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Comparison of the Sensitivity Test of Generic and Branded Antifungal Drugs Against Malassezia

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ABSTRACT

Introduction: Malassezia furfur is a lipophilic yeast commonly associated with pityriasis versicolor, characterized by skin discoloration and mild pruritus. Antifungal therapy is available as generic and branded products, yet differences in laboratory efficacy and cost implications remain relevant for clinical decision-making.
Objective: To compare the in vitro antifungal susceptibility of generic versus branded antifungal agents against M. furfur using the disk diffusion method and to consider the economic implications.
Methods: A laboratory experimental study was conducted using disk diffusion susceptibility testing on M. furfur isolates. Generic ketoconazole was compared with several branded formulations. The primary outcome was the inhibition zone diameter as an indicator of antifungal effectiveness. Statistical analysis was performed using ANOVA followed by Tukey's post hoc test to identify intergroup differences.
Results: Both generic ketoconazole and branded antifungal agents demonstrated good inhibitory activity against M. furfur. Certain branded products, particularly Brand D showed a slightly larger mean inhibition zone diameter than the generic formulation. ANOVA and Tukey's tests indicated statistically significant differences among some treatment groups. However, the incremental advantage observed in selected branded products was not proportional to their higher prices, as the generic drug remained substantially more affordable while maintaining comparable inhibitory performance.
Conclusions: Based on the results, it is concluded that both generic and branded antifungal topical (ointment) and antifungal oral (capsule) demonstrated "sensitive" results against *Malassezia furfur*, with no statistically significant difference in efficacy between them.

Introduction

Pityriasis versicolor, a common skin infection caused by the fungus *Malassezia furfur*, leads to characteristic hypo- or hyperpigmented patches on the chest, back, arms, and face, often accompanied by mild

itching (Eliya Mursyida & Yashi Putri Anjeli, 2024; Rahmi Safira & Wizar Putri Mellaratna, 2024). Standard management involves antifungal drugs from classes like azoles, polyenes, and allylamines, which target the fungal cell membrane (Rakhmawatie et al., 2022). Among these, azoles such as ketoconazole and itraconazole are frequently used and have demonstrated high *in vitro* effectiveness against *Malassezia* (Galvis-Marín et al., 2025; Pusmarani et al., 2023). However, the rising threat of antifungal resistance underscores the critical need for ongoing sensitivity testing to ensure treatment success (Leong et al., 2021). The broth microdilution method, for instance, is a valuable tool for accurately determining the minimum inhibitory concentration (MIC) of antifungal agents against *Malassezia* isolates (de Sousa et al., 2020).

Treatment options include both branded and more affordable generic antifungal drugs. While generic drugs are bioequivalent to their branded counterparts and offer a cost-effective alternative, a perception of lower quality or effectiveness can persist among some patients and healthcare providers (Amanda Dwijayanti & Musa Fitri Fatkhiyah, 2025; Azis, 2022). Although the efficacy of the active pharmaceutical ingredients is expected to be equivalent, direct comparative studies on the sensitivity of *Malassezia furfur* to generic versus branded formulations are notably lacking. This research gap is significant, as confirmed differences in sensitivity could have profound implications for treatment guidelines, cost-effectiveness, and the growing challenge of antifungal resistance, potentially leading to therapy failure. Therefore, this study aims to compare the *in vitro* sensitivity of generic and branded antifungal drugs against clinical isolates of *Malassezia furfur*. Specifically, we will test the hypothesis that there is no significant difference in the inhibition zone diameter (or MIC values, depending on your method) between generic and branded formulations of both topical and oral antifungal agents. The findings are expected to provide valuable evidence for clinicians, patients, and researchers in making informed, rational choices for antifungal therapy, thereby contributing to more effective and economical management of *Malassezia* infections.

Methods

Study design and setting

This study employed an in vitro experimental design to compare the sensitivity of generic and branded antifungal drugs against *Malassezia furfur* (Ketaren et al., 2024). The research was conducted at the Research Laboratory of the Faculty of Medicine, Muslim University of

Indonesia, in 2025. Ethical approval for this study was obtained (Number: UMI012508733).

Variables

The independent variable in this study was the type of antifungal drug formulation (generic or branded). The dependent variable was the sensitivity of Malassezia furfur, determined by measuring the diameter of the inhibition zone (in millimeters) produced by each drug in a disc diffusion assay.

Sample preparation

A culture of Malassezia furfur was obtained from the Microbiology Laboratory, Faculty of Medicine, Muslim University of Indonesia. The fungus was cultured on Sabouraud Dextrose Agar (SDA) medium supplemented with chloramphenicol to inhibit bacterial growth. To support optimal growth of the lipophilic M. furfur, the medium was overlaid with a thin layer of sterile olive oil. Cultures were incubated at 28°C for 18-24 hours.

Following incubation, a fungal suspension was prepared in sterile saline. The turbidity of this suspension was standardized to a 0.5 McFarland standard, which corresponds to approximately 1-5 x 10^6 colony-forming units per milliliter (CFU/mL).

Antifungal sensitivity testing

Sensitivity testing was performed using the Kirby-Bauer disk diffusion method. A sterile cotton swab was dipped into the standardized fungal suspension and used to inoculate the entire surface of a fresh SDA plate supplemented with olive oil. Filter paper discs impregnated with the test antifungal agents were then placed on the agar surface using sterile forceps. The specific drugs tested were antifungal topical (ointment) and antifungal oral (capsule) formulations, each in its generic and branded version. The capsule contents were dissolved in a suitable, validated solvent to achieve a standardized concentration for disc impregnation.

The plates were incubated at 28°C for 48-72 hours. After incubation, the diameter of the clear zone of inhibition around each disc was measured in millimeters using a caliper. The sensitivity of M. furfur to each drug was interpreted based on Clinical and Laboratory Standards Institute (CLSI) guidelines adapted from (Weinstein & Lewis, 2020) as follows:

1. Sensitive: Inhibition zone ≥ 20 mm
2. Intermediate: Inhibition zone 15-19 mm
3. Resistant: Inhibition zone ≤ 14 mm

Statistical analysis

All experiments were performed in triplicate (n=3 per drug group). The mean inhibition zone diameters and standard deviations were calculated for each formulation. Data were analyzed using SPSS software (Darma, 2021). To compare the mean inhibition zones between generic

and branded formulations, the appropriate statistical tests were applied based on the results of a test for normality of distribution. For normally distributed data, an independent samples t-test was used. For non-normally distributed data, the non-parametric Mann-Whitney U test was employed. A p-value of less than 0.05 was considered statistically significant. It is important to acknowledge that the small sample size (n=3 per group) limits the statistical power and generalizability of the findings, and this study should be considered preliminary (Darma, 2021).

Results and Discussion

Antifungal sensitivity test results of generic antifungal topical (ointment) type ketoconazole and branded with generic antifungal oral (capsule) type fluconazole and branded against Malassezia furfur

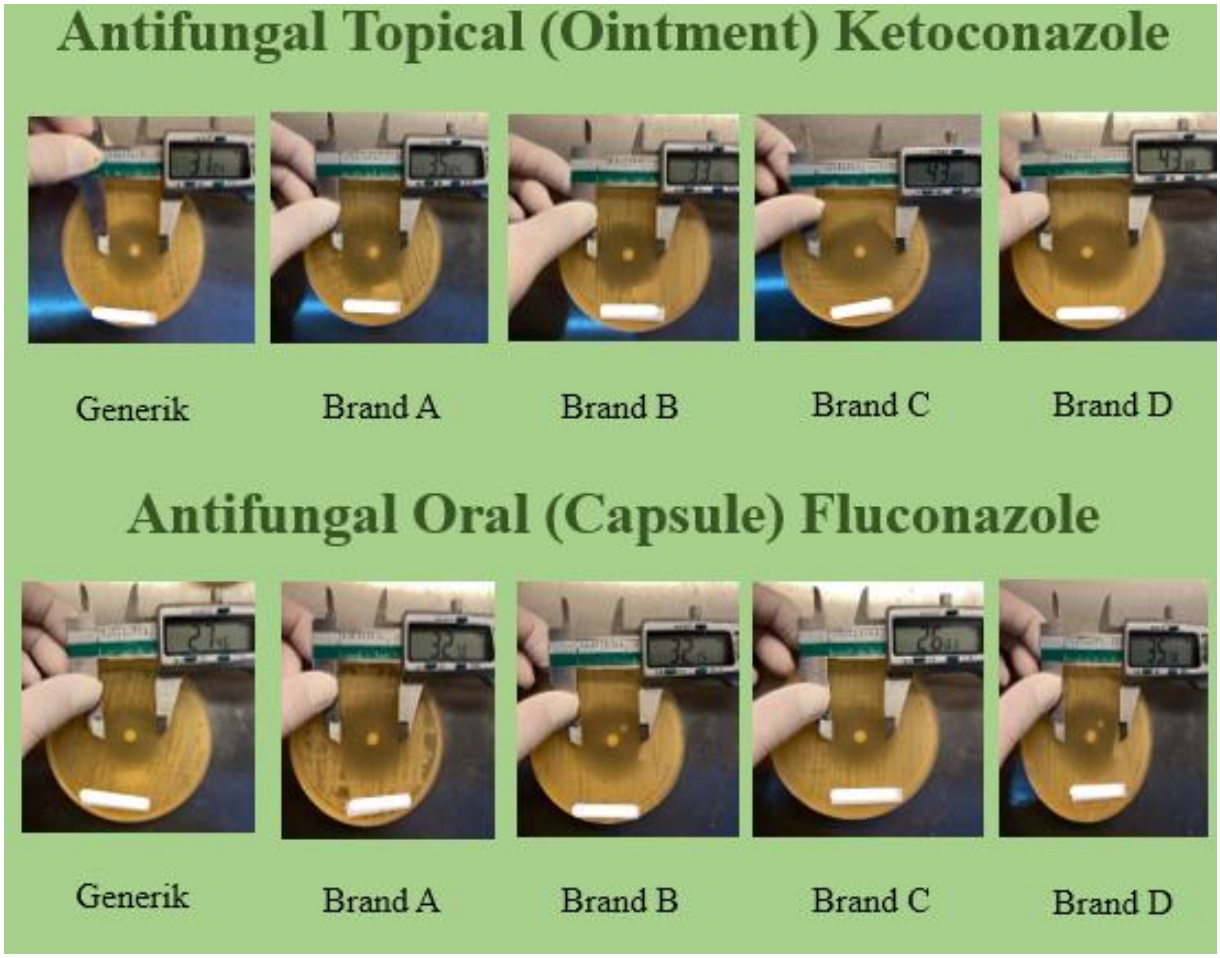

Figure 1. Measurement results of antifungal inhibition zone ketoconazole generic and branded antifungal topical (ointment) with generic and branded antifungal oral (capsule)

Table 1. Comparison of average diameter of generic and branded antifungal inhibitor zones in antifungal topical (ointment) and antifungal oral (capsule) preparations against *Malassezia furfur*

Generic Antifungal Topical (Ointment)	**N**	**Average**	**Standard Deviation**	**Remarks**
Ketoconazole Generic	3	24,63	1,02	Sensitive
Branded Antifungal Topical (Ointment)	**N**	**Average**	**Standard Deviation**	**Remarks**
Brand A	3	28,33	2,57	Sensitive
Brand B	3	24,57	1,10	Sensitive
Brand C	3	28,80	1,83	Sensitive
Brand D	3	32,43	1,90	Sensitive
Generic Antifungal Oral (Capsule)	**N**	**Average**	**Standard Deviation**	**Remarks**
Fluconazole Generic	3	22,97	0,20	Sensitive
Branded Antifungal Oral (Capsule)	**N**	**Average**	**Standard Deviation**	**Remarks**
Brand A	3	25,77	1,74	Sensitive
Brand B	3	24,83	1,53	Sensitive
Brand C	3	20,97	0,37	Sensitive
Brand D	3	20,97	0,68	Sensitive

Table 1 shows the comparison of the average diameter of the inhibition zone between generic and branded antifungal drugs in antifungal topical (ointment) and antifungal oral (capsule) preparations against *Malassezia furfur*. Ketoconazole, a generic antifungal topical (ointment), shows an average inhibition zone of 24.63 mm, which is classified as sensitive. In the branded antifungal topical (ointment) group, Brand D showed the largest inhibition zone with an average of 32.43 mm, followed by Brand C (28.80 mm) and Brand A (28.33 mm), all of which showed sensitivity. For antifungal oral (capsule) preparations, generic Fluconazole showed an inhibition zone of 22.97 mm, while Brand D in the branded antifungal oral (capsule) group also showed the lowest inhibition zone (20.97 mm) along with Brand C. Despite the differences in the size of the barrier zone between generic and branded drugs, the results obtained showed that both generic and branded antifungal topical (ointment) preparations, in general, had high effectiveness against *Malassezia furfur*. This indicates that although the price of branded drugs is higher, the quality of the

antifungal effect is not much different from that of generic drugs, which are certainly more affordable. Researchers argue that price is not the main factor that determines the effectiveness of treatment, but rather the quality of the product and the dosage used.

Table 2. Price of antifungal drugs ketoconazole generic and branded antifungal topical (ointment) with antifungal fluconazole generic and branded antifungal oral (capsule)

Antifungal Medicine Name	Antifungal Medicine Price (Rp.)
Ketoconazole generic	8.159
Brand A	20.480
Brand B	24.359
Brand C	31.000
Brand D	31.890
Fluconazole capsule generic	18.000
Brand A	81.700
Brand B	85.000
Brand C	110.000
Brand D	173.952

Table 2 shows the prices of the antifungal drugs used in the study, namely generic and branded antifungal topical (ointment) and generic and branded antifungal oral (capsule). The generic drug Ketoconazole has a price of IDR 8,159, much cheaper compared to Brand A (IDR 20,480) to Brand D (IDR 31,890). Similarly, generic Fluconazole is priced at Rp 18,000, while branded brands such as Brand A and Brand B have a much higher price, Rp 81,700 and Rp 85,000, respectively. In terms of price, generic drugs are clearly more affordable and provide a more economical alternative for patients. However, researchers argue that although generic drugs are cheaper, their effectiveness is not inferior to brand-name drugs. It is important for the public and medical personnel to better understand that quality and price are not always directly proportional. This knowledge can help in making decisions regarding the right choice of medication, especially in situations where cost is a major consideration.

Normality test and homogeneity test

Table 3. Normality Test Results of Antifungal Topical (Ointment) and Fluconazole Generic and Branded Antifungal Oral (Capsule)

Antifungal Topical (Ointment) Group	N	Sig.
Ketoconazole Generic	3	0,281
Brand A	3	0,721
Brand B	3	0,174
Brand C	3	0,637
Brand D	3	0,942
Antifungal Oral (Capsule) Group	**N**	**Sig.**
Fluconazole Generic	3	0,463
Brand A	3	0,554
Brand B	3	0,187
Brand C	3	0,253
Brand D	3	0,424

Table 3 shows the results of the normality test for the antifungal topical (ointment) and antifungal oral (capsule) groups. The normality test was carried out using a Sig. value which indicates that all groups (generic Ketoconazole, Brand A, Brand B, Brand C, Brand D, generic Fluconazole, and branded) had a Sig. value greater than 0.05, which means that the data from each group were normally distributed. This suggests that the data obtained from the inhibition zone measurements can be further analyzed in the absence of significant distribution disruptions. Good normality of the data is important in this study because it ensures that statistical analyses such as ANOVA tests and Tukey tests can be done legitimately and the results are trustworthy. The researchers considered that the normality tests successfully passed by all of these groups showed higher data validity and supported stronger conclusions regarding the effectiveness of the antifungal drugs tested.

Table 4. Ketoconazole homogeneity test results of generic and branded antifungal topical (ointment) with generic and branded fluconazole antifungal oral (capsule)

Groups	F	df1	df2	Sig.
Antifungal Topical (Ointment)	0,768	4	10	0,570
Antifungal Oral (Capsule)	4,285	4	10	0,028

Table 4 shows the results of the homogeneity test for the difference in variance between groups of antifungal topical (ointment) and antifungal oral (capsule). For the antifungal topical (ointment) group, the Sig. value is 0.570, which is greater than 0.05, indicating that the variance between groups of antifungal topical (ointment) is homogeneous. However, in the antifungal oral (capsule) group, the Sig. value of 0.028 was smaller than 0.05, indicating that the variance between the antifungal oral (capsule) groups was not homogeneous, which means that the difference in variance between the antifungal oral (capsule) groups was greater than that of the antifungal topical (ointment). The results of the homogeneity test showed that although the variance between the antifungal topical (ointment) groups was not problematic, the difference in variance in the antifungal oral (capsule) group needed to be noted. The researchers argue that although there is inhomogeneity in the antifungal oral (capsule) group, this does not preclude further tests being carried out, but it needs to be taken into account in a more in-depth analysis so as not to affect the interpretation of the results.

Hypothesis Test

Table 5. Test results of anova ketoconazole generic and branded antifungal topical (ointment) against Malassezia furfur

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	129,671	4	32,418	10,211	0,001
Within Groups	31,747	10	3,175		
Total	161,417	14			

Table 5 shows the results of the ANOVA test for the generic and branded antifungal topical (ointment) group against *Malassezia furfur*. The results of the ANOVA test showed a Sig. value of 0.001, which is smaller than 0.05, which means there is a significant difference between the generic and branded antifungal topical (ointment) groups. This suggests that the effectiveness between generic Ketoconazole and brand-name drugs differs statistically, with ANOVA results showing significant differences, researchers argue that although generic Ketoconazole provides good results, there are indications that some branded drugs such as Brand D show higher effectiveness. Therefore, clinical decision-making should consider the results of these tests to select the most effective drug based on its measurable effectiveness and the clinical needs of the patient.

Table 6. Test results of Welch ANOVA fluconazole generic and branded kaspul against *Malassezia furfur*

	Statistic[a]	df1	df2	Sig.
Welch	16,773	4	4,520	0,006

Table 6 shows the results of the Welch ANOVA test for the comparison between generic and branded Fluconazole against *Malassezia furfur*. Welch's statistical value of 16.773 with a Sig. value of 0.006, which is smaller than 0.05, shows a significant difference between generic Fluconazole and brand-name brands. This indicates that the antifungal effectiveness of generic and branded Fluconazole is not the same. The researchers argue that although generic Fluconazole has a lower price, the results of these tests suggest that brand-name may have an advantage in terms of effectiveness against *Malassezia furfur*. Therefore, wise clinical decisions need to involve consideration of the price, effectiveness, and availability of the drug, as well as the individual needs of the patient.

Table 7. Tukey generic and branded ketoconazole follow-up test results against Malassezia furfur

(I) Antifungal Topical (Ointment)	(J) Antifungal Topical (Ointment)	Mean Difference (I-J)	Sig.	95% Confidence Interval	
				Lower Bound	Upper Bound
Ketoconazole Generic	Brand A	-3,70000	0,156	-8,4879	1,0879
	Brand B	0,06667	1,000	-4,7212	4,8545
	Brand C	-4,16667	0,097	-8,9545	0,6212
	Brand D	-7,80000*	0,002	-12,5879	-3,0121
Brand A	Ketoconazole Generic	3,70000	0,156	-1,0879	8,4879
	Brand B	3,76667	0,146	-1,0212	8,5545
	Brand C	-0,46667	0,997	-5,2545	4,3212
	Brand D	-4,10000	0,104	-8,8879	0,6879
Brand B	Ketoconazole Generic	-0,06667	1,000	-4,8545	4,7212
	Brand A	-3,76667	0,146	-8,5545	1,0212
	Brand C	-4,23333	0,090	-9,0212	0,5545
	Brand D	-7,86667*	0,002	-12,6545	-3,0788
Brand C	Ketoconazole Generic	4,16667	0,097	-0,6212	8,9545
	Brand A	0,46667	0,997	-4,3212	5,2545
	Brand B	4,23333	0,090	-0,5545	9,0212
	Brand D	-3,63333	0,167	-8,4212	1,1545
Brand D	Ketoconazole Generic	7,80000*	0,002	3,0121	12,5879
	Brand A	4,10000	0,104	-0,6879	8,8879
	Brand B	7,86667*	0,002	3,0788	12,6545
	Brand C	3,63333	0,167	-1,1545	8,4212

Table 7 shows the results of Tukey's follow-up test for the comparison of generic and branded ketoconazole against *Malassezia furfur*. Based on the Tukey test, there was a significant difference between generic Ketoconazole and Brand D, with a Sig. value of 0.002 which showed a very noticeable difference. However, the difference between generic Ketoconazole and some other brands, such as Brand A, is not significant, with a Sig. value greater than 0.05. The researchers argue that although some brands such as Brand D show significant differences, these results suggest that generic Ketoconazole is still an effective alternative. However, the choice of branded brands with this significant difference can be further considered if the results of treatment in the field show an advantage in higher effectiveness, especially in cases of more severe infections.

Table 8. Games-Howell generic and branded fluconazole follow-up test results against *Malassezia furfur*

(I) Antifungal Oral (Capsule)	(J) Antifungal Oral (Capsule)	Mean Difference (I-J)	Sig.	95% Confidence Interval	
				Lower Bound	Upper Bound
Fluconazole Generik	Brand A	-2,80000	0,302	-10,3735	4,7735
	Brand B	-1,86667	0,448	-8,4842	4,7509
	Brand C	2,00000*	0,014	0,7094	3,2906
	Brand D	2,00000	0,092	-0,6479	4,6479
Brand A	Fluconazole Generic				
		2,80000	0,302	-4,7735	10,3735
	Brand B	0,93333	0,947	-5,0909	6,9576
	Brand C	4,80000	0,114	-2,4025	12,0025
	Brand D	4,80000	0,099	-1,6372	11,2372
Brand B	Fluconazole Generic				
		1,86667	0,448	-4,7509	8,4842
	Brand A	-0,93333	0,947	-6,9576	5,0909
	Brand C	3,86667	0,132	-2,3534	10,0868
	Brand D	3,86667	0,116	-1,6245	9,3578
Brand C	Fluconazole Generic				
		-2,00000*	0,014	-3,2906	-0,7094
	Brand A	-4,80000	0,114	-12,0025	2,4025
	Brand B	-3,86667	0,132	-10,0868	2,3534
	Brand D	0,00000	1,000	-2,3157	2,3157
Brand D	Fluconazole Generic	-2,00000	0,092	-4,6479	0,6479
	Brand A	-4,80000	0,099	-11,2372	1,6372
	Brand B	-3,86667	0,116	-9,3578	1,6245
	Brand C	0,00000	1,000	-2,3157	2,3157

Table 8 shows the results of the Games-Howell follow-up test for the comparison of generic and branded Fluconazole against *Malassezia furfur*. The test results showed a significant difference between generic and Brand C fluconazole, with a Sig. value of 0.014. In addition, the difference between generic and Brand D Fluconazole was not significant, with a Sig. value greater than 0.05. Based on the results of this test, researchers argue that although generic Fluconazole is effective, certain brands such as Brand C may have a slight advantage in dealing with *Malassezia furfur* infection. Nonetheless, the final decision should consider other factors such as cost,

accessibility, and the patient's specific condition in determining the right treatment option.

Discussion

Fungal infections, especially those caused by *Malassezia furfur*, are a common clinical problem in dermatology. One of the fungal infections that is often found is Pityriasis versicolor, which is caused by this fungus. To treat such infections, the use of antifungal drugs such as Ketoconazole and Fluconazole is very common in clinical practice. Based on the research conducted, it was found that there is a significant difference between the two types of drugs in terms of inhibition zone diameter and price. This is in line with previous research that reported significant differences between generic and branded antifungal drugs, both in terms of effectiveness shown through the diameter of the barrier zone and in terms of significant price differences (Ahmad et al., 2023; Freilich & Kesselheim, 2025).

Based on Table 1, it can be seen that the generic antifungal topical (ointment) had an average diameter of the barrier zone that varied in several studies. Although specific results regarding inhibitory zone diameter for these generic drugs are not always listed in the existing literature, some Ketoconazole-based formulations have been shown to show excellent effectiveness in the treatment of fungal infections. These results are supported by previous studies that show that Ketoconazole, both generic and branded, can provide effective results in treating *Malassezia furfur infections* (Massiot et al., 2022; Miranda et al., 2024). The ANOVA test conducted in this study also showed significant differences between generic and branded drugs, with a Sig. value of 0.001, which confirms that the difference in effectiveness between the two types of drugs does play an important role in treatment (Ahmad et al., 2023; Eniayewu et al., 2025).

Table 2 reveals the price aspect of the drugs tested in this study. Generic drugs Ketoconazole and Fluconazole have proven to be much more affordable compared to brand-name drugs, with significant price differences (Alsuhibani et al., 2025; Freilich & Kesselheim, 2025). Although brand-name drugs often have higher prices, previous research has shown that prices are not always directly proportional to the effectiveness of the drug. Generic drugs are no less effective than brand-name drugs and are often a better economic option for patients, especially for those with limited budgets (Freilich & Kesselheim, 2025; Wulandari et al., 2025). Therefore, generic drugs are becoming a very important option in medication management, especially in situations where cost is a major consideration factor.

Normality tests performed on all groups showed that the data was normally distributed, which allowed further data processing without significant distribution disruption (Mishra et al., 2019; Park et al., 2020). In addition, a variance homogeneity test was performed on the antifungal topical (ointment) and antifungal oral (capsule). The test results showed that the variance in the antifungal topical (ointment) group was homogeneous, but not in the antifungal oral (capsule) group, which showed a greater difference in variance in the antifungal oral (capsule) group compared to the antifungal topical (ointment) group. It is important to consider appropriate statistical tests in further data analysis, such as the Tukey test, which can note significant differences between generic Ketoconazole and various other branded brands (Silva et al., 2025).

Tukey's follow-up test results showed that despite the differences between some brand-name and generic Ketoconazole, the generic drug is still considered an effective alternative to the treatment *of Malassezia furfur*. Previous research has also revealed that herbs containing active substances such as Ketoconazole have a powerful effect in the treatment of fungal infections (Leong et al., 2021). Therefore, despite the difference in effectiveness between branded and generic brands, both types of drugs still show good results. However, researchers argue that in choosing the right treatment, both in terms of cost and effectiveness, an in-depth clinical evaluation is required, especially in choosing a treatment according to the patient's condition (Al Aboody & Mickymaray, 2020).

This study provides important insights for medical personnel and the public regarding the effectiveness of generic and branded antifungal drugs in treating *Malassezia furfur* infection. The findings demonstrate that all tested formulations, both generic and branded, are effective against the fungus, with inhibition zones falling within the "sensitive" category. While some branded oral antifungals produced statistically larger inhibition zones, this difference is unlikely to translate to superior clinical outcomes, as generic formulations already achieve adequate therapeutic levels. Importantly, generic drugs such as Ketoconazole provide clinically equivalent results at a substantially lower cost, 4 to 8 times more affordable than their branded counterparts. This evidence can encourage the use of generic drugs as a first-line, cost-effective alternative, particularly for patients with financial constraints, without compromising treatment efficacy. Furthermore, these results can serve as a reference for clinical decision-making, enabling healthcare providers to balance effectiveness, cost, and individual patient

circumstances when selecting antifungal therapy.

This research has several limitations that need to be considered when interpreting the findings. First, the sample size was limited, with only three replicates for each drug group, which may affect the generalizability of the results. Second, sensitivity testing was performed *in vitro* using the disk diffusion method, which may not fully reflect the complex pharmacokinetic and pharmacodynamic responses that occur in actual patients, including factors such as drug absorption, metabolism, and tissue penetration. Additionally, this study did not evaluate the effect of dose variation and treatment duration on drug effectiveness, factors that could yield different outcomes under more complex clinical conditions. Future research should address these limitations by incorporating larger sample sizes, *in vivo* study designs, and clinical trials that account for patient-specific variables to further validate these findings and optimize treatment strategies for *Malassezia furfur* infections.

Conclusion

This study demonstrated that all tested formulations of both topical and oral antifungal drugs, regardless of being generic or branded, were effective in vitro against Malassezia furfur, producing inhibition zones that fell within the "sensitive" category. While all drugs were clinically effective, statistical analysis revealed that among the oral antifungals, Brand C and Brand D produced significantly larger mean inhibition zones compared to their generic equivalents ($p < 0.05$). Despite this statistically significant difference in zone diameter, it is crucial to consider the pharmacoeconomic context: these branded formulations (Brands C and D) are priced 4 to 8 times higher than their generic counterparts. Therefore, while branded options may offer marginally greater in vitro activity, generic antifungals provide a highly sensitive and considerably more cost-effective alternative for the management of Malassezia furfur infections. These findings support the rational selection of antifungal therapy, balancing clinical efficacy with economic considerations.

References

Ahmad, I., Farheen, M., Kukreti, A., Afzal, O., Akhter, M. H., Chitme, H., Visht, S., Altamimi, A. S. A., Alossaimi, M. A., Alsulami, E. R., Jaremko, M., & Emwas, A.-H. (2023). Natural Oils Enhance the Topical Delivery of Ketoconazole by Nanoemulgel for Fungal Infections. *ACS Omega*, *8*(31), 28233–28248. https://doi.org/10.1021/acsomega.3c01571

Al Aboody, M. S., & Mickymaray, S.

(2020). Anti-Fungal Efficacy and Mechanisms of Flavonoids. *Antibiotics*, *9*(2), 45. https://doi.org/10.3390/antibiotics9020045

Alsuhibani, A. A., Alobaid, N. A., Alahmadi, M. H., Alqannas, J. S., Alfreaj, W. S., Albadrani, R. F., Alamer, K. A., Almogbel, Y. S., Alhomaidan, A., & Guo, J. J. (2025). Antifungal Agents' Trends of Utilization, Spending, and Prices in the US Medicaid Programs: 2009–2023. *Antibiotics*, *14*(5), 518. https://doi.org/10.3390/antibiotics14050518

Amanda Dwijayanti, & Musa Fitri Fatkhiyah. (2025). Analisis Pengetahuan Penggunaan Obat Paten dan Obat Generik di Desa Sukorejo Kecamatan Ulujami Kabupaten Pemalang. *OBAT: Jurnal Riset Ilmu Farmasi Dan Kesehatan*, *3*(1), 75–92. https://doi.org/10.61132/obat.v3i1.973

Azis, M. (2022). Tingkat Pengetahuan Masyarakat Tentang Obat Generik dan Obat dengan Nama Dagang di Apotek K24 Bawakarang Makassar. *Jurnal Farmasi Pelamonia*, *2*(1), 60–67. https://ojs.iikpelamonia.ac.id/index.php/Pharmacy/article/view/339

Darma, B. (2021). *Statistika Penelitian Menggunakan SPSS (Uji Validitas, Uji Reliabilitas, Regresi Linier Sederhana, Regresi Linier Berganda, Uji t, Uji F, R2)*. Guepedia.

de Sousa, E. S. O., Cortez, A. C. A., de Souza Carvalho Melhem, M., Frickmann, H., & de Souza, J. V. B. (2020). Factors Influencing Susceptibility Testing of Antifungal Drugs: A Critical Review of Document M27-A4 From The Clinical and Laboratory Standards Institute (CLSI). *Brazilian Journal of Microbiology*, *51*(4), 1791–1800. https://doi.org/10.1007/s42770-020-00354-6

Eliya Mursyida, & Yashi Putri Anjeli. (2024). Nanopartikel Perak dari Ekstrak Kulit Nanas: Potensi Antifungal terhadap Malassezia furfur ATCC 14521. *Termometer: Jurnal Ilmiah Ilmu Kesehatan Dan Kedokteran*, *3*(1), 101–114. https://doi.org/10.55606/termometer.v3i1.4563

Eniayewu, O. ., Faidat, F. ., Afosi, A. ., Bamidele, O. ., Abdullahi S.T, A. S. ., Abdullahi, S. ., Aiyelero, O. ., & Giwa, H. . (2025). Preliminary Quality Evaluation of New Generic Brands of Ciprofloxacin Tablets. *International Journal of Science for Global Sustainability*, *11*(3), 275–280. https://doi.org/10.57233/ijsgs.v11i3.944

Freilich, J., & Kesselheim, A. S. (2025). Frequency and Nature of Generic "Design Around" of Brand-Name

Patents in the United States. *Clinical Pharmacology & Therapeutics*, *118*(1), 190–194. https://doi.org/10.1002/cpt.3659

Galvis-Marín, J. C., Celis-Ramírez, A. M., Tabares-Villa, F. A., Zuluaga-Vélez, A., & Sepúlveda-Arias, J. C. (2025). Characterisation of Antifungal Resistance to Azoles in Colombian Isolates of Malassezia spp. *Mycoses*, *68*(9), e70112. https://doi.org/10.1111/myc.70112

Ketaren, D. R., Suhartomi, S., Fadillah, Q., Panjaitan, J. S. G., Syarifah, S., & Sihombing, J. R. (2024). Perbandingan Obat Anti Jamur Ketoconazole dan Salep 2-4 Pada Kasus Tinea Pedis di Tempat Pembuangan Akhir Sampah Terjun Kota Medan. *Kieraha Medical Journal*, *6*(2), 122–128. https://doi.org/10.33387/kmj.v6i2.9100

Leong, C., Chan, J. W. K., Lee, S. M., Lam, Y. I., Goh, J. P. Z., Ianiri, G., & Dawson, T. L. (2021). Azole Resistance Mechanisms in Pathogenic Malassezia furfur. *Antimicrobial Agents and Chemotherapy*, *65*(5), e01975-20. https://doi.org/10.1128/AAC.01975-20

Massiot, P., Clavaud, C., Thomas, M., Ott, A., Guéniche, A., Panhard, S., Muller, B., Michelin, C., Kerob, D., Bouloc, A., & Reygagne, P. (2022). Continuous Clinical Improvement of Mild-To-Moderate Seborrheic Dermatitis and Rebalancing of The Scalp Microbiome Using A Selenium Disulfide–Based Shampoo After an Initial Treatment With Ketoconazole. *Journal of Cosmetic Dermatology*, *21*(5), 2215–2225. https://doi.org/10.1111/jocd.14362

Miranda, M., Volmer, Z., Cornick, A., Goody, A., Cardoso, C., Pais, A. A. C. C., Brown, M., & Vitorino, C. (2024). In Vitro Studies Into Establishing Therapeutic Bioequivalence of Complex Topical Products: Weight of Evidence. *International Journal of Pharmaceutics*, *656*, 124012. https://doi.org/10.1016/j.ijpharm.2024.124012

Mishra, P., Pandey, C., Singh, U., Gupta, A., Sahu, C., & Keshri, A. (2019). Descriptive Statistics and Normality tests For Statistical Data. *Annals of Cardiac Anaesthesia*, *22*(1), 67. https://doi.org/10.4103/aca.ACA_157_18

Park, M., Cho, Y.-J., Lee, Y. W., & Jung, W. H. (2020). Genomic Multiplication and Drug Efflux Influence Ketoconazole Resistance in Malassezia restricta. *Frontiers in Cellular and Infection Microbiology*, *10*, 1–11. https://doi.org/10.3389/fcimb.2020.00191

Pusmarani, J., Tilu, M. A., & Juliansyah, R. (2023). Uji Aktivitas Antijamur Ekstrak Etanol Biji Keben (Barringtonia asiatica

L .) Terhadap Jamur Malassezia furfur Antifungal Activity of Ethanol Extract of Keben Seeds (Barringtonia asiatica L .) Against Malassezia furfur Info Artikel : Penyakit infeksi me. *Jurnal Pharmacia Mandala Waluya*, *2*(4), 199–210. https://doi.org/https://doi.org/10.54883/jpmw.v2i4.23

Rahmi Safira, & Wizar Putri Mellaratna. (2024). Pitiriasis Versikolor. *Termometer: Jurnal Ilmiah Ilmu Kesehatan Dan Kedokteran*, *2*(3), 112–121. https://doi.org/10.55606/termometer.v2i3.4077

Rakhmawatie, M. D., Lumban Gaol, T. R., & Kurniati, I. D. (2022). Aktivitas Antifungi Cuka Nanas (Ananas Comosus) Pada Pertumbuhan Jamur Malassezia Furfur. *Biomedika*, *14*(2), 136–146. https://doi.org/10.23917/biomedika.v14i2.18564

Shin, J., & Bae, S. (2023). In Vitro Effects of Omeprazole in Combination with Antifungal Compounds Against Malassezia Pachydermatis. *Veterinary Medicine and Science*, *9*(6), 2594–2599. https://doi.org/10.1002/vms3.1305

Shufyani, F., Katiandagho, D., Hayati, R., Fitri, K., Tanjung, D. A., Harahap, N. D., Jannah, F., Sya'diah, Y., Rahmi, S., Fadhilah, H., Kurniasih, D. A. A., & Brata, A. (2025). *Farmakoepidemiologi*. Media Pustaka Indo.

Silva, L. B. B. da, Castilho, I. G., Souza Silva, F. A. de, Ghannoum, M., Garcia, M. T., & Carmo, P. H. F. do. (2025). Antimicrobial Photodynamic Therapy for Superficial, Skin, and Mucosal Fungal Infections: An Update. *Microorganisms*, *13*(6), 1406. https://doi.org/10.3390/microorganisms13061406

Weinstein, M. P., & Lewis, J. S. (2020). The Clinical and Laboratory Standards Institute Subcommittee on Antimicrobial Susceptibility Testing: Background, Organization, Functions, and Processes. *Journal of Clinical Microbiology*, *58*(3), 1–7. https://doi.org/10.1128/JCM.01864-19

Wulandari, M., Arsal, A. S. F., Sodiqah, Y., Fattah, N., & Hadele, A. M. (2025). Comparison of The Sensitivity of Generic and Branded Ciprofloxacin Antibiotics Against Salmonella Typhi. *Healthy Tadulako Journal (Jurnal Kesehatan Tadulako)*, *11*(3), 352–360. https://doi.org/10.22487/htj.v11i3.1659