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# The Silent Fungal Threat: *Candida tropicalis* in Domestic Animals and the Blueprint for One Health Preparedness

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### *Abstract*

The global landscape of veterinary mycology is witnessing an unprecedented epidemiological shift from *Candida albicans* toward non-albicans *Candida* (NAC) species. Among these, *Candida tropicalis* has emerged as a formidable, highly virulent opportunistic pathogen affecting a wide range of domestic animals. This comprehensive popular article reviews the clinical manifestations of *C. tropicalis* across livestock, equines, and companion animals, detailing its role in mycotic mastitis, abortions, gastroenteritis, and systemic candidiasis. We dissect the critical virulence factors—such as robust biofilm formation, phenotypic switching, and lytic enzyme secretion—that drive its pathogenesis. Furthermore, we address the alarming rise of azole resistance spurred by the widespread use of agricultural fungicides and indiscriminate veterinary therapeutics. Finally, this article establishes a comprehensive One Health preparedness framework integrating mycological surveillance, antifungal stewardship, biosecurity, and future research directions to safeguard animal health, livestock productivity, and public health ecosystems.

**Keywords:** *Candida tropicalis*, One Health, Mycotic Mastitis, Azole Resistance, Biofilms, Veterinary Stewardship, Antimicrobial Resistance (AMR).

## Introduction: Beyond the Shadow of *Candida albicans*

For decades, *Candida albicans* dominated the narrative of veterinary mycology as the primary opportunistic yeast causing mucosal and systemic infections in domestic animals. However, a significant epidemiological shift is underway globally. Non-albicans *Candida*



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(NAC) species have dramatically increased in prevalence, with *Candida tropicalis* emerging as a highly virulent, clinically relevant threat. Ubiquitous in soil, water, decaying organic matter, and the gastrointestinal tracts of mammals, *C. tropicalis* transitions rapidly from a benign commensal to a lethal pathogen when a host's immune system or native microflora is compromised. As intensive farming systems expand, antibiotic misuse escalates, and prolonged immunosuppressive therapies become common, understanding *C. tropicalis* through a One Health lens is no longer optional—it is a veterinary and public health necessity (Fisher *et al*., 2024).

## Epidemiology and Global Emergence

Historically dismissed as an environmental contaminant, *C. tropicalis* is now recognized as one of the most frequently isolated NAC species in tropical and subtropical veterinary medicine (Kaur *et al*., 2025). Global surveillance data indicate a rising incidence of this yeast in intensive dairy setups, commercial swine operations, and companion animal clinics. The epidemiology of *C. tropicalis* is heavily influenced by environmental persistence; its resilience to ambient heat and humidity allows it to thrive in tropical farming climates. Unlike *C. albicans*, which relies closely on direct host-to-host transmission, *C. tropicalis* establishes durable environmental reservoirs in farm bedding, contaminated water troughs, and poorly sanitized milking equipment, making outbreaks harder to eliminate (Sanyal & Chowdhary, 2024).

## Clinical Landscape in Domestic Animals

*C. tropicalis* does not discriminate among animal hosts, manifesting in diverse clinical conditions that challenge routine veterinary practices:

- **Cattle & Buffaloes**: The yeast is an established etiological agent of chronic mycotic mastitis and bovine abortions. Mastitis cases typically manifest as a hard, swollen udder unresponsive to conventional antibacterial therapies, often occurring as a direct sequel to non-sterile intramammary drug infusions (Kumar *et al*., 2024).
- **Swine:** Severe gastrointestinal candidiasis, oesophageal /gastric ulcers, and fatal septicemia have been documented in pregnant and postpartum sows, as well as unweaned piglets, leading to high mortality rates in affected herds.
- **Equines**: *C. tropicalis* causes debilitating mycotic keratitis, uterine infections leading to prolonged infertility, and deep soft-tissue infections following trauma.
- **Canines & Felines**: It is increasingly isolated from stubborn, recurrent cases of otitis externa, lower urinary tract infections (cystitis), and deep mucocutaneous lesions in immunocompromised or diabetic pets (Nowak *et al*., 2025).

## Pathogenesis and Molecular Virulence Factors

What makes *C. tropicalis* a formidable pathogen is its robust, sophisticated toolkit of virulence factors, which matches or sometimes exceeds that of *C. albicans*:

- Biofilm Formation: It excels at forming dense, mature, three-dimensional biofilms on host tissues and medical devices (such as intravenous catheters and teat cannulas). These biofilms act as physical shields against host immune cells and prevent antifungal drug penetration (Bhattacharya *et al*., 2025).
- Secretion of Lytic Enzymes: The organism actively secretes extracellular hydrolases,

primarily secreted aspartyl proteinases (SAPs), phospholipases, and hemolysins. These enzymes destroy host epithelial and endothelial barriers, facilitating deep tissue invasion and vascular entry.

- Phenotypic Switching: *C. tropicalis* can rapidly alter its cellular morphology between budding yeast forms and filamentous hyphae/pseudohyphae. The yeast form aids in dissemination through the bloodstream, while the hyphal form physically penetrates host tissues (Santos *et al*., 2024).

## The Crux of the Problem: Environmental and Clinical Azole Resistance

Compounding this virulence is the rapid rise of antifungal resistance, a major concern for veterinary and human clinicians alike. Due to the widespread, intensive use of azole fungicides in agriculture for crop protection (such as tebuconazole and propiconazole), *C. tropicalis* populations in the soil and environment have faced intense selective pressure (Verweij *et al*., 2024). This environmental driver means animals are acquiring pre-resistant strains directly from their surroundings. Inside the veterinary clinic, the unregulated or empirical use of human triazoles (like fluconazole and itraconazole) further drives resistance. Molecular mechanisms like the upregulation of efflux pumps (*CDR1* and *MDR1* genes) and mutations in the *ERG11* gene make these infections increasingly difficult to treat (Meis *et al*., 2025).

## Diagnostic Challenges in Veterinary Mycology

Accurate diagnosis of *C. tropicalis* remains a bottleneck in veterinary practices. On conventional media like Sabouraud Dextrose Agar (SDA), colonies appear as non-specific, smooth, cream-colored yeasts that are easily misidentified as *C. albicans*. While differential media like CHROM agar can distinguish *C. tropicalis* by its distinct bluish-gray colony morphology, definitive identification requires advanced methods (Pfaller *et al*., 2024). Automated biochemical systems (like VITEK-2) or molecular techniques, including Polymerase Chain Reaction (PCR) and DNA sequencing of the internal transcribed spacer (ITS) region, are vital to differentiate *C. tropicalis* accurately from other morphologically identical yeasts (Rodrigues *et al*., 2025).

To assist laboratory personnel and veterinary clinicians in bypassing these challenges, Table 1 details the core phenotypic, structural, and physiological points of divergence between these two major species:

## Table 1: Phenotypic and Diagnostic Differentiation Framework

| Diagnostic Parameter | *Candida albicans* | *Candida tropicalis* | Veterinary Clinical Significance |
|---|---|---|---|
| **Colony Morphology (SDA)** | Smooth, creamy white, dome-shaped | Smooth, dull cream-white, occasionally fringed borders | Poorly differentiated on standard media; causes high rate of misidentification. |
| **CHROM agar Candida** | Light green to emerald green | Distinct metallic blue to bluish-gray | Crucial for rapid, visual pen-side identification of non-albicans species. |



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| **Germ Tube Test** | Positive (within 2–3 hours at 37°C) | Negative (rarely produces pseudo-germ tubes) | Standard screening test; a negative result often misleads clinicians to rule out pathogenic *Candida*. |
| **Chlamydospore Production** | Abundant terminal chlamydospores on Cornmeal Agar | Absent (produces abundant pseudohyphae with blastoconidia) | Microscopic hallmark used for structural differentiation in veterinary labs. |
| **Biofilm Architecture** | Highly structured, matrix-rich, less dense | Thick, highly cohesive, single or multi-layered blastoconidia dense | Explains the enhanced resistance of *C. tropicalis* to teat cannulas and implants. |
| **Primary Azole Resistance** | Generally susceptible (resistance is acquired/induced) | High rate of intrinsic or rapidly induced environmental resistance | Demands mandatory Antifungal Susceptibility Testing (AST) before treatment. |

## The One Health Preparedness Framework

Because *C. tropicalis* bridges human medicine, veterinary health, and environmental management, a unilateral approach will fail. Mitigating this emerging fungal threat requires a proactive One Health preparedness plan based on four pillars:

- Integrated Mycological Surveillance: Establish cross-sector networks to monitor fungal profiles and antifungal susceptibility across human clinics, veterinary hospitals, farms, and agricultural runoff. This unified surveillance will help track the zoonotic and sapronotic transmission pathways of drug-resistant strains (One Health Joint Plan of Action, 2024).
- Antifungal Stewardship in Veterinary Practices: Veterinary professionals must exercise strict discipline in prescribing broad-spectrum antibiotics and corticosteroids, both of which deplete native bacterial microflora and pave the way for opportunistic fungal colonization. Standard protocols must demand antifungal susceptibility testing before treating confirmed yeast infections.
- Biosecurity and Farm Hygiene: Preventive management on livestock farms must focus on minimizing environmental stressors, maintaining optimal water quality, and practicing flawless hygiene during assisted calvings or intramammary infusions. Regular disinfection of milking machinery and feeding equipment is vital to check the buildup of fungal biofilms.
- Public Awareness and Joint Research: Educate farmers, pet owners, and paravets about the opportunistic nature of fungal zoonoses and the risks of poor hygiene. Joint research

initiatives between veterinarians, medical mycologists, and environmental scientists are crucial to uncover the exact molecular mechanisms driving clonal spread and cross-resistance between plant-protection azoles and animal therapeutics.

## Conclusion

*Candida tropicalis* can no longer be dismissed as a minor environmental contaminant. Its rising incidence, formidable virulence, and expanding drug-resistance profile position it as an apex opportunistic pathogen of the 21st century. Managing this threat demands a shift away from traditional monodisciplinary boundaries. By implementing robust One Health surveillance, strict antimicrobial stewardship, and innovative diagnostic technologies, the veterinary community can safeguard livestock productivity, companion animal welfare, and broader public health ecosystems against this resilient fungal adversary.

## Future Perspectives and Path Forward

To transition from a reactive model to proactive preparedness, the trajectory of *C. tropicalis* interventions must be built on tangible technological advancements:

- Point-of-Care Molecular Diagnostics: Developing pen-side diagnostics, such as loop-mediated isothermal amplification (LAMP) assays and paper-based microfluidics, will eliminate long laboratory wait times and allow for immediate isolation of affected livestock.
- Genomic Mapping of the Resistome: Utilizing next-generation sequencing (NGS) to map environmental soils and agricultural surfaces will chart the precise evolutionary patterns showing how crop-protection triazoles confer cross-resistance to medical and veterinary therapeutics (Arora *et al*., 2026).
- Novel Antifungal Strategies: Research must actively invest in non-traditional antimicrobial approaches. This includes evaluating plant-derived nano-emulsions (e.g., thymol or carvacrol nanoparticles) and biofilm-disrupting enzymes to dismantle fungal barriers without inducing further genetic resistance (Alvarez-Fernandez *et al*., 2025).
- Regulatory Policy Integration: A successful path forward requires integrating national veterinary frameworks with agricultural chemical regulatory boards. Restricting specific azole chemical classes from simultaneous dual-use in plant farming and veterinary care will preserve the therapeutic efficacy of crucial frontline therapeutics.

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