Infection and Drug Resistance

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ORIGINAL RESEARCH

# "Antimicrobial Activity of the Latex of Jatropha Curcas Against Cutaneous Wound and Burns Infection"

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**Background:** There is a growing interest in natural materials with antibacterial qualities as alternatives. Jatropha curcas latex has long been used to treat infections.

**Objective:** Compare the antimicrobial activities of both *Jatropha curcas latex* and the used antibiotics against the isolated microorganisms which cause wound burn infection.

**Methods:** An experimental study was carried out in Sana'a City, Yemen, to assess the antimicrobial properties of J. curcas latex. Infected burn wounds were found to contain pathogenic microorganisms such as Staphylococcus aureus, Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, and Candida albicans. Standard antimicrobial strains were subjected to testing as well. We obtained latex from verified J. curcas specimens and subjected it to phytochemical analysis. The assessment of antimicrobial activity involved the use of agar well diffusion, disc diffusion, and broth dilution methods to establish inhibition zones and minimum inhibitory concentrations (MICs).

**Results:** The phytochemical examination of J. curcas latex identified the presence of tannins, flavonoids, alkaloids, glycosides, sterols, saponins, and terpenes. The latex exhibited considerable antibacterial efficacy against all tested species, with inhibition zones measuring from 23 mm (K. pneumoniae) to 31.3 mm (S. aureus). The MIC values varied from 6.25 mg/mL (eg, E. coli, K. pneumoniae, C. albicans) to 25 mg/mL (S. aureus, P. aeruginosa). The comparative research indicated that J. curcas latex surpassed tetracycline and had equivalent or better efficacy to ofloxacin and fluconazole against several isolates.

**Conclusion:** The latex of J. curcas has extensive antibacterial action against major burn wound pathogens. Its efficacy can be linked to the presence of several bioactive substances. These findings point to its potential use as a topical antibacterial agent in burn wound treatment, particularly in countries with significant antibiotic resistance.

**Keywords:** *Jatropha curcas*, antimicrobial activity, latex, burn wound infection

## Introduction

Historically, ethnomedicine has made extensive use of the plant's whole spectrum of parts, including its bark, fruit, leaves, stem, and roots, all of which have therapeutic qualities.People recognise the use of herbal medicine and botanical extracts as a substitute for synthetic or pharmaceutical medications, often due to their reduced side effects. The evidence indicates that the application of herbal medicine techniques aligns with a resurgence in natural remedies that typically have fewer or no side effects.[1,2] For thousands of years, this plant has been utilized not only as a preventative and curative measure for various ailments but also as a vegetable with high nutritional value.[3] It is extensively described in the Vedic literature for the treatment of various diseases.[4] Burn injuries constitute a major public health issue globally, particularly in low- and middle-income nations where resources for advanced burn treatment are scarce. The World Health Organisation (WHO) reports that burns result in over 180,000 deaths each year, predominantly in developing regions.[5] Infection is a significant complication of burn injuries, potentially delaying healing, causing systemic complications, and increasing mortality rates. The impaired skin barrier in burn victims facilitates colonisation and invasion by opportunistic pathogens, including Staphylococcus aureus,

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Pseudomonas aeruginosa, Klebsiella pneumoniae, and Candida albicans.[6,7] The standard method for managing burn wound infections involves the administration of systemic or topical antibiotics. The emergence of multidrug-resistant (MDR) organisms has markedly reduced treatment efficacy and heightened the strain on healthcare systems.[8,9] The increasing challenge of antimicrobial resistance (AMR) has prompted investigations into alternative therapies, particularly those originating from natural sources like medicinal plants.[10] Jatropha curcas L., belonging to the Euphorbiaceae family, has been used in traditional medicine to treat various conditions, including skin disorders, infections, and inflammation. The latex comprises various secondary metabolites, including flavonoids, tannins, alkaloids, saponins, terpenoids, and glycosides, which are recognised for their antimicrobial, anti-inflammatory, and wound-healing properties.[11,12] Herbal medicine has contributed numerous powerful medications to the extensive drug arsenal of contemporary medical research worldwide, both in crude form and as a pure chemical on which modern medicines are structured.[13] Recent studies have demonstrated the antimicrobial efficacy of J. curcas latex. Kumar et al formulated a topical herbal cream using J. curcas latex, which demonstrated notable inhibition of prevalent burn pathogens and enhanced wound healing in an in vivo rat model.[14] Ikoyi et al demonstrated that ethanol extracts of J. curcas leaves and latex were effective against clinical isolates of S. aureus, E. coli, and C. albicans obtained from surgical wounds.[15] The results corroborate previous research that emphasised the wound-healing capabilities of J. curcas latex, which are attributed to its proteolytic and angiogenic properties.[16] This study contrasts J. curcas latex with established antibiotics, including ofloxacin, tetracycline, and fluconazole, rather than evaluating herbal extracts in isolation as previous research has done. The results indicate that the latex demonstrates either superior or comparable inhibitory effects against certain pathogens, thereby supporting its potential as a complementary or alternative treatment in response to increasing antimicrobial resistance.[9,15] This study associates the antimicrobial activity of latex with its bioactive constituents, including tannins, flavonoids, saponins, and alkaloids. It quantifies this effect using Minimum Inhibitory Concentration (MIC) values, offering mechanistic insights into its efficacy.[11,12] Considering its favourable antimicrobial properties and historical applications, J. curcas latex merits additional research as a possible alternative or complement to standard antimicrobials in the management of burn wounds. This research evaluates the antimicrobial efficacy of J. curcas latex against clinical sample was isolated for this research from infected burn wounds in Sana'a, Yemen, and compares its effectiveness with that of commonly used antibiotics.

# Methodology

## Study Design and Setting

This study was carried out in a laboratory setting in Sana'a City, Yemen. We conducted the study at the Microbiology Laboratories of Ibin Sina Hospital and the National Centre of Public Health Laboratories, with a focus on pathogen isolation. Phytochemical screening and antimicrobial analysis were performed in the Microbiology Laboratory at the Faculty of Medicine and Health Sciences, Sanaa University.

## Collection and Identification of Plant Material

We cultivated healthy Jatropha curcas specimens in Sana'a to obtain fresh latex. Botanical authentication was conducted at the Botany Unit within the Department of Plant Biology at Sanaa University. We extracted the latex by incising mature stems, collected the exudate in sterile amber bottles, and stored it at 4°C.

## Test Microorganisms

Clinical isolates were obtained from infected wound and burn swabs collected from patients at Ibin Sina Hospital. The microorganisms included:

*Staphylococcus aureus*
*Escherichia coli*
*Klebsiella pneumoniae*
*Pseudomonas aeruginosa*
*Candida albicans*.

## Standard ATCC Reference Strains Were Also Tested for Comparison

*S. aureus* ATCC 13704

*E. coli* ATCC 35218

*K. pneumoniae* ATCC 10273

*P. aeruginosa* ATCC 27853

*C. albicans* ATCC 10231

Identification was confirmed using standard microbiological techniques, including culture, Gram staining, and biochemical tests, as shown in Figures 1–6.

## Preparation of Latex Extract

The crude latex was diluted with 20% dimethyl sulfoxide (DMSO) to create a stock solution at a concentration of 100 mg/mL. Serial dilutions were conducted for the assessment of Minimum Inhibitory Concentration (MIC).

## Antimicrobial Susceptibility Testing

The agar diffusion method using wells was employed to assess antimicrobial activity. Mueller-Hinton agar plates, intended for bacterial cultures, and Sabouraud Dextrose agar plates, designed for fungal cultures, were inoculated with 0.1 mL of a standardised microbial suspension at approximately $10^8$ CFU/mL. Wells with a diameter of 6 mm were filled with 100 µL of latex extract at a concentration of 100 mg/mL. Plates were incubated at 37°C for 24 hours for bacterial

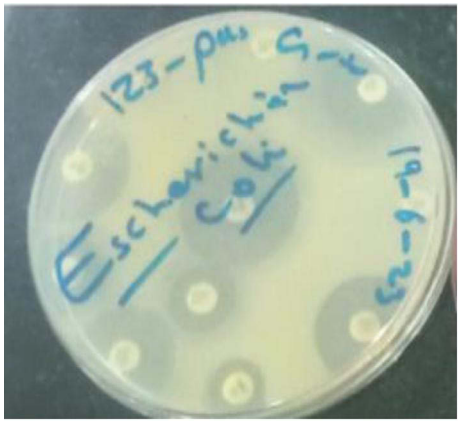


**Figure 1** Culture morphology of Escherichia coli.


**Figure 2** Culture morphology of Klebsiella pneumonia.


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**Figure 3** Culture morphology of Pseudomonas aeruginosa.

**Figure 4** Culture morphology of Staphylococcus aureus.

**Figure 5** Culture morphology of Candida albicans.

cultures and at 25°C for 48 hours for fungal cultures. The inhibition zones were quantified in millimetres. DMSO functioned as a negative control. Standard antibiotics, including ofloxacin (5 µg), tetracycline (30 µg), and fluconazole (25 µg), were used as positive controls. The study was conducted by.[17]

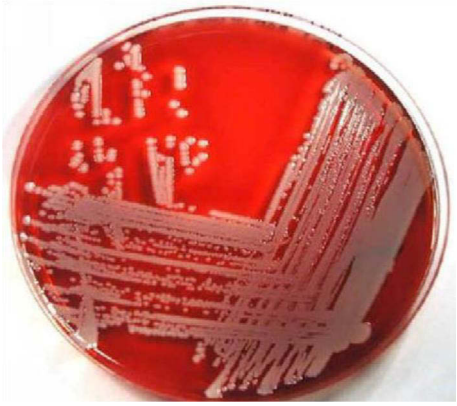

**Figure 6** Culture morphology of Staphylococcus aureus on agar medium.

## Antimicrobial Susceptibility Testing

### Agar Well Diffusion Method

The antibacterial activity of J. curcas latex was determined using the agar well diffusion method. To test for bacteria and Candida albicans, 0.1 mL of a standard microbial suspension (about $10^8$ CFU/mL) was added to Mueller-Hinton agar and Sabouraud Dextrose agar, respectively. Agar wells with a diameter of 6 mm were filled with 100 µL of latex extract (100 mg/mL). Plates were left at room temperature for 30 minutes to allow for pre-diffusion before being incubated at 37°C for 24 hours (bacteria) or 25°C for 48 hours (fungi). The sizes of the inhibition zones were measured in millimetres. as shown in Figure 7.

## Controls

**Negative control**: 20% DMSO

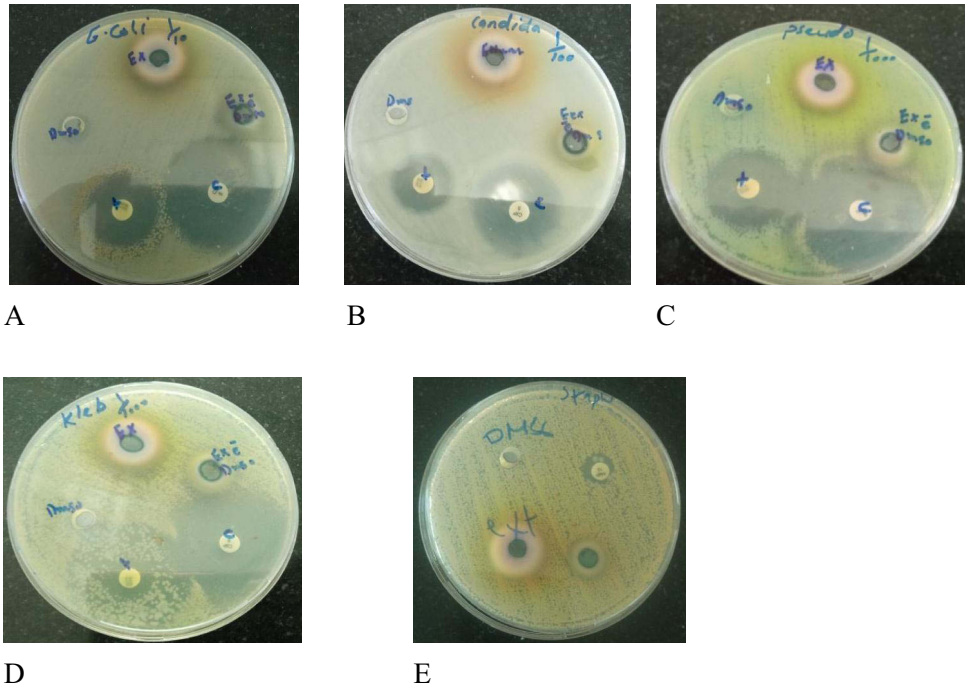


**Figure 7** Anti sensitivity test of J. curcas latex on different microorganism (**A**) Escherichia coli, (**B**) candida albicans, (**C**) Pseudomonas aeruginosa, (**D**) Klebsiella pneumonia, (**E**) Staphylococcus aureus).


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### Positive controls

- Ofloxacin (5 µg) and Tetracycline (30 µg) for bacterial isolates
- Fluconazole (25 µg) for *C. albicans*.[17–19]

## Minimum Inhibitory Concentration (MIC) Determination

As shown in Figures 8 and 9 we assessed the minimum inhibitory concentration (MIC) values using the broth microdilution method on sterile 96-well microplates. Serial two-fold dilutions of latex extract, ranging from 100 to 0.19 mg/mL, were prepared in nutrient broth. Each well was treated with 100 µL of diluted latex and 5 µL of microbial suspension. The plates underwent incubation at 37°C for a duration of 24 hours. The minimum inhibitory concentration (MIC) was defined as the lowest concentration that prevented visible microbial growth. Optical density was assessed at 600 nm using a microplate reader.[20]

## Statistically Analysis

Data were analyzed by using the SPSS program (Social Package of Statistical Science) version 21, were checked for normally distribution, and were expressed as percent, mean ± SD. Differences in variables were tested by using Independent sample *T*-test and chi- square test. Parametric multiple comparisons between the control and the treatment groups and the significant interrelationships between parameters were, analyzed by using One-way ANOVA. The significant differences were indicated if P-value < 0.05.

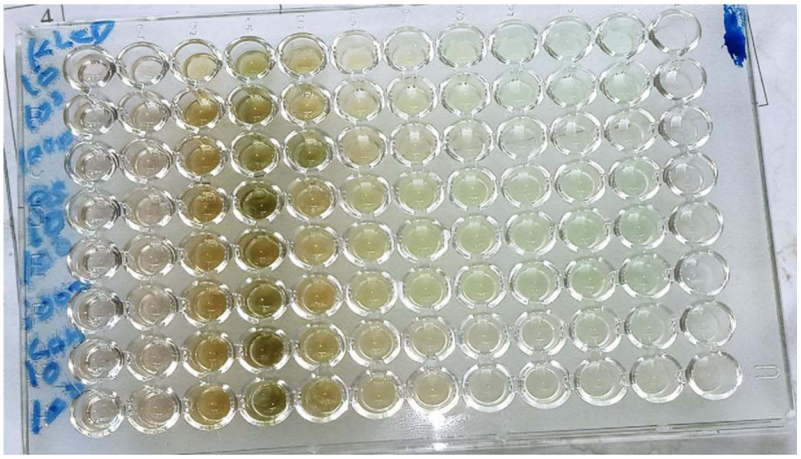

**Figure 8** MIC of Jatropha latex against the isolated microorganisms in the band1 in well of ELISA microplate.

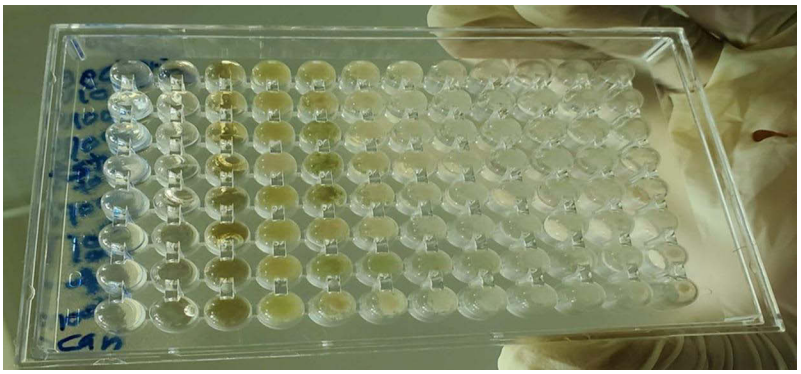

**Figure 9** MIC of Jatropha latex against the isolated microorganisms in the band2 in well of ELISA. Microplate.

## Results

Table 1 illustrates that Staphylococcus aureus was the predominant bacterium detected in burn wound infections, succeeded by P. aeruginosa. This research indicates that these two bacteria are significant contributors to wound sepsis in the study population, highlighting the need for effective antimicrobial treatments for both species.

Table 2 indicates that latex displayed a stronger inhibitory effect on E. coli than both antibiotics, especially against the standard strain. The evidence demonstrates that the latex possesses significant antibacterial activity against E. coli.

Table 3 shows that Latex displayed either marginally higher or comparable inhibition relative to Ofloxacin and significantly exceeded Tetracycline, thus confirming its effectiveness against P. aeruginosa, a recognised drug-resistant pathogen.

Table 4 illustrates Ofloxacin showed marginally better results; however, the latex displayed significant antimicrobial activity and surpassed tetracycline, which was largely ineffective.

**Table 1** Prevalence of the Isolated Pathogens From the Clinical Burn Wounds Samples

| Type of Bacteria | N | % |
|---|---|---|
| *Staphylococcus aureus* | 4 | 33.3 |
| *Pseudomonas aeruginosa* | 3 | 25 |
| *Escherichia coli* | 2 | 16.7 |
| *Candida albicans* | 2 | 16.7 |
| *Klebsiella pneumonia* | 1 | 8.3 |

**Table 2** Mean of Inhibition Zone (in Mm) of Jatropha Latex and the Studied Antibiotics (Positive Control) Against the Isolated E. *Coli* From the Clinical Burn Wounds Samples

| Antibiotics | Mean of Inhibition Zone Against (in mm) | |
|---|---|---|
| | The Clinical Isolate of *E. coli* | *E. coli* ATCC 35218 |
| | Mean ± SD | Mean ± SD |
| Jatropha Curcas latex (100mg/mL) | 28.3± 1.5 | 30.0± 1.4 |
| Ofloxacin (5mcg) | 26.0± 1.5 | 25.8± 1.7 |
| Tetracycline (30mcg) | 24.7± 4.2 | 22.1± 4.8 |

**Table 3** Mean of Inhibition Zone (in Mm) of Jatropha Curcas Latex and the Studied Antibiotics (Positive Control) Against the Isolated Pseudomonas *Aeruginosa* From the Clinical Burn Wounds Samples

| Antibiotics | Mean of Inhibition Zone Against (in mm) | |
|---|---|---|
| | The Clinical Isolate of *Pseudomonas aeruginosa* Mean ± SD | *Pseudomonas aeruginosa* ATCC®27853 Mean ± SD |
| Jatropha Curcas latex (100mg/mL) | 29.0± 2.0 | 29.2± 2.0 |
| Ofloxacin (5mcg) | 28.7± 5.5 | 27.8± 5.7 |
| Tetracycline (30mcg) | 18.3± 2.3 | 20.1± 3.8 |


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**Table 4** Mean of Inhibition Zone (in Mm) of Jatropha Curcas Latex and the Studied Antibiotics (Positive Control) Against the Isolated Klebsiella *Pneumonia* From the Clinical Burn Wounds Samples

| Antibiotics | Mean of Inhibition Zone Against (in mm) | |
|---|---|---|
| | The Clinical Isolate of *Klebsiella pneumonia* | *Klebsiella pneumonia* ATCC 10273 |
| | Mean ± SD | Mean ± SD |
| Jatropha Curcas latex (100mg/mL) | 23.0± 2.2 | 24.0± 2.0 |
| Ofloxacin (5mcg) | 26.3± 1.7 | 25.8± 1.5 |
| Tetracycline (30mcg) | 8.7± 1.5 | 10.1± 1.3 |

**Note**: Data are, expressed as means ± S.D.

Table 5 indicates that latex exhibited superior antibacterial activity against S. aureus compared to both antibiotics, with inhibition zones exceeding 30 mm.

Table 6 demonstrates that Latex exhibits greater antifungal activity than the established treatment, Fluconazole, indicating its considerable antifungal potential.

Table 7 indicates a statistically significant enhancement ($p < 0.05$) in the inhibition of S. aureus by latex. K. pneumoniae demonstrated diminished inhibition from latex; however, this effect remained significant, likely due to variability.

Table 8 displays in all cases, J. curcas latex demonstrated enhanced efficacy relative to tetracycline, suggesting its potential as a broad-spectrum agent.

**Table 5** Mean of Inhibition Zone (in Mm) of Jatropha Curcas Latex and the Studied Antibiotics (Positive Control) Against the Isolated *Staphylococcus* Aureus From the Clinical Burn Wounds Samples

| Antibiotics | Mean of Inhibition Zone Against (in mm) | |
|---|---|---|
| | The Clinical Isolate of *Staphylococcus aureus* | *Staphylococcus aureus* ATCC 13704 |
| | Mean ± SD | Mean ± SD |
| Jatropha Curcas latex (100mg/mL) | 31.3± 1.5 | 32.0± 1.4 |
| Ofloxacin (5mcg) | 23.0± 3.5 | 22.2± 3.7 |
| Tetracycline (30mcg) | 17.7± 2.3 | 16.1± 2.5 |

**Note**: Data are, expressed as means ± S.D.

**Table 6** Mean of Inhibition Zone (in Mm) of Jatropha Curcas Latex and the Studied Antibiotics (Positive Control) Against the Isolated *Candida Albicans* From the Clinical Burn Wounds Samples

| Antibiotics | Mean of Inhibition Zone Against (in mm) | |
|---|---|---|
| | The Clinical Isolate of *Candida albicans* | *Candida albicans ATCC 10231* |
| | Mean ± SD | Mean ± SD |
| Jatropha Curcas latex (100mg/mL) | 29.3± 1.5 | 29.0± 2.0 |
| Fluconazole | 24.3± 2.0 | 24.8± 1.5 |

**Table 7** The Association Between Jatropha Curcas Latex and the Studied Ofloxacin (5mcg) (Positive Control) Against the Isolated Microorganisms From the Clinical Burn Wounds Samples

| Microorganism | Jatropha.Curcas latex | Ofloxacin (5mcg) | P value |
|---|---|---|---|
| *Staphylococcus aureus* | 31.3± 1.5 | 23.0± 3.5 | **0.029** |
| *Klebsiella pneumonia* | 23.0± 2.2 | 26.3± 1.7 | **0.006** |
| *Pseudomonas aeruginosa* | 29.0± 2.0 | 28.7± 5.5 | 0.775 |
| *Escherichia coli* | 28.3± 1.5 | 26.0± 1.5 | 0.053 |

**Notes**: Values highlighted in bold red font indicate statistically significant differences ($p < 0.05$). or key findings of interest, such as the lowest MIC values or highest inhibition zones observed.

**Table 8** The Association Between Jatropha Curcas Latex and the Studied Tetracycline (30mcg) (Positive Control) Against the Isolated Microorganisms From the Clinical Burn Wounds Samples

| Microorganism | Jatropha.Curcas latex | Tetracycline (30mcg) | P value |
|---|---|---|---|
| *Staphylococcus aureus* | 31.3± 1.5 | 17.7± 2.3 | **0.004** |
| *Klebsiella pneumonia* | 23.0± 2.2 | 8.7± 1.5 | **0.001** |
| *Pseudomonas aeruginosa* | 29.0± 2.0 | 18.3± 2.3 | **0.004** |
| *Escherichia coli* | 28.3± 1.5 | 24.7± 4.2 | 0.159 |

**Notes**: Values highlighted in bold red font indicate statistically significant differences ($p < 0.05$). or key findings of interest, such as the lowest MIC values or highest inhibition zones observed.

Table 9 indicates that the antifungal efficacy of latex surpassed that of fluconazole ($p = 0.002$).

All strains exhibited sensitivity to latex; however, several strains displayed resistance or an intermediate response to conventional pharmaceuticals, emphasising the advantage of latex in addressing resistant diseases, as demonstrated in Table 10.

**Table 9** The Association Between Jatropha Curcas Latex and the Studied Fluconazole (Positive Control) Against the Isolated Candida *Albicans* From the Clinical Burn Wounds Samples

| Microorganism | Jatropha.Curcas Latex | Fluconazole (25mcg) | P value |
|---|---|---|---|
| *Candida albicans* | 29.3± 1.5 | 24.3± 2.0 | **0.002** |

**Notes**: Values highlighted in bold red font indicate statistically significant differences ($p < 0.05$). or key findings of interest, such as the lowest MIC values or highest inhibition zones observed.

**Table 10** The Susceptibility of Latex of Jatropha Curcas Against the Isolated Microorganisms From the Clinical Burn Wounds Samples

| Typed sTrains and the Isolated Microorganism | Susceptibility of Latex of Jatropha Curcas Against the Isolated Microorganisms | | | |
|---|---|---|---|---|
| | Jatropha Curcas latex | Ofloxacin (5mcg) | Tetracycline (30mcg) | Fluconazole |
| *Staphylococcus aureus* | S | S | I | R |
| *Klebsiella pneumonia* | S | S | R | R |

(*Continued*)


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**Table 10** (Continued).

| Typed sTrains and the Isolated Microorganism | Susceptibility of Latex of Jatropha Curcas Against the Isolated Microorganisms | | | |
|---|---|---|---|---|
| | Jatropha Curcas latex | Ofloxacin (5mcg) | Tetracycline (30mcg) | Fluconazole |
| *Pseudomonas aeruginosa* | S | S | S | R |
| *Escherichia coli* | S | S | I | R |
| *Candida albicans* | S | R | R | S |
| *Staphylococcus aureus ATCC 13704* | S | S | I | R |
| *Klebsiella pneumonia ATCC 10273* | S | S | R | R |
| *Pseudomonas aeruginosa ATCC®27853* | S | S | S | R |
| *Escherichia coli ATCC 35218* | S | S | I | R |
| *Candida albicans ATCC 10231* | S | R | R | S |

**Abbreviations**: R, Resistance; I, Intermediate; S, Sensitive.

Tables 11 and 12 exhibit MIC values that validate the effectiveness of latex, especially against E. coli and K. pneumoniae. The increased MICs for S. aureus and P. aeruginosa remain within a therapeutic range.

## Discussions

Because of tissue necrosis, moisture, and immunosuppression, burned wounds provide an ideal environment for microbial colonisation, which usually results in severe infections that impede healing and increase patient morbidity.[6,21] The most common pathogens found in this study were Staphylococcus aureus (33.3%) and Pseudomonas aeruginosa (25%), which supports previous research that found both species to be common in nosocomial burn wound infections.[22,23]

According to our findings, Jatropha curcas latex had broad antibacterial activity against all of the wound pathogens that were investigated, including the fungus Candida albicans, Gram-positive bacteria (S. aureus), and Gram-negative bacteria (E. coli, K. pneumoniae, and P. aeruginosa). These results are consistent with other studies that showed the antibacterial efficacy of J. curcas extracts, including those derived from latex and leaves.[12,14]

S. aureus had the greatest sensitivity to latex, displaying the largest zone of inhibition (31.3 mm), significantly exceeding those of ofloxacin and tetracycline ($p < 0.05$). This discovery is important because of the global rise of methicillin-resistant Staphylococcus aureus (MRSA), which poses a considerable challenge in wound treatment.[8] The latex exhibited significant antifungal efficacy against C. albicans, exceeding that of fluconazole ($p = 0.002$), which is noteworthy given the increasing resistance to azole antifungals.[10]

The Minimum Inhibitory Concentration (MIC) values confirmed the effectiveness of the latex. The minimum inhibitory concentrations (MICs) were determined to be 6.25 mg/mL for E. coli, K. pneumoniae, and C. albicans, while S. aureus and P. aeruginosa required higher concentrations of 25 mg/mL. The observed values correspond with previous studies highlighting species-specific variations in sensitivity to J. curcas extracts.[15,17]

The latex is effective against bacteria that are resistant to common antibiotics, particularly tetracycline. In certain instances, the latex produced inhibitory zones for K. pneumoniae and P. aeruginosa, while tetracycline showed none. According to this research, J. curcas latex may be a useful treatment for burn wound infections that are resistant to many drugs, especially in settings with limited resources when second-line antibiotics are not available.[5,9]

**Table 11** Absorbance of Jatropha Curcas Latex Concentration of Each Cell in the Brands Against the Isolated Microorganisms

| Tube No | MIC (mg/mL) | Absorbance of each cell in the brands | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Staphylococcus aureus* | *Klebsiella pneumonia* | *Pseudomonas aeruginosa* | *Pseudomonas aeruginosa* | *Candida albicans* | *S aureus ATCC 13704* | *K. pneumonia ATCC 10273* | *P aeruginosa ATCC®27853* | *E coli ATCC 35218* | *C. albicans ATCC 10231* |
| 1(+v C) | 100 | 0.093 | 0.115 | 0.068 | 0.086 | 0.087 | 0.106 | 0.099 | 0.102 | 0.091 | 0.096 |
| 2 | 50 | 0.102 | 0.116 | 0.112 | 0.105 | 0.096 | 0.015 | 0.107 | 0.112 | 0.105 | 0.113 |
| 3 | 25 | **0.300** | 0.287 | **0.293** | 0.269 | 0.203 | **0.251** | 0.210 | **0.328** | 0.206 | 0.205 |
| 4 | 12.5 | 0.356 | 0.298 | 0.451 | 0.305 | 0.**283** | 0.506 | **0.271** | 0.474 | 0.278 | 0.287 |
| 5 | 6.25 | 0.503 | **0.311** | 0.601 | **0.367** | 0.372 | 0.445 | 0.441 | 0.655 | **0.323** | **0.333** |
| 6 | 3.125 | 0.593 | 0.677 | 0.740 | 0.597 | 0.496 | 0.491 | 0.599 | 0.792 | 0.519 | 0.508 |
| 7 | 1.56 | 0.492 | 0.609 | 0.752 | 0.570 | 0.513 | 0.522 | 0.659 | 0.782 | 0.561 | 0.603 |
| 8 | 0.78 | 0.509 | 0.517 | 0.704 | 0.524 | 0.469 | 0.583 | 0.669 | 0.729 | 0.562 | 0.575 |
| 9 | 0.39 | 0.514 | 0.458 | 0.594 | 0.489 | 0.414 | 0.526 | 0.603 | 0.638 | 0.492 | 0.450 |
| 10 | 0.19 | 0.430 | 0.425 | 0.546 | 0.469 | 0.370 | 0.487 | 0.552 | 0.596 | 0.433 | 0.421 |
| 11 | 0.097 | 0.387 | 0.412 | 0.489 | 0.405 | 0.348 | 0.428 | 0.522 | 0.573 | 0.384 | 0.390 |
| 12(-v C) | | 0.312 | 0.314 | 0.295 | 0.384 | 0.299 | 0.297 | 0.275 | 0.333 | 0.345 | 0.342 |

**Notes**: Values highlighted in bold red font indicate statistically significant differences ($p < 0.05$). or key findings of interest, such as the lowest MIC values or highest inhibition zones observed.

**Table 12** Minimum Inhibitory Concentration (MIC) of Jatropha Curcas Latex Against the Isolated Microorganisms

| | **MIC of Jatropha Curcas Latex Against the Isolated Microorganisms** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tube No | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | MIC (mg/mL) |
| MIC (mg/mL) | 100 | 50 | 25 | 12.5 | 6.25 | 3.125 | 1.56 | 0.78 | 0.39 | 0.19 | 0.097 | 0. 049 | |
| *Staphylococcus aureus* | - | - | - | + | + | + | + | + | + | + | + | + | 25 |
| *Klebsiella pneumonia* | - | - | - | - | - | + | + | + | + | + | + | + | 6.25 |
| *Pseudomonas aeruginosa* | - | - | - | + | + | + | + | + | + | + | + | + | 25 |
| *Escherichia coli* | - | - | - | - | - | + | + | + | + | + | + | + | 6.25 |
| *Candida albicans* | - | - | - | - | + | + | + | + | + | + | + | + | 12.5 |
| *Staphylococcus aureus* ATCC 13704 | - | - | - | + | + | + | + | + | + | + | + | + | 25 |
| *Klebsiella pneumonia* ATCC 10273 | - | - | - | - | + | + | + | + | + | + | + | + | 12.5 |
| *Pseudomonas aeruginosa* ATCC®27853 | - | - | - | + | + | + | + | + | + | + | + | + | 25 |
| *Escherichia coli* ATCC 35218 | - | - | - | - | + | + | + | + | + | + | + | + | 6.25 |
| *Candida albicans* ATCC 10231 | - | - | - | - | - | + | + | + | + | + | + | + | 6.25 |

## Conclusions

According to this study, Jatropha curcas latex exhibits potent and wide-ranging antimicrobial activity against the main bacterial and fungal pathogens linked to burn wound infections, including Candida albicans, Pseudomonas aeruginosa, Klebsiella pneumoniae, Escherichia coli, and Staphylococcus aureus. The latex showed exceptional effectiveness against clinical isolates, including those resistant to common antibiotics like tetracycline and fluconazole, in addition to inhibiting the growth of common laboratory strains. The antibacterial qualities of the latex are probably due to the presence of active phytochemicals like flavonoids, tannins, saponins, alkaloids, and terpenoids. Crucially, the study found that J. curcas latex had low minimum inhibitory concentrations (MICs) and was just as effective—and occasionally even more effective—than conventional antibiotics, especially against Gram-negative bacteria and fungi. According to these results, J. curcas latex has a lot of promise as a natural, plant-based antibacterial agent for burn wound infections, especially in places where access to pharmaceutical therapies is restricted and antibiotic resistance is a growing problem. Isolating active compounds, assessing safety and toxicity profiles, and confirming these results in in vivo wound healing models should be the main goals of future research.

## Data Sharing Statement

All data included in the manuscript are available upon request.

## Consent to Participate

Written informed consent was obtained from all.

## Institutional Review Board

The Institutional Review Board of the Ethics Committee of the Faculty of Medicine and Health Science, Sanaa University, Yemen, authorized this study, which was carried out in accordance with the Declaration of Helsinki's criteria (Research code: REC-25-2024).

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## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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## Disclosure

The authors of this study report no conflicts of interest.

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