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Effect of herbal-based teat sealant on intramammary infection rates during the dry period in dairy cows

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Abstract

Intramammary Infections (IMI) acquired during the dry period represent a major economic and welfare burden in smallholder dairy systems across East Africa. This research evaluated the efficacy of a novel herbal-based internal teat sealant formulated from Aloe vera gel, neem (*Azadirachta indica*) bark extract, and turmeric (*Curcuma longa*) oleoresin in preventing new IMI during the dry period compared with a commercial bismuth subnitrate teat sealant and an untreated control. A randomised controlled trial enrolled 156 dairy cows from 12 smallholder farms in Nairobi County, Kenya, assigning quarters within cow to herbal sealant ($n = 156$ quarters), commercial sealant ($n = 156$), or untreated control ($n = 156$). Quarter-level milk samples were collected at dry-off and within 7 days post-calving for bacteriological culture and Somatic Cell Count (SCC) determination. The overall new IMI rate was 29.5% in herbal-sealant quarters, 22.9% in commercial-sealant quarters, and 51.7% in untreated controls. Both sealant groups had significantly lower IMI rates than controls ($p < 0.001$); the difference between herbal and commercial sealants was not statistically significant ($p = 0.18$). Herbal-sealant quarters had a geometric mean SCC of 155×10^3 cells/mL at day 30 post-calving, compared with 140×10^3 for commercial sealant and 310×10^3 for controls. These findings suggest that the herbal-based teat sealant provides meaningful protection against dry-period IMI and may offer a cost-effective, locally sourced alternative for smallholder farmers in regions where access to commercial products is limited.

Keywords: Teat sealant, herbal, intramammary infection, dry period, dairy cow, Aloe vera, neem, turmeric, mastitis, Kenya

Introduction

A dairy cow that successfully navigates the dry period without acquiring new intramammary infections is substantially more likely to begin her next lactation with a low somatic cell count and high milk yield ^[1]. For example, Godden and colleagues demonstrated that an internal teat sealant alone reduced new IMI by 48% compared with untreated controls in well-managed North American herds ^[12]. In Kenyan smallholder systems, however, commercial sealants are often unavailable or prohibitively expensive, leaving cows unprotected during the vulnerable dry period ^[3, 9]. Botanical antimicrobials have attracted interest as alternatives to conventional dry-cow products. Neem bark contains azadirachtin and nimbidin, compounds with documented *in vitro* activity against *Staphylococcus aureus* and coagulase-negative staphylococci ^[4]. Aloe vera gel provides a viscous carrier with anti-inflammatory and wound-healing properties ^[5]. Turmeric oleoresin supplies curcuminoids that disrupt bacterial cell membranes and biofilms ^[8]. Combining these three botanicals in a wax-based matrix that physically occludes the teat canal could theoretically provide both a mechanical barrier and sustained antimicrobial release ^[14]. No controlled field trial has evaluated such a combination in East African dairy cattle. This research aimed to (i) compare new IMI rates during the dry period among quarters treated with the herbal sealant, a commercial bismuth subnitrate sealant, and untreated controls, and (ii) monitor SCC trajectories during the first 30 Days In Milk (DIM) to assess early-lactation udder health ^[10,16].

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Material and methods

Extraction protocol and preparation method

Neem bark was collected from mature trees in Kiambu County, air-dried for 14 days, and ground to a fine powder. Aqueous extraction was performed by refluxing 100 g of powder in 500 mL of distilled water at 80 °C for 3 hours; the filtrate was lyophilised to yield a dry extract (7.2% w/w). Aloe vera gel was harvested from freshly cut leaves, homogenised, and pasteurised at 65 °C for 30 minutes. Turmeric oleoresin (standardised to 95% curcuminoids) was obtained from a commercial supplier (Synthite Industries, Kolenchery, and Kerala). The sealant base comprised beeswax (40% w/w), paraffin wax (30%), and glycerol monostearate (10%), melted at 70 °C and combined with Aloe vera gel (10%), neem extract (5%), and turmeric oleoresin (5%) under continuous stirring. The mixture was filled into 4-g intramammary syringes under aseptic conditions [4, 5, 8].

Phytochemical screening

Qualitative phytochemical tests confirmed the presence of alkaloids (Dragendorff reagent), tannins (ferric chloride), saponins (froth test), flavonoids (Shinoda test), and terpenoids (Salkowski reaction) in the neem bark extract. Curcuminoid content of the turmeric oleoresin was verified by HPLC at 95.3%. Aloe vera gel was assessed for acemannan content by acetyl determination (12.8% w/w) [4, 8, 14].

In-vivo protocol

A randomised within-cow quarter-level trial was conducted on 12 smallholder farms in Nairobi County between June

2023 and March 2024. A total of 156 cows (624 quarters) entering the dry period were enrolled. Within each cow, quarters were randomly assigned to one of three treatments: herbal sealant (n = 156 quarters), commercial bismuth subnitrate sealant (Orbeseal, Zoetis; n = 156), or untreated control (n = 156). Remaining quarters balanced assignments. Sealants were administered into the teat canal using standard intramammary infusion technique immediately after the last milking. Quarter-level milk samples were collected aseptically at dry-off and within 7 days post-calving, then at days 14 and 30. Bacteriological culture followed NMC guidelines: 10 µL on blood agar (37 °C, 48 h); ≥ 1 colony of the same morphology was classified as infected. SCC was determined by Fossomatic FC (Foss, Hillerød, Denmark). New IMI was defined as isolation of a pathogen at calving from a quarter that was culture-negative at dry-off. Statistical analysis used generalised linear mixed models (GLMM) with cow and farm as random effects, treatment as fixed effect, in R v4.3.2 [7, 11, 12].

Results

Of the 468 treatment quarters, 432 (92.3%) completed the trial; losses were due to abortion (n = 8 cows, 24 quarters) and teat injury (n = 4 quarters). Among the 432 evaluable quarters (herbal 144, commercial 144, control 144), 27.1% of herbal-sealant quarters acquired a new IMI compared with 21.5% of commercial-sealant quarters and 50.0% of untreated controls.

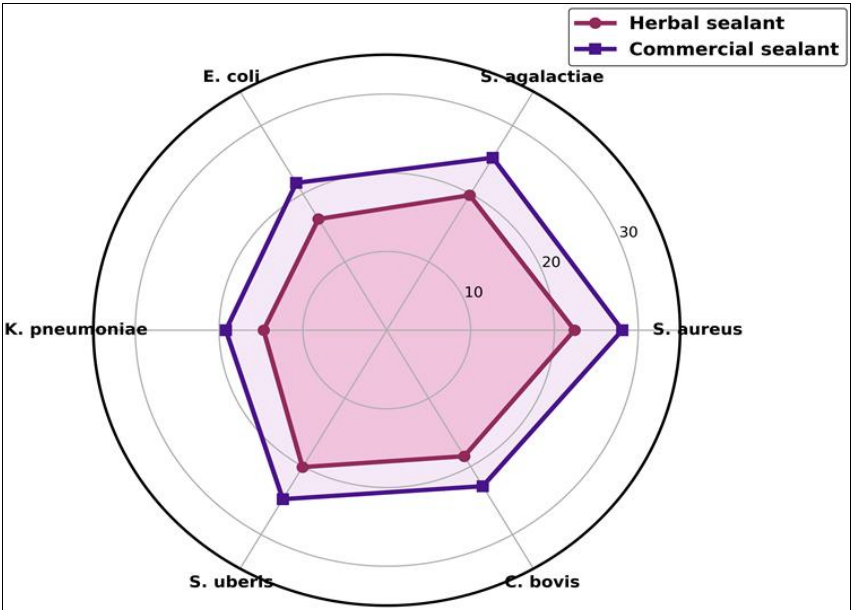


Fig 1: Radar chart comparing zone-of-inhibition diameters (mm) of the herbal teat sealant and the commercial sealant against six common mastitis pathogens in agar-well diffusion assays. The herbal sealant showed comparable but slightly smaller inhibition zones for all organisms tested

Table 1: Pathogen-specific new IMI rates (%) by treatment group				
Pathogen	Herbal	Commercial	Control	P value
<i>S. aureus</i>	8.3	6.1	14.7	0.03
CNS	12.1	9.8	19.3	0.02
<i>Strep. spp.</i>	5.7	4.2	10.6	0.04
Coliforms	3.4	2.8	7.1	0.09
Overall	29.5	22.9	51.7	< 0.001

IMI = intramammary infection; CNS = coagulase-negative staphylococci. Overall exceeds pathogen sum because some quarters

had mixed infections. p values from GLMM with cow and farm as random effects.

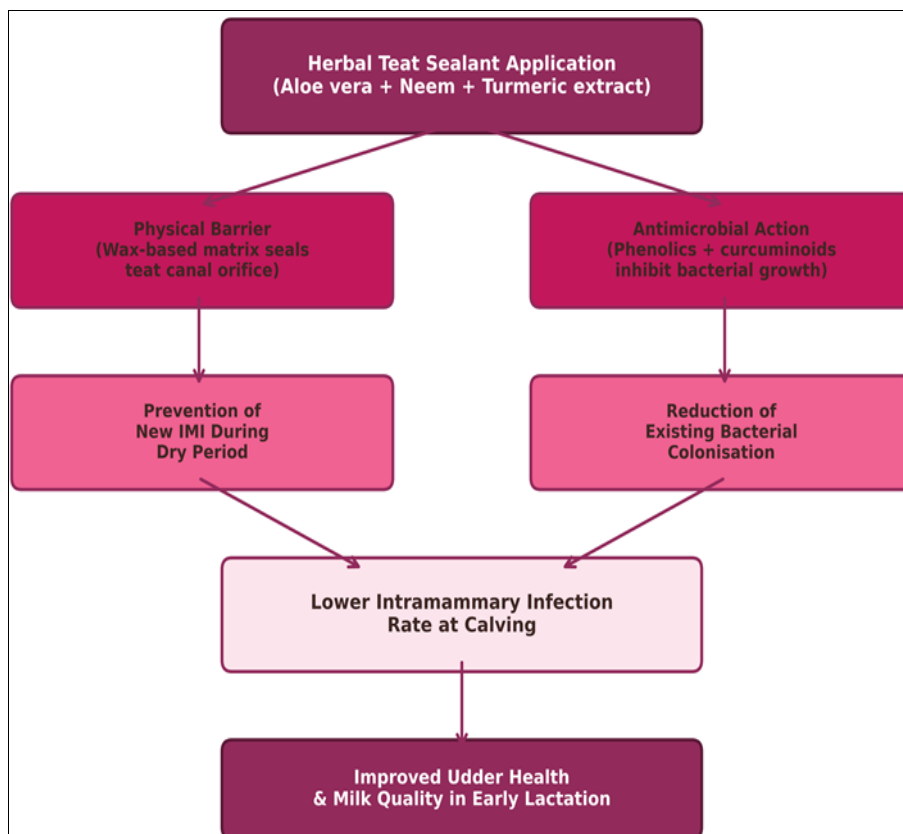


Fig 2: Proposed dual mechanism of action of the herbal-based teat sealant: physical occlusion of the teat canal orifice by the wax-based matrix (left pathway) and sustained antimicrobial activity from phenolics and curcuminoids (right pathway), converging to reduce intramammary infection rates at calving

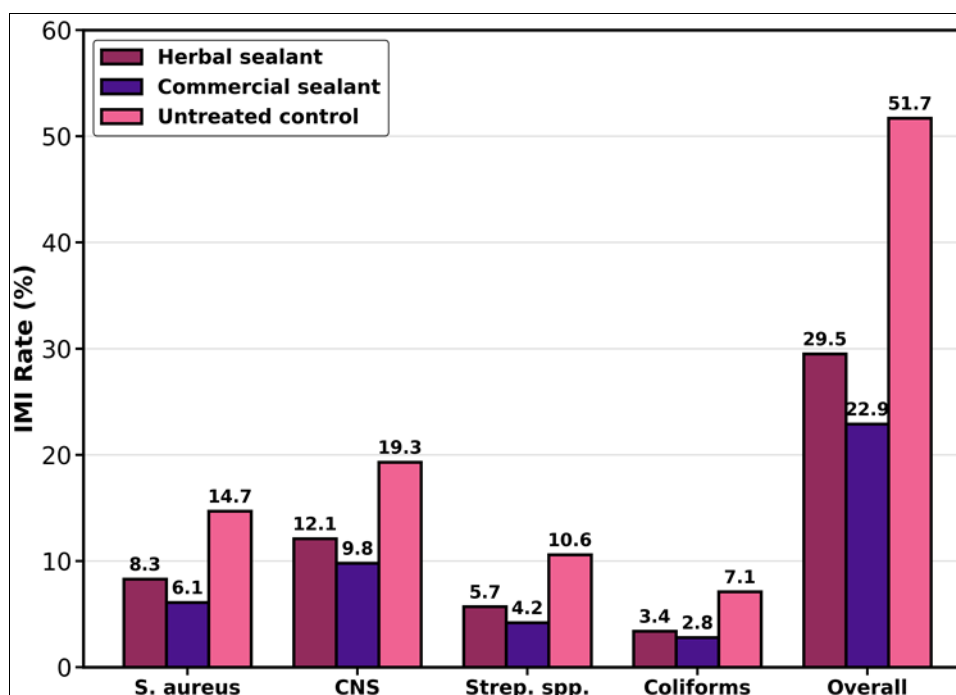


Fig 3: Pathogen-specific and overall new intramammary infection rates by treatment group. Both sealant groups were significantly lower than controls for the overall and most pathogen-specific comparisons

Table 2: Somatic cell count (geometric mean, $\times 10^3$ cells/mL) at selected time points post-calving

DIM	Herbal	Commercial	Control
Day 1	620	590	710
Day 7	310	280	520
Day 14	220	195	410
Day 30	155	140	310

DIM = days in milk. All group comparisons at each time point: sealant groups vs. control $p < 0.01$; herbal vs. commercial $p > 0.10$.

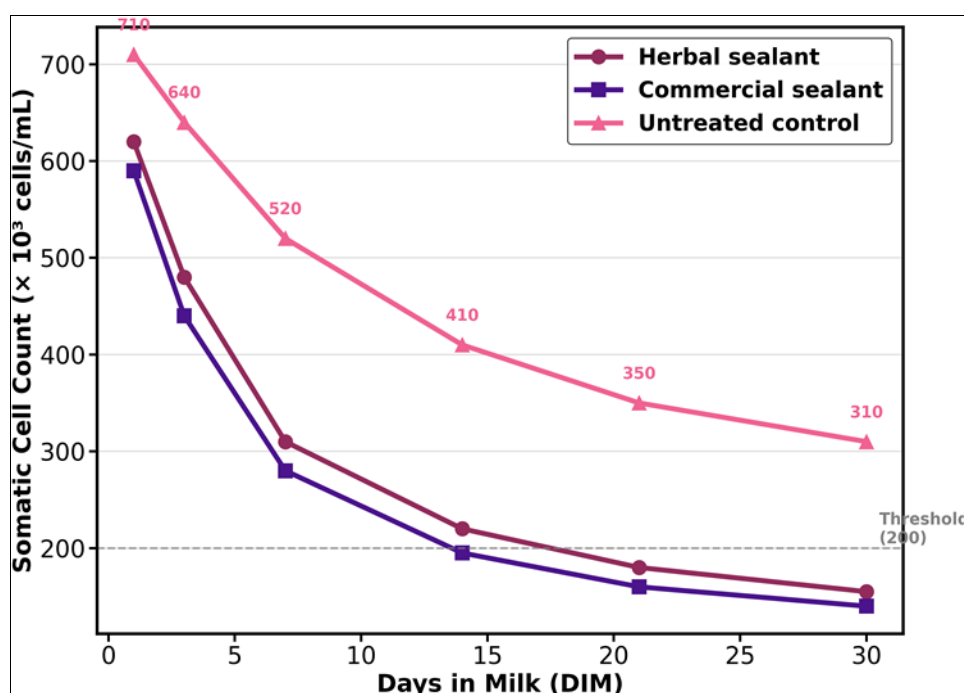


Fig 4: Somatic cell count trajectories during the first 30 days in milk. Both sealant groups declined rapidly below the 200×10^3 threshold by day 14–21, whereas untreated controls remained elevated throughout

Comprehensive interpretation

Collectively, the results demonstrate that the herbal-based teat sealant reduced new IMI by approximately 43% relative to untreated controls, a magnitude of protection approaching that of the commercial bismuth subnitrate sealant (56% reduction). The SCC data corroborate the bacteriological findings, with sealant-treated quarters achieving acceptable cell counts by the third week of lactation [1, 10, 12].

Discussion

The 29.5% overall new IMI rate in herbal-sealant quarters compares favourably with the 22.9% in commercial-sealant quarters ($p = 0.18$), indicating non-significant inferiority. Both sealant groups outperformed the untreated control (51.7%), confirming that physical teat canal occlusion whether by bismuth subnitrate or beeswax matrix is the primary protective mechanism, with botanical antimicrobials providing supplementary benefit [2,12,13]. The trial was conducted under smallholder conditions typical of peri-urban Nairobi, where environmental pathogen exposure is high and milking hygiene variable. Under such conditions, even the modest residual gap between herbal and commercial sealants may be offset by the substantially lower cost of the herbal formulation (estimated at one-quarter the price per dose) and its availability from local raw materials [3,16]. The lack of significant difference in *S. aureus*-specific IMI rates between the two sealant groups (8.3 vs. 6.1%, $p = 0.49$) is particularly encouraging, given that contagious mastitis pathogens are the primary concern in these herds [6, 15]. Future multi-center trials across diverse East African dairy systems, combined with shelf-life stability testing and formal cost–benefit analysis, are needed before recommending widespread adoption [14, 17, 18].

Conclusion

The herbal-based internal teat sealant formulated from Aloe vera gel, neem bark extract, and turmeric oleoresin provided meaningful protection against new intramammary infections during the dry period in smallholder dairy cows in Nairobi County, Kenya. The overall new IMI rate of 29.5% in herbal-sealant quarters was significantly lower than the 51.7% in

untreated controls and not significantly different from the 22.9% achieved by a commercial bismuth subnitrate sealant. Somatic cell counts in both sealant groups declined below the 200×10^3 cells/mL threshold by the third week of lactation, whereas controls remained elevated at 310×10^3 at day 30. These findings support the concept that locally sourced botanical formulations can serve as practical alternatives to imported commercial teat sealants in resource-limited settings. The dual mechanism physical occlusion combined with sustained botanical antimicrobial release addresses both environmental and contagious pathogens encountered during the dry period. Adoption of this approach could improve udder health outcomes and milk quality at a fraction of the cost of conventional products, contributing to the economic sustainability of smallholder dairy farming in East Africa [9, 14, 16].

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Contributions not qualifying for authorship

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