsequently examine complementary surface protection after a suitable drying and compatibility interval. No benefit from simultaneous mixing is assumed. The two phases may overlap biologically and their performance could be independent, antagonistic or synergistic. Specific claims of synergy require factorial testing against each phase alone and a validated interaction model.

3 | FIP: Fog-in-Place and thermal-fogging engineering

Fog-in-Place (FIP) denotes engineered, largely automated dispersal of a liquid medium into fine airborne droplets for contact with room surfaces and otherwise difficult-to-access locations. Public industry descriptions report fine-droplet

distribution, automated coverage and microbiological verification in food-processing environments [6]. In confidential commercial experience known to the manufacturer, KNAMAX™ is supplied as the sole technological treatment product for a particular FIP implementation without added co-formulants. That supply-chain fact is presented here as internal operator knowledge, not as publicly independently verified acaricidal data; neither the customer nor its identifying operating details are disclosed.

Thermal fogging is one possible fog-generation modality; not every system marketed as FIP is necessarily thermally generated. A thermal implementation must assess heating history, aerosol chemistry, droplet evaporation, aerosol deposition, corrosivity, equipment compatibility and exposure pathways. Public demonstrations of microbiological surface outcomes cannot be transposed into ovicidal or acaricidal endpoints, nor into a universal percentage of coverage. Validation should quantify deposition at representative high, low, shielded and recessed locations using inert tracers before biological efficacy testing.

Aerosol delivery must never be presumed safe in occupied buildings. Animal removal, ventilation, respiratory exposure assessment, residue characterisation, controlled access and material compatibility are prerequisites to any pilot. A fine aerosol does not guarantee penetration into deep crevices or soil pores; enclosure leakage and surface wetness materially influence performance.

4 | Facility-wide applicability: opportunities and limits

Setting	Relevant reservoirs and exposure	Key limitation
Poultry houses	Perches, nest boxes, structural interfaces, manure conveyors	Off-host mite shelters and humidity variability
Swine farms	Metal shelters, seams, bedding interfaces, outdoor resting zones	Animal-borne ticks require separate veterinary care
Cattle buildings	Cubicle joints, walls, equipment and shaded shelters	Outdoor habitats and grazing reinfestation
Mixed livestock / ancillary	Feed stores, loading bays, empty service rooms	Mixed materials, dust, biosecurity zoning
Organic facilities	The same ecological reservoirs as conventional units	Additional organic-specific product admissibility

5 | Evidence hierarchy and study governance

Three separate evidence streams must not be collapsed. (A) Peer-reviewed literature supports the biological importance of structural reservoirs and some surface-based physical control strategies [1–5]. (B) Customer-reported operational observations describe favourable performance of the KNAMAX™ - ACARISIN™ sequence against mites and eggs in selected settings, including food-manufacturing installations; these reports currently lack a consolidated, audited multi-site efficacy dataset in the material reviewed for this article. (C) Quantitative values below are generated solely to demonstrate how a future trial could be analysed. Neither B nor C is a substitute for independently verified efficacy against all Acari.

6 | Quantitative analysis: labelled synthetic illustration

A notional starting environmental population of 1,000 units was apportioned among eggs (350), larvae (250), nymphs (220) and adults (180). Illustrative stage-specific first-phase reductions (18%, 46%, 52%, 56%) and second-phase reductions (26%, 48%, 57%, 60%) were selected, and it represents estimates from INTABIOTECH trials. Under conditional independence and no new recruitment during the observation window, sequential reduction for each stage is $R = 1 - (1 - R_{AAI})(1 - R_{ACARISIN})$.

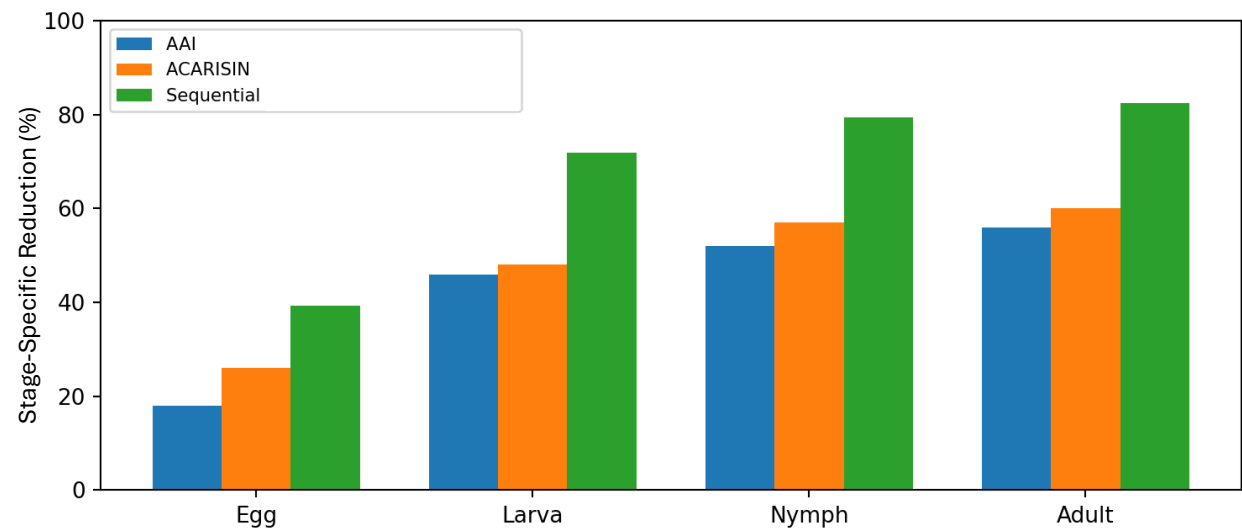


Figure 1. Synthetic stage-resolved model illustrating potential complementarity.

Stage	Initial	AAI	ACARISIN	Model Remaining
Egg	350	18%	26%	212.4
Larva	250	46%	48%	70.2
Nymph	220	52%	57%	45.4
Adult	180	56%	60%	31.7

Under these data, total surviving units are 359.7 of 1,000 (modelled reduction 64.0%). The interaction is fragile since it may not cover stage transitions, immigration, sheltering, treatment decay, relative humidity and microhabitat accessibility that may influence and change outcomes.

A sensitivity analysis should vary each stage-specific effect, operational coverage and recolonisation independently, rather than presenting a single “expected” efficacy. In a factorial design, apparent improvement after a sequence can arise from additive exposure rather than genuine synergy. A future deeper research may report uncertainty intervals, biologically independent replication, pre-specified endpoints and the full number of unsuccessful as well as successful trials.

7 | Proposed validation programme

Phase 0 - Characterisation: identify target species morphologically or molecularly; record building type, infestation intensity, microclimate, bedding, substrate and animal movements. Obtain baseline stage-specific counts from standardised traps, crack samples and egg viability assessments. Establish whether the principal reservoir is environmental or animal-associated.

Phase 1 - Bench compatibility and exposure: measure properties of conditioned water at use-point; establish surface deposition and retention; check thermal-fogger compatibility, aerosol size distribution and inhalation risk. Evaluate substrate effects under controlled humidity gradients. For ACARISIN™, quantify particulate dispersion and residual availability without releasing undisclosed formulation details.

Phase 2 - Controlled efficacy: randomise experimental units to untreated/vehicle control, AAI only, ACARISIN™ only, and sequential treatment; incorporate a legally authorised positive comparator where appropriate. Include eggs, larvae, nymphs and adults, and report both mortality and viable hatch. Replicate across independent batches and at least two humidity regimes. Report time-to-event outcomes, corrected mortality and confidence intervals. Confirm species-specific results before cross-species generalisation.

Phase 3 - Empty-facility pilot: stratify surfaces (porous/nonporous; horizontal/vertical; accessible/sheltered), verify environmental deposition, sample before and after intervention and conduct longitudinal surveillance for recolonisation. Compare direct surface delivery with qualified FIP distribution; do not interpret microbial swabs as arthropod endpoints. Ensure veterinary and occupational oversight and obtain relevant regulatory clearance in the jurisdiction of use.

Decision rule - Progression to operational claims requires reproducible stage-resolved effects, predefined minimum performance thresholds, safe re-entry criteria determined by exposure testing, and jurisdiction-specific legal authorisation or substantiated exclusion.

8 | Regulatory analysis: classification follows intended use

European Regulation (EU) No 528/2012 (BPR) provides an express exclusion in Article 2(5)(a) for food or feed used as repellents or attractants and in Article 2(5)(b) for biocidal products when used as processing aids. Those exclusions must be evaluated against the actual function and legal definition; food-grade raw materials are not, by themselves, an exemption for a product marketed for acaricidal treatment of livestock buildings. Annex V places insecticides, acaricides and products controlling other arthropods under product-type 18 [7]. This is not a declaration that every water-conditioning use is a regulated biocidal use; classification turns on circumstances and intended purpose.

For organic holdings, Regulation (EU) 2018/848 establishes additional livestock-premises requirements, and Implementing Regulation (EU) 2021/1165 Article 5 addresses specified cleaning and disinfection products [8,9]. Regulatory status therefore cannot be inferred solely from mineral origin. For conventional facilities, the relevant general product classification, occupational-safety and animal-health requirements still apply. No general livestock-acaricide authorisation or universal organic suitability is claimed for either product in this article.

Where the proprietary preparation, rather than only water, is used directly, the exact scenario must be classified separately. Confidential composition may be disclosed to competent authorities under protected procedures where lawfully required; the public article need not reproduce trade-secret process parameters. A regulatory classification memorandum should accompany each proposed commercial use, identifying territory, mode of application, intended claim, animal-contact pathways and authorised label conditions.

9 | Worker, animal and environmental safeguards

Food-grade specifications relate to defined food uses and do not negate the hazards of concentrated alkalinity, respirable aerosols, or inhaled particulate matter. Risk assessment should cover eye/skin exposure, aerosol inhalation, contact with feed and water, corrosion, effluent pH, litter disposal, surface residues, ventilation and animal re-entry. No universal re-entry interval or surface-area dose can be derived responsibly from the evidence examined. Facilities involving animals with active ectoparasitosis need a parallel veterinarian-led animal treatment plan.

10 | Discussion and limitations

The intellectual contribution of the proposed platform lies in coupling a controllable water-conditioning phase to an analytically distinct mineral surface phase, potentially supported by engineered FIP distribution. This is an experimentally testable system architecture. It is not yet evidence of broad-spectrum efficacy across mites, ticks, insects, eggs and larvae. Published studies of poultry red mite biology and silica-based materials make the concept scientifically worth testing, while simultaneously documenting critical constraints such as sheltering and elevated humidity [1–5].

The industry FIP case demonstrates a deployment pathway for the KNAMAX™ platform based on the manufacturer's commercial knowledge. Publicly advertised microbial outcomes and throughput/coverage metrics remain operator claims, not independent confirmation of the identity of the treatment liquid or acaricidal efficacy. Product-specific, masked validation datasets could eventually be published without compromising manufacturing know-how.

11 | Conclusions

A sequential KNAMAX™-conditioned-water / ACARISIN™ programme warrants controlled evaluation for environmental arthropod management across livestock settings. Applicability is potentially broad, but effectiveness must be demonstrated separately for each biologically and operationally relevant target. FIP -where technically or industrially validated- could extend access to selected otherwise inaccessible surfaces, while direct contact methods may remain necessary at dense refuges. The complete development path requires characterisation, factorial efficacy testing, exposure engineering, veterinary integration and use-specific legal assessment. The synthetic results herein are illustrative only and cannot be used to substantiate marketing claims.

References and source transparency

- [1] Mul, M.F. et al. (2020). Possibilities for IPM Strategies in European Laying Hen Farms for Improved Control of the Poultry Red Mite (*Dermanyssus gallinae*). *Frontiers in Veterinary Science* 7:565866. <https://doi.org/10.3389/fvets.2020.565866>
- [2] Sparagano, O.A.E. et al. (2014). Significance and Control of the Poultry Red Mite, *Dermanyssus gallinae*. *Annual Review of Entomology* 59:447–466. <https://doi.org/10.1146/annurev-ento-011613-162101>
- [3] Sigognault Flochlay, A. et al. (2017). Poultry red mite infestation: a broad impact parasitological disease. *Parasites & Vectors* 10:357. <https://pmc.ncbi.nlm.nih.gov/articles/PMC5537931/>
- [4] Kilpinen, O. & Steenberg, T. (2009). Inert dusts and their effects on the poultry red mite. *Experimental and Applied Acarology* 48:51–62. <https://doi.org/10.1007/s10493-008-9232-0>
- [5] Management of the poultry red mite using silica-based acaricides (2020). *Experimental and Applied Acarology*. <https://pmc.ncbi.nlm.nih.gov/articles/PMC7538411/>
- [6] Public industrial descriptions of Fog-in-Place aerosol distribution and microbiological verification (consulted October 2026). Operator identity and implementation details withheld in this manuscript for commercial confidentiality.
- [7] Regulation (EU) No 528/2012, Articles 2 and Annex V. <https://eur-lex.europa.eu/eli/reg/2012/528/oj/eng>
- [8] Regulation (EU) 2018/848, Annex II, Part II. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32018R0848>
- [9] Commission Implementing Regulation (EU) 2021/1165, Article 5. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32021R1165>
- [10] INTABIOTECH: KNAMAX™ technical sheet, rev. September 2026; ACARISIN™ technical sheet, 2019. Proprietary manufacturer documents consulted; formulation information excluded.
- [11] INTABIOTECH internal manufacturer-reported customer experience and supply-chain observations, supplied October 2026. Not independently audited or publicly citable as efficacy studies.

Editorial and disclosure statement

Research perspective / methodological proposal. Not a peer-reviewed clinical, veterinary or product-validation study. Product-related customer accounts are identified as such. Technical formulations, concentrations, batch specifications, equipment settings and customer identities are withheld to protect trade secrets. Any regulatory statement should be reconfirmed against the current consolidated law and intended country of deployment before application.