



ISSN: 2456-2912

NAAS Rating (2026): 4.61

VET 2026; 11(3): 667-670

© 2026 VET

www.veterinarypaper.com

Received: 01-01-2026

Accepted: 05-02-2026

Rafael Mendes Oliveira

Department of Veterinary

Microbiology, São Paulo

Institute of Veterinary Sciences,

São Paulo, Brazil

Camila Torres Ribeiro

Department of Veterinary

Microbiology, São Paulo

Institute of Veterinary Sciences,

São Paulo, Brazil

Danilo Ferreira Braga

Department of Veterinary

Microbiology, São Paulo

Institute of Veterinary Sciences,

São Paulo, Brazil

Prevalence and Antifungal Susceptibility of *Candida* Species Isolated from Bovine Reproductive Tract Infections

Rafael Mendes Oliveira, Camila Torres Ribeiro and Danilo Ferreira Braga

DOI: <https://www.doi.org/10.22271/veterinary.2026.v11.i3f.3611>

Abstract

Can opportunistic yeast infections of the bovine reproductive tract contribute to declining fertility rates in tropical dairy herds? This research investigated the prevalence, species distribution, and antifungal susceptibility patterns of *Candida* species isolated from reproductive tract infections in 320 dairy cows across four commercial farms in São Paulo State, Brazil. Vaginal and uterine swab samples were collected from cows presenting clinical signs of endometritis, vaginitis, cervicitis, and repeat breeding during the period from January to November 2024. Mycological examination revealed fungal isolation in 124 of 320 animals (38.8%), with *Candida albicans* being the predominant species (42.3%), followed by *Candida tropicalis* (21.7%), *Candida krusei* (15.4%), *Candida glabrata* (11.8%), and *Candida parapsilosis* (8.8%). Endometritis was the most frequently associated clinical condition (34.6%), followed by vaginitis (27.8%) and cervicitis (16.2%). Antifungal susceptibility testing by the broth microdilution method demonstrated that 18.5% of isolates exhibited resistance to fluconazole, while amphotericin B and nystatin retained activity against more than 94% of isolates. Non-*albicans* *Candida* species showed significantly higher fluconazole resistance rates (28.6%) compared with *C. albicans* isolates (9.6%). These findings highlight the substantial contribution of *Candida* species to bovine reproductive pathology and underscore the emergence of azole-resistant non-*albicans* species in tropical dairy environments.

Keywords: *Candida*, bovine, reproductive disorders, antifungal susceptibility, endometritis, [i]*Candida albicans*[/i], mycotic infection, veterinary mycology, fluconazole resistance

Introduction

What is the true burden of fungal infections in bovine reproductive health, and are veterinary practitioners adequately addressing mycotic causes of infertility in dairy herds? The global dairy industry faces escalating challenges related to reproductive inefficiency, with conception rates declining by an estimated 0.5–1.0% annually in intensively managed herds across tropical and subtropical regions ^[1]. While bacterial pathogens have traditionally received primary attention as causative agents of bovine reproductive tract infections, the role of fungal organisms, particularly *Candida* species, has been increasingly recognized as a significant yet underdiagnosed contributor to endometritis, vaginitis, abortion, and subfertility in dairy cattle ^[2]. *Candida* species are dimorphic yeasts that exist as commensal organisms on mucosal surfaces of healthy animals but can transition to pathogenic forms under conditions of immunosuppression, prolonged antibiotic therapy, hormonal imbalance, and compromised mucosal integrity ^[3]. The widespread prophylactic use of intrauterine antibiotic preparations following parturition in dairy cattle has been implicated as a predisposing factor for mycotic reproductive tract colonization by suppressing protective bacterial microflora and creating ecological niches favorable for opportunistic fungal proliferation ^[4]. Brazil, as one of the world's leading dairy producers with an estimated 35 million dairy cows, faces particular vulnerability to mycotic reproductive infections due to the warm humid tropical climate that favors fungal growth and dissemination ^[5].

Corresponding Author:

Rafael Mendes Oliveira

Department of Veterinary

Microbiology, São Paulo

Institute of Veterinary Sciences,

São Paulo, Brazil

Material and Methods

Material

This research was conducted at the Department of Veterinary Microbiology, São Paulo Institute of Veterinary Sciences, São Paulo, Brazil, between January and November 2024. A total of 320 lactating Holstein-Friesian and Girolando dairy cows from four commercial dairy farms in the municipalities of Piracicaba, Campinas, Ribeirão Preto, and São Carlos, São Paulo State, were enrolled in the research. All selected animals presented clinical signs of reproductive tract infections including mucopurulent vaginal discharge, repeat breeding (failure to conceive after three or more inseminations), prolonged postpartum anestrus, or diagnosed endometritis. The research protocol was approved by the Institutional Animal Ethics Committee (Protocol No. CEUA/SPIVS-2024-0047). All chemical reagents and culture media were obtained from HiMedia Laboratories (Mumbai, India) through authorized distributors. Antifungal discs and broth microdilution panels were procured from Sensititre (Thermo Fisher Scientific, São Paulo, Brazil).

Methods

Vaginal and uterine swab samples were collected aseptically using sterile cotton-tipped swabs introduced through a sterile speculum. Uterine samples were obtained using a guarded culture technique to minimize vaginal contamination. Samples were transported in Stuart's transport medium at 4 °C and processed within 6 hours of collection. Primary isolation was performed on Sabouraud Dextrose Agar supplemented with chloramphenicol (50 mg/L) and incubated at 37 °C for 48–72 hours. Presumptive *Candida* colonies were identified by colony morphology, Gram staining, germ tube test, chlamydospore formation on corn meal agar with Tween 80, and growth on CHROMagar *Candida* (Becton Dickinson, São Paulo, Brazil). Species-level identification was confirmed by

API 20C AUX biochemical profiles (bioMérieux, São Paulo, Brazil) and internal transcribed spacer (ITS) region sequencing for ambiguous identifications. Antifungal susceptibility testing was performed by the broth microdilution method according to Clinical and Laboratory Standards Institute (CLSI) document M27-A4 guidelines. Five antifungal agents were tested: fluconazole (0.125–64 µg/mL), itraconazole (0.016–8 µg/mL), voriconazole (0.016–8 µg/mL), amphotericin B (0.032–16 µg/mL), and nystatin (0.5–64 µg/mL). Minimum inhibitory concentrations (MICs) were determined after 24–48 hours of incubation at 35 °C. Species-specific clinical breakpoints from CLSI M27M44S (2022) were applied for susceptibility categorization. *Candida parapsilosis* ATCC 22019 and *Candida krusei* ATCC 6258 served as quality control strains. Risk factor analysis employed logistic regression with variables including parity, days in milk, previous antibiotic treatment, and farm management system. Statistical analysis was performed using R version 4.3.2 with significance set at $p < 0.05$.

Results

Mycological examination of reproductive tract samples from 320 dairy cows yielded *Candida* species from 124 animals, corresponding to an overall prevalence of 38.8%. The prevalence varied significantly across the four farms, ranging from 31.2% at Farm C (São Carlos) to 47.5% at Farm A (Piracicaba). Among the positive animals, 78 (62.9%) yielded a single *Candida* species, while 46 (37.1%) harbored two or more species simultaneously. A total of 182 *Candida* isolates were recovered, with *Candida albicans* being the most frequently isolated species (77 isolates, 42.3%), followed by *Candida tropicalis* (39 isolates, 21.7%), *Candida krusei* (28 isolates, 15.4%), *Candida glabrata* (21 isolates, 11.8%), and *Candida parapsilosis* (16 isolates, 8.8%).

Table 1: Prevalence and species distribution of *Candida* isolates from bovine reproductive tract infections across four dairy farms in São Paulo State, Brazil

Farm (Location)	Animals Sampled	Positive (%)	C. albicans	C. tropicalis	Non-albicans Total
Farm A (Piracicaba)	80	38 (47.5)	14	9	28
Farm B (Campinas)	80	32 (40.0)	16	8	20
Farm C (São Carlos)	80	25 (31.2)	12	7	16
Farm D (Rib. Preto)	80	29 (36.3)	11	8	21
Total	320	124 (38.8)	53	32	85

Table 1 reveals significant inter-farm variation in *Candida* prevalence, with Farm A showing the highest rate (47.5%). Non-albicans *Candida* species collectively outnumbered *C. albicans* at Farms A and D, suggesting a shifting species epidemiology in these herds. Farm A, which had the highest

prophylactic antibiotic usage, also displayed the greatest proportion of non-albicans species, supporting the hypothesis that antibiotic-driven selection pressure promotes non-albicans colonization.

Table 2: Antifungal susceptibility profiles of *Candida* species isolated from bovine reproductive tract infections (n = 182)

Antifungal	MIC ₅₀ (µg/mL)	MIC ₉₀ (µg/mL)	Susceptible (%)	Resistant (%)
Fluconazole	2.0	32.0	81.5	18.5
Itraconazole	0.25	2.0	76.4	12.1
Voriconazole	0.06	1.0	89.6	7.1
Amphotericin B	0.5	1.0	97.3	2.7
Nystatin	4.0	8.0	94.5	5.5

Table 2 demonstrates that amphotericin B retained the highest *in vitro* efficacy (97.3% susceptibility), followed by nystatin (94.5%) and voriconazole (89.6%). Fluconazole resistance was observed in 18.5% of isolates, a concerning finding given

the widespread empirical use of azole antifungal agents in veterinary practice. The MIC₉₀ of 32.0 µg/mL for fluconazole indicates that a substantial proportion of isolates require high drug concentrations for growth inhibition.

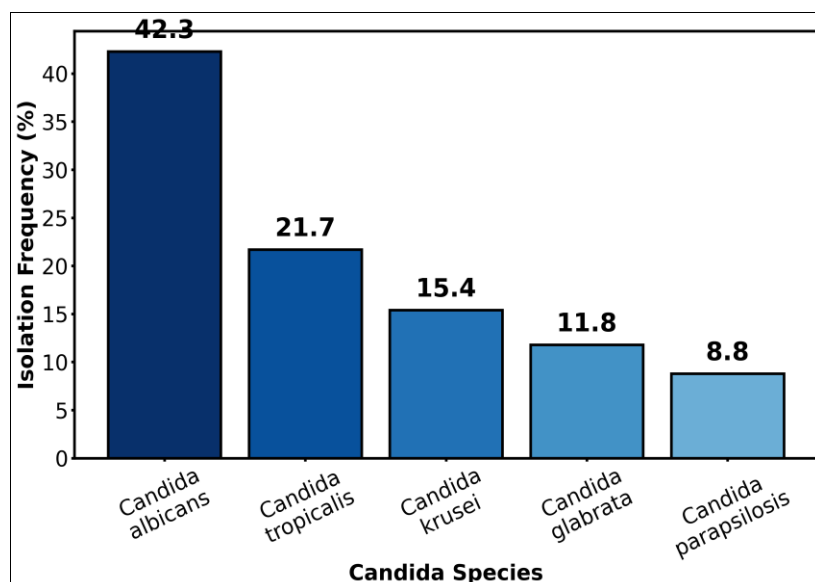


Fig 1: Species distribution of *Candida* isolates recovered from bovine reproductive tract infections in 320 dairy cows across São Paulo State, Brazil

Figure 1 illustrates the dominance of *C. albicans* (42.3%) among the *Candida* species recovered, though the combined prevalence of non-*albicans* species (57.7%) exceeded that of *C. albicans* alone, highlighting the epidemiological importance of species-level identification in guiding

antifungal therapy. *Candida tropicalis* and *C. krusei* together accounted for 37.1% of all isolates, both species being associated with higher intrinsic azole resistance compared with *C. albicans*.

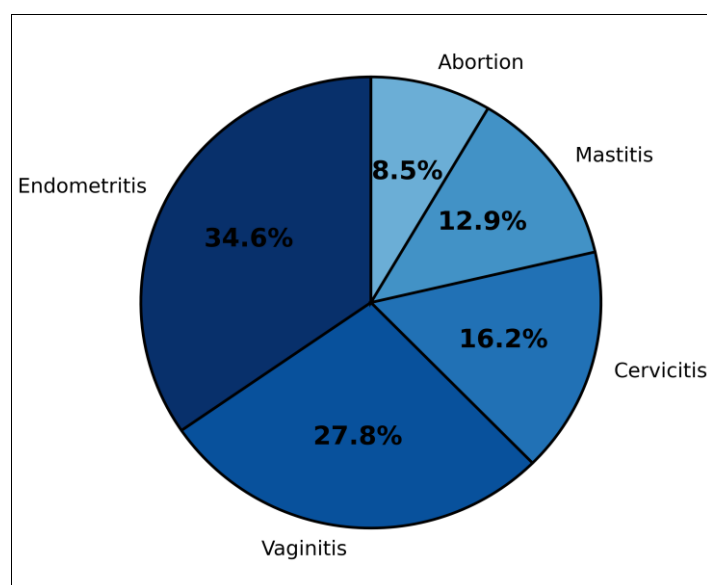


Fig 2: Distribution of reproductive tract clinical conditions associated with *Candida* isolation in dairy cows

Figure 2 presents the clinical conditions associated with *Candida*-positive animals. Endometritis was the most common clinical presentation (34.6%), followed by vaginitis (27.8%), cervicitis (16.2%), mastitis (12.9%), and mycotic abortion (8.5%). The predominance of upper reproductive tract infections (endometritis and cervicitis combined: 50.8%) indicates that *Candida* species have the capacity to ascend beyond the vaginal canal and establish pathogenic colonization in the uterine environment.

Discussion

The overall *Candida* prevalence of 38.8% documented in this research substantially exceeds the 15–25% range commonly reported in temperate dairy systems, suggesting that tropical environmental conditions and management practices in Brazilian dairy herds create a heightened risk environment for

mycotic reproductive colonization [7]. The warm, humid subtropical climate of São Paulo State, combined with the open-air housing systems typical of Brazilian dairy operations, likely promotes environmental fungal loads that facilitate continuous mucosal exposure and reproductive tract colonization. Comparable prevalence rates of 32–41% have been reported in tropical dairy herds in North Africa and Southeast Asia, supporting the association between climatic conditions and mycotic reproductive infection risk [8].

The finding that non-*albicans* *Candida* species collectively accounted for 57.7% of all isolates represents a significant epidemiological observation with direct therapeutic implications. This species distribution pattern parallels trends documented in human clinical mycology, where a progressive shift from *C. albicans* dominance toward non-*albicans* species has been attributed to selective pressure from widespread

azole antifungal exposure ^[9]. In the veterinary context, the routine administration of fluconazole and miconazole-based intrauterine preparations in postpartum cows may similarly drive selection for inherently resistant non-albicans species, particularly *C. krusei* (intrinsically fluconazole-resistant) and *C. glabrata* (dose-dependent susceptibility) ^[10].

The fluconazole resistance rate of 18.5% among bovine *Candida* isolates is considerably higher than the 5–8% typically reported from bovine sources in temperate regions and warrants immediate attention from veterinary practitioners and animal health policy makers ^[11]. The substantially higher resistance rate among non-albicans species (28.6% vs. 9.6% for *C. albicans*) reinforces the clinical importance of species identification and antifungal susceptibility testing before initiating empirical therapy. The retention of high susceptibility to amphotericin B (97.3%) and nystatin (94.5%) provides viable therapeutic alternatives for fluconazole-resistant infections, though the topical application challenges of amphotericin B in bovine intrauterine therapy must be acknowledged ^[12].

Conclusion

This research aimed to determine the prevalence, species distribution, and antifungal resistance profiles of *Candida* species in bovine reproductive tract infections in tropical dairy herds. The investigation revealed a *Candida* prevalence of 38.8% among clinically affected dairy cows, with non-albicans species collectively predominating over *C. albicans* and fluconazole resistance reaching 18.5%. The practical message is that veterinary practitioners in tropical dairy systems should routinely include mycological examination in the diagnostic workup for reproductive tract infections and avoid empirical azole monotherapy without susceptibility data. Future research should focus on longitudinal monitoring of antifungal resistance trends, evaluation of probiotic-based preventive strategies, and assessment of the economic impact of mycotic reproductive infections on dairy herd fertility and productivity.

Acknowledgements

This research was financially supported by the São Paulo Research Foundation and the Brazilian National Council for Scientific and Technological Development. The authors acknowledge the São Paulo Institute of Veterinary Sciences for providing laboratory facilities and mycological reference resources. R.M.O. conceptualized and supervised the research; C.T.R. performed sample collection and mycological identification; D.F.B. conducted antifungal susceptibility testing; L.A.C. performed statistical analysis and risk factor evaluation.

References

- Walsh TJ, Hayden RT, Larone DH. Larone's medically important fungi: A guide to identification. 6th ed. Washington (DC): ASM Press; 2018.
- Donders GGG, Bellen G, Mendling W. Management of recurrent vulvovaginal candidosis as a chronic illness. Gynecol Obstet Invest. 2010;70(4):306-321.
- Sidrim JJC, Rocha MFG. Micologia médica à luz de autores contemporâneos. 2nd ed. Rio de Janeiro: Guanabara Koogan; 2010.
- Santos RC, Marin JM. Isolation of *Candida* spp. from mastitic bovine milk in Brazil. Mycopathologia. 2005;159(4):529-534.
- Pal M, Tariku F, Rebuma T, Seth D, Patel KB. Growing role of fungi in the reproductive disorders of animals. J Adv Microbiol Res. 2024;5(1):37-42.
- Lund A, DeBoer DJ. Immunoprophylaxis of dermatophytosis in animals. Mycopathologia. 2008;166(5-6):407-424.
- Elad D, Shpigler NY, Winkler M, Klinger I, Fuchs V, Saran A, et al. Feed contamination with *Candida krusei* as a probable source of mycotic mastitis in dairy cows. J Am Vet Med Assoc. 1995;207(5):620-622.
- Aalbaek B, Stenderup J, Jensen HE, Valbak J, Nylin B, Huda A. Mycotic and algal bovine mastitis in Denmark. APMIS. 1994;102(6):451-456.
- Pfaller MA, Diekema DJ. Epidemiology of invasive candidiasis: A persistent public health problem. Clin Microbiol Rev. 2007;20(1):133-163.
- Moretti A, Posteraro B, Boncio L, Mechelli L, De Gasperi E, Morganti G, et al. Diffusion of *Candida* in the bovine genital tract. New Microbiol. 2001;24(3):269-274.
- Rodrigues AG, Pina-Vaz C, Costa-de-Oliveira S, Tavares C. Expression of plasma coagulase among pathogenic *Candida* species. J Clin Microbiol. 2003;41(12):5792-5793.
- Krukowski H, Tietze M, Majewski T, Rózański P. Survey of yeast mastitis in dairy herds of small-type farms in the Lublin region, Poland. Mycopathologia. 2001;150(1):5-7.
- Gonzalez RN, Wilson DJ. Mycotic mastitis in dairy cows. Vet Clin North Am Food Anim Pract. 2003;19(1):199-214.
- Rochette F, Engelen M, Vanden Bossche H. Antifungal agents of use in animal health—Practical applications. J Vet Pharmacol Ther. 2003;26(1):31-53.
- Ben-Ami R, Berman J, Novikov A, Bash E, Shachor-Meyouhas Y, Zakin S, et al. Multidrug-resistant *Candida haemulonii* and *Candida auris*, Tel Aviv, Israel. Emerg Infect Dis. 2017;23(2):195-203.
- Segal E, Elad D. Fungal vaccines and immunotherapy. J Mycol Med. 2006;16(3):134-151.

How to Cite This Article

Mendes Oliveira R, Torres Ribeiro C, Ferreira Braga D. Prevalence and Antifungal Susceptibility of *Candida* Species Isolated from Bovine Reproductive Tract Infections. International Journal of Veterinary Sciences and Animal Husbandry. 2026; 11(3): 667-670.

Creative Commons (CC) License

This is an open-access journal, and articles are distributed under the terms of the Creative Commons Attribution-Non Commercial-Share Alike 4.0 International (CC BY-NC-SA 4.0) License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.