

Ethnobotanical survey and anti-candidal activity of *Silene vulgaris* (Moench) Garcke

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Abstract: According to the ethnobotanical survey, *Silene vulgaris* (Moench) Garcke roots were used by local women as vaginal suppositories to cure vaginal yeast infections; however, there is a lack of scientific evidence of the antifungal capabilities of this plant species. This research sought to conduct an ethnobotanical survey and assess the antifungal efficacy of several extracts from *S. vulgaris* roots against *Candida albicans*, the primary pathogen responsible for many vaginal infections. Disc diffusion and well diffusion methods were performed to determine the inhibition growth zone of aqueous and methanolic extracts. Moreover, the minimum inhibitory concentrations (MIC) and the minimum fungicidal concentrations were determined using the microdilution method. The outcomes revealed that water-based extracts, especially the decocted aqueous extract (Dec-H₂O), had a greater effect against *C. albicans* relative to methanolic extracts. The MIC has been determined to be $8.68 \pm 5.68 \text{ mg} \cdot \text{mL}^{-1}$, while the growth inhibition zones, assessed using disc and well diffusion methods at a concentration of $500 \text{ mg} \cdot \text{mL}^{-1}$, were $16.66 \pm 1.52 \text{ mm}$ and $23.33 \pm 2.08 \text{ mm}$, respectively. The findings indicate that the bioactive compounds present in the aqueous extracts of *S. vulgaris* roots may serve as alternative antifungal agents, presenting a viable strategy to combat antibiotic resistance of *C. albicans* in the future. Additionally, the current results demonstrate that the use of medicinal plants by local populations, based on their traditional knowledge and practical experiences, may provide significant and precise insights into the therapeutic attributes of these plants, providing easy guidance for further investigations and applications.

1. INTRODUCTION

The use of medicinal herbs by native peoples, based on their traditional knowledge and practical experiences, may provide significant and precise understanding of the curative attributes of these plants and offer valuable insights into their therapeutic properties. This practice may facilitate the integration of traditional knowledge with modern pharmacology through the scientific assessment of the biological and chemical potentials of these herbs (Mukhrejee, 2019). Throughout generations, communities have maintained a solid understanding of local flora, identifying specific plants that are effective in treating particular diseases (Fabricant & Farnsworth, 2001).

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This experiential knowledge often includes information on the plant parts used, preparation techniques (including decoction, infusion, or direct application), dose, and any adverse effects (Pieroni & Quave, 2005). *Silene vulgaris* (Moench) Garcke is among several plants with potential medicinal applications. It belongs to the Caryophyllaceae family, one of the largest angiosperm families, comprising approximately 86 genera and 2,200 herbaceous species globally, predominantly found in the Mediterranean region, the Middle East, and Central Asia (Mamadalieva *et al.*, 2014).

S. vulgaris, known as "Tighighet" in the Algerian west, is a medicinal plant that has been traditionally used for laundering due to its high saponins content, obtained by simmering the plant's roots in hot water to produce a soap alternative (Berrezig *et al.*, 2024). Studies on *S. vulgaris* indicate noticeable antioxidant, anti-hemolytic, and anti-inflammatory properties that affect its phytochemical composition (Mamadalieva *et al.*, 2014). Multiple classes of compounds, such as saponins, triterpenes, essential oils, flavonoids, ecdysteroids, and phytoecdysteroids, have been isolated from different *Silene* species (Yildirim *et al.*, 2016).

In an ethnobotanical survey conducted in various regions, some women reported that they used *S. vulgaris* roots in a specific recipe as vaginal suppositories for treating uterine disease including candidiasis. *Candida albicans* is a yeast that normally resides on the skin as well as inside the human body, such as the mouth, throat, gastrointestinal tract, and vagina, without eliciting adverse effects (Venyo, 2023). In certain instances, it proliferates excessively, leading to multiple infections, predominantly vaginal candidiasis. Candidiasis can be treated with topical antifungal medications and oral antifungal drugs, including fluconazole, amphotericin B or itraconazole, which are effective against most *Candida* isolates (Lyon & Sunay, 2010).

The current investigation seeks towards evaluating the antifungal activity of *S. vulgaris* extracts against *C. albicans*, the principal pathogen responsible for vaginal candidiasis, through the application of microbiological methodologies.

2. MATERIALS and METHODS

2.1 Instruments/Equipment

The following equipment was used: Rotavapor HeidolphTM (Hei-vap) with vacuum pump; water bath; Reflux condenser assembly ;Cell density meter (WPA CO8000).

2.2. Chemicals

The chemicals used included the following: Methanol from Honeywell (99.7%) – Poland; dimethyl sulfoxide from Sigma-Aldrich (99.9 %); 2,3,5-Triphenyltetrazolium chloride (TTC) from Merck.

2.3. Ethnobotanical Survey

Ethnomedicinal data on *S. vulgaris* plant were collected via direct interviews with fifty-two knowledgeable individuals and visits to herbal shops in multiple regions of Algeria. Data collection employed semi-structured questionnaires, enabling respondents to provide details on the plant's vernacular name, the part used, preparation methods, modes of administration, and intended purposes.

2.4. Plant Collection and Identification

S. vulgaris roots were collected from Ain Dehab province, Tiaret city (located in the Algerian west in a semi-arid climate, latitude: 34.8440, longitude: 1.5500, altitude: 1084 meters) in November 2021. The collected roots were cleaned from the soil using distilled water, subsequently dried away from sunlight and ground into powder by an electric herb grinder, then stored at 4°C in the dark until further use. In addition, the plant was previously identified at the molecular level, and the sequence has been uploaded to NCBI GenBank (accession number: PP316332.1).

2.5. Extraction Procedure

Maceration: 10 g of powdered *S. vulgaris* roots were macerated in 100 mL of distilled water and methanol at room temperature. After 24 h, the mixture underwent filtration and centrifugation for 10 min at 4000 rpm to eliminate the insoluble residue, and then the solution was concentrated using a rotary evaporator under pressure (Hibi *et al.*, 2022).

Under reflux: 10 g of powdered plant materials were combined with 100 mL of distilled water and methanol (100 mL x 2). The mixture was decocted under reflux for 30 min, followed by filtration, centrifugation, and drying using a rotary evaporator under vacuum conditions. The extracts were kept in the dark at 4°C until further analysis (El hadj berrezig *et al.*, 2024).

2.6. Preparation and Inoculation of *C. albicans*

C. albicans ATCC 10231 was acquired from the Microbiology laboratory, Faculty of Natural Science and Life, Bechar University (UTMB), Algeria. The yeast colony was suspended in a 10 mL tube containing a 0.85% NaCl solution. The turbidity was standardised to 0.50 McFarland.

2.7. Disc-Diffusion Method

The antifungal activity of various extracts of *S. vulgaris* was assessed using a disc diffusion assay. The fresh inocula of *C. albicans* ATCC 10231 were suspended in sterile saline water (equivalent to the 0.5 McFarland standard) in order to smear it on Sabouraud Dextrose Agar (SDA). 6 mm diameter sterile filter paper discs were saturated with a 50 µL extract solution of serial dilutions in 1% dimethyl sulfoxide (DMSO) and subsequently deposited on the agar media plates. The positive control was done using standard antibiotics (fluconazole, fluconad, itraconazole, mycozan, and amphotericin B), while the negative control employed a solvent (DMSO) at concentrations of 1%, 5%, and 10%. The growth inhibition zone was measured with a caliper after 24 h of incubation at 37°C, with the diameter including the disc (Utami & Putri, 2020).

2.8. Agar Well Diffusion Method

The agar well diffusion method is a standard technique used to assess the efficacy of plant extracts against microorganisms. An appropriate agar medium, such as SDA for *C. albicans*, was prepared, sterilised, and distributed onto sterile petri plates. Upon solidification, the agar surface was uniformly inoculated with a standardised microbial suspension, adjusted to the 0.5 McFarland standard, to establish a fungal lawn. Using a sterile cork borer or pipette tip, wells of uniform size (6-8 mm in diameter) were made in the agar and subsequently filled with fixed volumes (50–100 µL) of the test sample, positive control (antibiotics), and negative control (DMSO at concentrations of 1%, 5% and 10 %).

After a 1h diffusion of the samples at ambient temperature, the petri dishes are incubated at 37°C for 24 h. Zones of inhibition, defined as clean areas around the wells, were then measured in mm to evaluate antifungal efficacy (Gonelimali *et al.*, 2018).

2.9. Microdilution Method

Microdilution assays were conducted in sterile 96-well round-bottom microplates; 90 µL of Sabouraud broth was dispensed into each well of the plates. In the first well (row A) of each column (columns 1 to 12), 100 µL of plant extracts dissolved in 1% DMSO were introduced. Subsequently, serial dilutions were executed by transferring 100 µL from wells 1 to 8, yielding the following ratios: 1:2 (A1), 1:4 (A2), 1:8 (A3), 1:16 (A4), 1:32 (A5), 1:64 (A6), 1:128 (A7), 1:256 (A8). In each test well, 10 µL of the corresponding inoculum was introduced (0.5 McFarland). The positive controls were 100 µL of each antibiotic (50 mg·mL⁻¹), 90 µL of medium and 10 µL of inoculum. The control test consisted of 100 µL of Sabouraud broth, 100 µL of 1% DMSO, and 10 µL of inoculum. For the negative control, 100 µL of medium and 10 µL of inoculum were included. To prevent contamination of the media, an additional column

was filled with 100 μL of medium only (sterile control test). The plates were incubated at $37 \pm 2^\circ\text{C}$ for a duration of 22 h.

Following the incubation, 20 μL of 5% TTC solution was introduced to each well, and the plates were then incubated for an additional 2 h. Following incubation, visual assessments were conducted by examining the presence or lack of pink coloration resulting from the conversion of TTC (colorless) to formazan (pink). The minimum inhibitory concentration (MIC) was defined as the point at which no color development occurred to ascertain the MIC (Veiga *et al.*, 2019). Moreover, aliquots (often 10 μL) from wells at and above the MIC are inoculated into SDA medium. The agar plates are cultured under optimal conditions for fungal growth. Following incubation, the minimum fungicidal concentration (MFC) is identified as the lowest concentration of the antifungal agent that achieves a 99.9% (3-log) decrease in colony-forming units (CFU) relative to the initial inoculum (Sasoni *et al.*, 2023).

2.10. Statistical Analysis

Results of the disc diffusion method, the well diffusion method, and the microdilution method were presented as mean $\pm$ standard deviation (SD) using three replicates. For the ethnobotanical results, frequency calculations were used. Statistical analyses were conducted with GraphPad Prism 8.0.1 software.

3. RESULTS and DISCUSSION

3.1. Ethnobotanical Survey

The extensive distribution of *S. vulgaris* throughout Algeria has led to the emergence of numerous vernacular names, reflecting the country's vast geographic scope, the cultural and linguistic diversity of its population. The research revealed that elderly people have a greater understanding of medicinal herbs and use plants more often than younger people. The utilisation of *S. vulgaris* exhibits gender differences, as married women integrate it into their routines more frequently than men. Despite varying literacy levels, even those who are illiterate demonstrated familiarity with at least one practical use of this plant. All the gathered insights into its medicinal applications and potential to treat certain ailments have been carefully documented (Table 1, Figure 1). The findings underscore the varied importance of *S. vulgaris* in traditional practices, serving in both nutritional and therapeutic capabilities. The primary use as a food source (38.46%) highlights its significance in local diets, possibly enhancing nutritional security. The plant's therapeutic uses, particularly for treating worms (28.84%) and uterine infections (9.61%), indicate its significance in addressing prevalent health issues in the community. Its employment in washing (15.38%) illustrates a practical application of its natural properties (saponins richness), but its exterior applications and diuretic effects (3.84% each) further exemplify its multifunctionality.

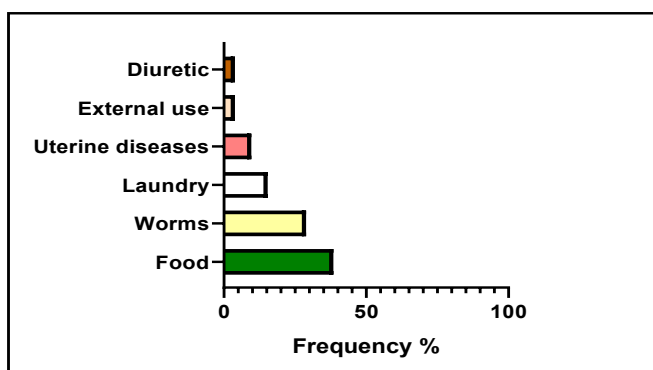


Figure 1. Frequency of intended usage of *S. vulgaris* plant.

Table 1. Ethnobotanical data collected from local people.

Scientific name	Vernacular names	Part/s used	Intended usage	Preparation method	Mode of administration	Recipe
<i>Silene vulgaris</i> (Moench) Garcke	1-Tighighet (Algerian west)	Roots	laundry	Maceration/ Decoction	/	- Wash clothes and sheep wool with the decocted extract.
	2-Tichekhchekh (Setif)	Roots	Intestinal worms	Decoction	Oral	- Boil water, and then include 0.5 to 1 g of powdered root. Allow it to cool and consume twice daily, upon awakening and before sleeping, for three consecutive nights. If needed, repeat the process after a 15-day interval.
	3-Tighechghech (Tebessa)	Roots	Diuretic	Decoction	Oral	- Remove stones from urinary tractus through diuresis by drinking the decocted roots.
	4-Aghighach ⵓⵔⵉⵖⵉⵎⵉⵏ	Roots	Uterine diseases	Direct	Vaginal suppositories	- Combine root powder with honey, freeze to create solid suppositories, and thereafter use in the vagina to address candidiasis, cold uterus, and infertility.
	Thighighache (kabyle)	Roots	Acne/hair	Decoction	Eternal use	- Cleanse your face with the decoction twice per day; it is also suitable for hair cleansing.
	5-Tighighecht (Algiers)	Young sheets and stems.	Anemia	Cooked	Oral	- Steam the leaves and stems, then include olive oil or prepare them fried with eggs, as an omelet. It is also used in “Bourak” preparation.
	6-Teririte (Tipaza)					- It's could mixed with flour and cooked like bread called “Khebiza” (referred to as “Aghroum elahchich” or “Aghroum lahwal” by the Kabyle people of Algeria).
	7-Haghighayt ⵓⵔⵉⵖⵉⵎⵉⵏ					- They may also be enjoyed raw as a salad with olive oil.
	(Chaouia)	Roots	Psoriasis/wounds/Eczema	Poultice	External use	- Applied crushed roots to the skin and wrapped in a towel to improve heat retention and promote the absorption of the active compounds.

These results underscore *S. vulgaris* as an essential resource in ethnobotanical practices, providing nutrition and treatments for several diseases. Moreover, the findings documented in Table 1 and Figure 1 align with many previous data on the various medicinal uses of this plant. *S. vulgaris* was conventionally used as an anti-anemic and as a treatment for eczema, psoriasis, wounds, itch, and several other dermatological disorders (Conforti *et al.*, 2011; Boukhira *et al.*, 2015). Additionally, *S. vulgaris* is recognized for its antiviral, antifungal, antibacterial, antioxidant characteristics, which corroborate its traditional use (Bushneva *et al.*, 2003; Kucukboyaci *et al.*, 2010; Mohti *et al.*, 2023; Orhan *et al.*, 2009).

3.2. Yields

The extraction yields of *S. vulgaris* roots or leaves are influenced by the solvent employed (water or methanol) and the extraction method used (maceration or decoction). Table 2 indicates that the aqueous macerated extract (Mac-H₂O) and aqueous decocted extract (Dec-H₂O) demonstrate better yields compared to the methanoic macerated extract (Mac-MeOH) and methanoic decocted extract (Dec-MeOH).

Table 2. Yields percentage of *S. vulgaris* extracts.

Compounds	Yields % (W/W)
Mac-H ₂ O	27.33
Dec-H ₂ O	23
Mac-MeOH	14.4
Dec-MeOH	13.6

3.3. Antifungal Activity Evaluation

3.3.1. Well diffusion results

The antifungal activity of several extracts has been tested against *C. albicans* applying the agar well diffusion method. The outcomes, shown as zones of inhibition (in mm), provide insight into the comparative efficacy of each treatment (Table 3, Figure 2).

Table 3. Results of well diffusion method.

Extracts	Zone of inhibition average $\pm$ SD (mm)			
	62.5 mg/mL	125 mg/mL	250 mg/mL	500 mg/mL
Dec-H ₂ O	16.16 $\pm$ 0.28	17.83 $\pm$ 0.28	20.66 $\pm$ 0.57	23.33 $\pm$ 2.08
Mac-H ₂ O	13.33 $\pm$ 0.57	15.33 $\pm$ 0.57	17.66 $\pm$ 2.08	19 $\pm$ 1.73
Dec-MeOH	8	8 $\pm$ 3.46	13.66 $\pm$ 0.57	16.33 $\pm$ 0.57
Mac-H ₂ O	8	8	13.66 $\pm$ 0.57	17 $\pm$ 1.73
Antibiotics	50 mg/mL			
Fluconazole	20.66 $\pm$ 1.15			
Fluconad	8			
Mycozan	18 $\pm$ 2.64			
Itraconazole	6			
Amphotericin B	17.5 $\pm$ 0.5			
DMSO 1%	6			

*Values expressed are means $\pm$ S.D. of three parallel measurements.

Fluconazole, a commonly used antifungal agent, had the most potent action with an average inhibition zone of 20.66 $\pm$ 1.15 mm, establishing a standard for comparison. Amphotericin B, an additional efficacious antifungal, provided slightly smaller zones (17.5 $\pm$ 0.5 mm) but remained active. Mycozan, an often-evaluated drug, had significant activity with inhibition

zones of 18 ± 2.64 mm. Both itraconazole and fluconad, as well as the solvent control (DMSO 1%), had no significant action, consistently exhibiting no inhibition over the baseline zone of 6 mm.

Dec-H₂O proved to be the most effective natural extract, with dose-dependent inhibition zones that expanded from 16.16 ± 0.28 mm at $62.5 \text{ mg} \cdot \text{mL}^{-1}$ to an impressive 23.33 ± 2.08 mm at $500 \text{ mg} \cdot \text{mL}^{-1}$, comparable to the standard fluconazole. Mac-H₂O exhibited significant antifungal efficacy, with inhibition zones ranging from 13.33 ± 0.57 mm at lower dosages to 19 ± 1.73 mm at $500 \text{ mg} \cdot \text{mL}^{-1}$. Although effective, it was less strong than its decoction equivalent.

Water-based extracts, especially Dec-H₂O, have been shown to be the most effective natural antifungal agents against *C. albicans* (Figure 2). Their efficacy at elevated concentrations competes with pharmaceutical standards such as fluconazole, indicating the presence of powerful water-soluble antifungal agents. Methanolic extracts, while effective, exhibited reduced potency, suggesting that the principal bioactive chemicals are likely more polar and preferentially extracted by water.

The dose-dependent augmentation of inhibitory zones for all extracts emphasizes the concentration-dependent antifungal efficacy, highlighting their potential therapeutic significance. A previous investigation on the secondary metabolites of *S. vulgaris* roots indicated that this portion is abundant in saponins, which may be responsible for this action. Furthermore, combining these natural extracts with conventional antifungal drugs may investigate possible synergistic effects for improved treatment techniques.

3.3.2. Disc diffusion results

Table 4 outlines the antifungal activity of several extracts and controls, measured by their zone of inhibition (in mm) across varying concentrations (62.5 – $500 \text{ mg} \cdot \text{mL}^{-1}$).

Table 4. Results of disc diffusion method.

Extracts	Zone of inhibition average $\pm$ SD (mm)			
	62.5 mg/mL	125 mg/mL	250 mg/mL	500 mg/mL
Dec-H ₂ O	6	10.66 ± 1.15	12.66 ± 1.52	16.66 ± 1.52
Mac-H ₂ O	6	9.33 ± 1.15	9.66 ± 0.57	11.66 ± 0.57
Dec-MeOH	6	6	6	8.66 ± 2.51
Mac-H ₂ O	6	6	6	7 ± 1.73
Antibiotics	50 mg/mL			
Fluconazole	12.33 ± 2.08			
Fluconad	6			
Mycozan	8.66 ± 4.61			
Itraconazole	6			
Amphotericin B	6			
DMSO 1%	6			

*Values expressed are means $\pm$ S.D. of three parallel measurements.

Fluconazole (12.33 ± 2.08 mm) exhibits the greatest inhibition among the controls, validating its effectiveness as a conventional antifungal drug. Additional controls, such as fluconad, itraconazole, amphotericin B, and DMSO 1%, exhibit no inhibition (zone = 6 mm), suggesting an absence of antifungal activity under these conditions.

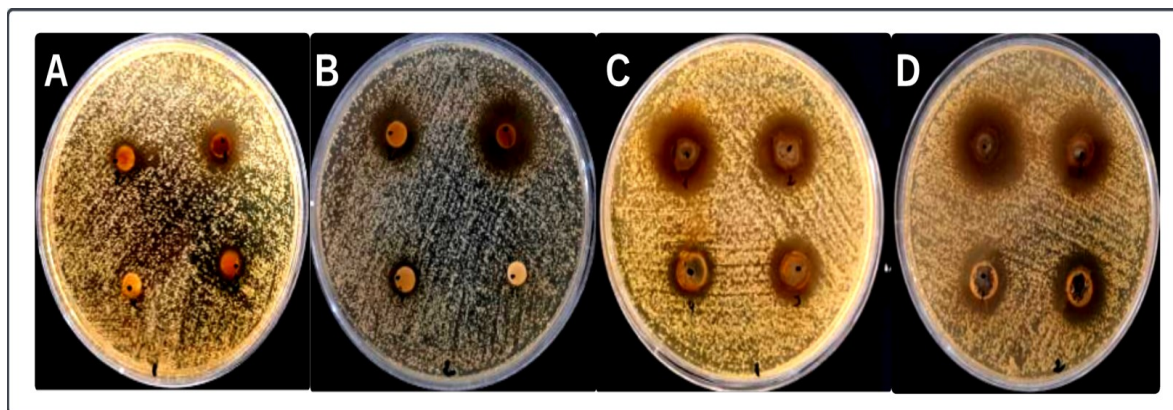


Figure 2. Visualization of antifungal activity of *S. vulgaris* water-base extracts in different concentrations (500; 250; 125; 62.5 mg/mL) using disc diffusion method (A: Dec-H₂O extract, B: Mac-H₂O) and well diffusion method (C: Dec-H₂O extract, D: Mac-H₂O).

Dec-H₂O and Mac-H₂O exhibit dose-dependent antifungal efficacy, with inhibition zones expanding from 10.66 ± 0.15 mm at $125 \text{ mg} \cdot \text{mL}^{-1}$ to 16.66 ± 1.52 mm at $500 \text{ mg} \cdot \text{mL}^{-1}$ for Dec-H₂O and from 9.33 ± 1.15 mm at $125 \text{ mg} \cdot \text{mL}^{-1}$ to 11.66 ± 0.57 mm at $500 \text{ mg} \cdot \text{mL}^{-1}$ for Mac-H₂O, respectively. This indicates that polar bioactive chemicals obtained by decoction effectively suppress the development of *C. albicans*.

Dec-MeOH and Mac-MeOH demonstrate limited antifungal activity, with inhibition zones varying from 6 mm (no inhibition) to 8.66 ± 2.51 mm at $500 \text{ mg} \cdot \text{mL}^{-1}$ for Dec-MeOH and 7 ± 1.73 mm for Mac-MeOH at the same concentration. This indicates that methanol extracts are often less effective, either owing to lower quantities of active polar chemicals or poor diffusion properties. These results warrant more research into *S. vulgaris* as a source of natural antifungal agents, specifically emphasising the isolation and characterisation of the active components in aqueous extracts.

In antifungal research, modest doses of DMSO (1-10%) may augment the efficacy of antifungal drugs without directly suppressing fungal proliferation, making it a significant additive in microbiological experiments. Nonetheless, appropriate negative controls (DMSO alone) are essential to confirm that the reported antifungal effects are due to the investigated chemical compounds rather than the solvent itself. The disc diffusion technique and agar well diffusion method (Figure 3) were used to verify repeatability and confirm the efficacy of the extracts under varying testing settings. To confirm that the inhibitory zones identified with *S. vulgaris* extracts were not attributable to DMSO, negative controls containing 1%, 5%, and 10% of DMSO were evaluated, given that DMSO alone may exhibit a little antifungal activity. The missing inhibitory zones in the negative control (DMSO 1% 5%, and 10%) support the natural antifungal activities of *S. vulgaris* extracts.

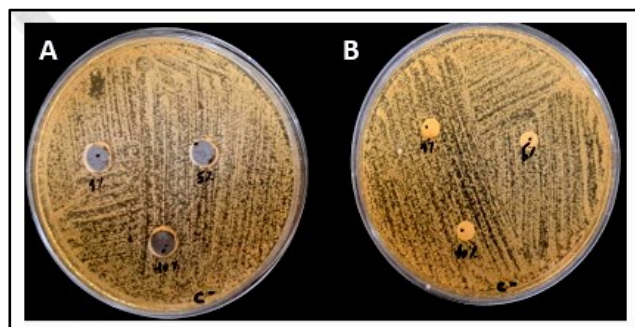


Figure 3. Negative controls consist of DMSO at concentrations of 1%, 5%, and 10%, using the agar well diffusion method (A) and the disc diffusion method (B).

3.3.3. Microdilution results

As demonstrated in Table 5, Dec-H₂O extract has the most potent antifungal activity, with an MIC of $8.68 \pm 5.68 \text{ mg} \cdot \text{mL}^{-1}$ and an MFC of $12.40 \pm 4.29 \text{ mg} \cdot \text{mL}^{-1}$. Mac-H₂O extract exhibits somewhat reduced activity relative to Dec-H₂O, with MIC and MFC values recorded at $12.40 \pm 4.29 \text{ mg} \cdot \text{mL}^{-1}$. Dec-MeOH extract exhibits markedly elevated MIC and MFC values ($29.76 \pm 0 \text{ mg} \cdot \text{mL}^{-1}$ and $19.87 \pm 8.56 \text{ mg} \cdot \text{mL}^{-1}$, respectively), suggesting lower antifungal efficacy relative to aqueous extracts.

Table 5. Results of microdilution method.

Compounds	MFC (mg/mL)	MIC (mg/mL)
Mac-H ₂ O	12.4±4.29	12.4±4.29
Dec-H ₂ O	12.4±4.29	8.68±5.68
Mac-MeOH	24.69±8.78	14.92±4.29
Dec-MeOH	29.76±0	19.87±8.56

The antifungal efficacy of *S. vulgaris* extracts against *C. albicans* shown in this work agrees with previous research emphasizing the *Silene* genus as a source of bioactive chemicals. A research study on *Silene uniflora* revealed substantial antimicrobial activities, especially against fungal infections, indicating the existence of effective antifungal compounds within this species (Buzón-Durán *et al.*, 2023). Also, the findings reported by Zengin *et al.* (2018) confirm that *S. vulgaris* exhibits potential antifungal activities, consistent with the current results. Furthermore, the previous study agrees with the ethnobotanical data collected (Table 1, Figure 1).



Figure 4. Visualization of inhibition zones of the used antibiotics against *C. albicans*.

The findings of Boukhira *et al.* (2017) indicate that *S. vulgaris* leaves exhibit an MIC above 10 mg/mL, suggesting a moderate anti-candida effect. In parallel, our findings for the Dec-H₂O root extract ($8.68 \pm 5.68 \text{ mg} \cdot \text{mL}^{-1}$) support this pattern, exhibiting similar antibacterial efficacy. This indicates that both the leaves and roots exhibit antifungal activities, but with differing efficacy, likely linked to variations in phytochemical composition.

This study's dose-dependent development in antifungal activity supports the prospective therapeutic use of *S. vulgaris* extracts. Comparable findings have been seen in investigations examining various plant extracts, whereby increased concentrations corresponded with enhanced suppression of fungal proliferation. A hydro-ethanoic extract from *Astronium urundeuva* showed increased antifungal efficacy against *Candida* species at elevated doses (Bonifácio *et al.*, 2019).

The antibiotic inhibition zones in the disc diffusion experiment (Figure 4) indicate tiny *C. albicans* colonies near the treated region. This indicates that the drugs were insufficient in inhibiting fungal proliferation. The persistence of *C. albicans* at the antibiotic doses generates selection pressure that may promote resistance development. Prolonged exposure may allow

the pathogen to adapt and endure elevated quantities of these antibiotics, hence increasing resistance.

The high level of saponins in *S. vulgaris* is intricately associated with its antifungal efficacy, since saponins are recognized for their capacity to disrupt fungal cell membranes. Saponins have amphiphilic characteristics, allowing them to interact with sterols, especially ergosterol, an essential element of fungal membranes. This interaction modifies membrane permeability, resulting in cell lysis and the suppression of fungal growth. Considering that, *C. albicans* depends on intact membranes for its life and virulence, the elevated saponins concentration in *S. vulgaris* extracts probably contributes substantially to its antifungal effectiveness.

4. CONCLUSION

The findings of the current research demonstrate that medicinal plants continue to play a significant role in the primary healthcare system of the Algerian population. *C. albicans* is the primary causative agent of vaginal yeast infections, a prevalent condition impacting millions of women globally. The development of efficient, plant-derived therapies could offer cost-effective and accessible treatment options, particularly in resource-constrained settings where standard antifungal medications may not be accessible. The findings of this study align with prior reports from local populations regarding the use of the plant roots to treat candidiasis, thereby supporting the potential of *S. vulgaris* as a source for natural antifungal agents. The beneficial effects of water-based extracts, especially those obtained through decoction, underscore the significance of extraction techniques in isolating active compound. Moreover, the growing threat of antibiotic resistance necessitates the investigation of alternative treatments, with plant metabolites representing a promising and viable option. Their diverse mechanisms of action, ability to synergise with antibiotics, and reduced possibility of resistance development render them a significant area of research in combating resistant pathogens.

Declaration of Conflicting Interests and Ethics

The authors declare no conflict of interest. This research study complies with research and publishing ethics. The scientific and legal responsibility for manuscripts published in IJSM belongs to the authors.

Authorship Contribution Statement

Abdelkader El hadj Berrezig: Plant sampling and molecular identification, Resources, Experimental studies, Formal analysis, and Writing - original draft. **Achraf Khaldi & Kheira Mehdi:** supervision, and validation. **Amar Yazid:** Resources.

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