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Phytochemical study and biological activity of *Lagenaria siceraria* from the El Oued region

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Abstract

The objective of this study is to examine the phytochemical properties and biological activities of the aerial parts of the *Lagenaria siceraria* plant from the Guemmar and Ourmes regions, extracted with methanol. The study demonstrated that the methanolic extracts from the Guemmar and Ourmes regions possess significant phytochemical and antioxidant properties, particularly those from the Guemmar region. It showed a total phenolic compound content of 25.866 ± 0.09 milligrams of gallic acid equivalent per gram of extract, flavonoid content of 7.625 ± 0.120 mg QAE/g Ex, and protein content of 260 mg/g. In comparison, the Ourmes extracts presented a phenolic compound content of 5.43 ± 0.44 mg GAE/g Ex, flavonoid content of 3.418 ± 0.227 mg QAE/g Ex, and protein content of 95 mg/g. Methanolic extract-based creams showed concentration-dependent wound healing, with the EG cream inducing nearly complete tissue repair in 20 days. These properties confer a notable therapeutic potential to the plant, particularly in terms of wound healing. Consequently, *Lagenaria siceraria* could be exploited as a valuable natural resource for nutritional and medicinal applications, allowing us to highlight the wound-healing potential of the plant through creams at different concentrations.

Keywords: **:** *Lagenaria siceraria*, phenolic compounds, phytochemical property, antioxidant activity, wound healing.

INTRODUCTION

The use of medicinal plants dates back centuries and continues to play a significant role in modern healthcare practices across the world. Despite the remarkable advancements in medical and pharmaceutical research, the importance of medicinal plants has not diminished. In fact, traditional medicine remains a vital resource for millions of people, especially in rural areas where access to modern medical facilities is limited. Plants have long been recognized for their therapeutic properties, and they offer immediate, affordable, and accessible remedies for various ailments (Srivastava *et al*., 1996; Mazid *et al*., 2012). Medicinal plants, used in their raw form, have become indispensable in many traditional medical systems, and nearly all parts of the plant, including fruits, stems, roots, flowers, and leaves, are used for their medicinal properties (Mukherjee, 2002).

Among the many families of medicinal plants, the Cucurbitaceae family is particularly important due to its economic value and its widespread use as a food source. Plants from this family, such as melons, squashes, and gourds, are commonly used not only for nutrition but also for their pharmacological properties, including anti-ulcer, anti-diabetic, analgesic, nephroprotective, and anticancer effects (Patel *et al*., 2020). With over 122 genera and 940 species worldwide, the Cucurbitaceae family holds a rich diversity of species, many of which are used in traditional medicine across various cultures (Renner & Pandey, 2013; Renner, 2013). This family of plants is renowned for its unique phytochemical composition, which includes bioactive compounds like cucurbitacins, known for their diverse therapeutic properties, including liver protection, cardiovascular benefits, and antimicrobial effects (Zhou *et al*., 2016).

One notable member of this family is *Lagenaria siceraria* (Figure 1), commonly known as bottle gourd. This climbing or trailing herb has a long history of use in traditional medicine and is valued for its many health benefits (Pullaiah, 2006). Different parts of the plant, including its fruit, seeds, and roots, are used for treating a variety of conditions such as muscle pain, cough, and inflammation. The fruit is known for its mild, diuretic, and antipyretic properties, while the seeds are used for respiratory and brain tonics, and the root is employed to treat dropsy (Kirtikar and Basu, 2005). Nutritional analysis of the edible part of the bottle gourd shows it is rich in glucose, fructose, amino acids, and vitamins B and C, along with other phytochemicals like triterpenoids and flavones (Ghosh *et al*., 2009).

Although extensive research has been conducted on the fruits and seeds of *Lagenaria siceraria*, the aerial parts of the plant, such as its leaves and stems, remain underexplored in terms of their pharmacological potential. This study aims to address this gap by investigating the phytochemical composition and biological activities of the aerial parts of *Lagenaria siceraria* from different regions, with a focus on their antioxidant, anti-inflammatory, and wound healing properties. With increasing interest in natural remedies as alternatives or complements to modern medicines in developed countries, the exploration of *Lagenaria siceraria*'s potential could contribute significantly to expanding its applications in healthcare (Uzma *et al*., 2020).

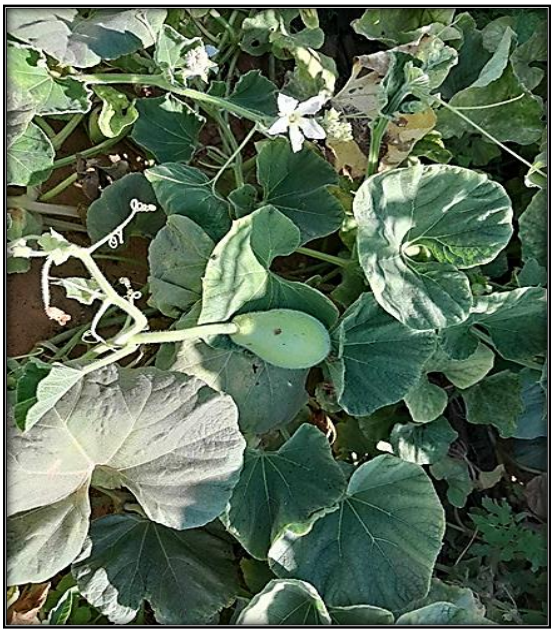

Figure 1. The organs of *Lagenaria Siceraria*.

MATERIALS AND METHODS

Preparation of plant material

In this study, the aerial parts of *Lagenaria siceraria* were collected from the Guemmar and Ourmes regions (El Oued province) between July and August. After cleaning the samples, the fruits were sliced thinly and dried in a shaded, moisture-free environment at room temperature for two months to preserve their components. Once fully dried, the material was ground into a fine powder using a coffee grinder. The resulting powder was stored in clean, airtight glass containers to protect it from moisture, ensuring optimal preservation for subsequent biological activity analyses.

Quantification of Primary Metabolites

Ash and Organic Matter Content

Following a modified method from AOAC (1995), one gram of dried plant material is placed in a pre-weighed porcelain crucible and incinerated at 600°C for 6 hours in a muffle furnace. The resulting ash, representing the mineral content, is used to estimate the organic matter present in the sample. The percentage of organic matter (OM) is calculated using the following formula:

$$OM\% = ((DMW - AW)/SW) \times 100$$

Where:

OM = Organic matter

DMW = Dry matter weight

AW = Ash weight

SW = Sample weight

The mineral content (ash) is calculated using:

$$Ash\% = ((WCA - WEC)/SW) \times 100$$

Where:

C % = Ash percentage

WCA = Weight of the crucible with ash

WEC = Weight of the empty crucible

SW = Sample weight

Estimation of Primary Metabolites (Carbohydrates, Proteins, and Lipids)

The methodology used for the estimation of primary metabolites (carbohydrates, proteins, and lipids) was adapted from Chouikh *et al*. (2024). One gram of plant material was mixed with 5 mL of trichloroacetic acid (TCA) and shaken for 5 minutes using a magnetic stirrer. The mixture was then centrifuged at 3000 rpm for 10 minutes, separating the supernatant, which was used for carbohydrate quantification. The first deposit (pellet) was further centrifuged with 2 mL of ether/chloroform (V/V) for 10 minutes, after which the second supernatant was collected for lipid analysis, while the remaining pellet was treated with 2.5 mL of 0.1 M sodium hydroxide (NaOH) for protein analysis.

Carbohydrate Estimation followed the DuBois *et al*. (1956) method, using a mixture of 5% phenol and concentrated sulfuric acid. The absorbance was measured at 490 nm, with

glucose as the calibration standard. Results were expressed as milligrams of carbohydrates per gram of plant material.

Protein Estimation was carried out using the Lowry method (1951), employing Folin-Ciocalteu reagent, NaOH (0.1 M), $CuSO_4$ (0.5%), and $KNaC_4H_4O_6 \cdot 4H_2O$ (0.1%). Bovine Serum Albumin (BSA) was used as the standard, and absorbance was read at 750 nm using a UV spectrophotometer. The protein content was expressed as milligrams per gram of plant material.

Lipid Estimation followed the method of Goldsworthy *et al*. (1972), with modifications, using sulfophosphovanillin reagent and concentrated sulfuric acid. The reaction tubes were placed in a 100°C water bath, and absorbance was measured at 530 nm, with soy serving as the lipid standard. Results were expressed as milligrams of lipids per gram of plant material.

Phytochemical study

Preparation of methanolic extract

50g of the dry matter was placed to macerate in 250ml of absolute methanol for 24 hours at room temperature for a test sample. Once the mixture was filtered, the extract was evaporated using laboratory ovens to obtain a dry extract (Chouikh *et al*., 2024a).

Determination of Total Polyphenols and Flavonoids Content

The total polyphenols content (TPC) in the extract was determined using the Folin-Ciocalteu method, following the procedure described by (Bousbia Brahim *et al*, 2022) with slight modifications. A volume of 0.4 mL of the sample solution was mixed with 2 mL of 10% Folin-Ciocalteu reagent and 1.6 mL of 7.5% sodium carbonate (Na_2CO_3) in a test tube. After incubating at room temperature for 30 minutes, the absorbance was measured at 765 nm using a UV-Vis spectrophotometer. The polyphenol content was expressed as milligrams of gallic acid equivalents (GAE) per gram of extract.

For the total flavonoids content (TFC), the method described by (Chouikh *et al*., 2024c) was followed. A 0.5 mL aliquot of the methanolic plant extract was mixed with 0.5 mL of a 2% aluminum chloride ($AlCl_3$) solution. After a 15-minute reaction period, the absorbance was recorded at 430 nm. The flavonoid content was expressed as milligrams of quercetin equivalents (QE) per gram of extract.

Evaluation of antioxidant activity

The DPPH• radical scavenging activity was evaluated using the method by (Ben Ali and Chouikh, 2024). Various concentrations of each sample were mixed with 0.5 mL of 0.1 mM DPPH• solution, shaken thoroughly, and incubated in the dark at room temperature for 15 minutes. Absorbance was measured at 517 nm using a UV-Vis spectrophotometer. Ascorbic acid, prepared at different concentrations, served as the positive control. The percentage of DPPH• radical scavenging activity was calculated using the formula:

$$\%Inhibition = [(A_C - A_S)/A_C] \times 100$$

Where:

A_C: absorbance of the DPPH solution (control)

A_S: absorbance of the sample or standard with the DPPH solution

The IC_{50} (concentration needed for 50% inhibition) was determined by plotting the inhibition percentage against the concentration and calculating it using a linear equation. Results were expressed in milligrams per milliliter (mg/mL).

The total antioxidant capacity (TAC) was assessed using the phosphor molybdenum method (Ben Ali *et al*., 2023). A 0.1 mL each sample were mixed with 1 mL of reagent solution (0.6 M sulfuric acid, 28 mM sodium phosphate, and 4 mM ammonium molybdate). The mixture was incubated at 95°C for 90 minutes. After cooling, absorbance was measured at 695 nm. The antioxidant capacity was expressed as milligrams of gallic acid equivalents (GAE) per gram of resin.

The ferric-reducing antioxidant power (FRAP) assay followed the protocol by Chouikh *et al*. (2020), in which 1 mL of resin was mixed with 2.5 mL of phosphate buffer (0.2 M, pH 6.6) and 2.5 mL of 1% potassium ferrocyanide. After incubation at 50°C for 20 minutes, the reaction was stopped by adding 2.5 mL of 10% trichloroacetic acid. The supernatant was centrifuged at 3000 rpm for 10 minutes, and 2.5 mL of it was mixed with 0.5 mL of 0.1% $FeCl_3$ and 2.5 mL of distilled water. The absorbance was measured at 700 nm.

$$FRAP\ values = [100 - (A_C \times 100)/A_S]$$

A_S: absorbance without the resin

A_C: absorbance with the resin or standard

Study of Wound-Healing Activity

In this study, female Wistar albino rats, weighing between 140 and 200 g, were obtained from the Pasteur Institute of Algiers and housed in the animal facility at the University of El Oued. The rats had free access to food and water. To investigate the wound-healing activity of methanolic extracts from the aerial parts of *Lagenaria siceraria* collected from the Guemmar and Ourmes regions, the rats were divided into four groups (Each group 3 rats) and treated for 20 days. On the first day, under chloroform anesthesia, transverse wounds were created on the shaved dorsal area using sterile surgical tools. A topical cream formulation containing the methanolic extract was prepared at different concentrations for treatment. Group 1 received creams based on the Ourmes extract, Group 2 was treated with creams from the Guemmar extract, Group 3 served as a positive control treated with Cicatril bio cream, and Group 4, the negative control, received no treatment. The wound-healing progress was photographed daily for evaluation (Chidambara Murthy *et al*., 2004).

RESULTS

Quantification of Primary Metabolites

The nutritional composition of *Lagenaria siceraria* was assessed by quantifying the ash, organic matter, carbohydrates, proteins, and lipids, as presented in Table 1. After incinerating the dry matter in a muffle furnace, the ash content was found to be similar between the two regions studied, with values of 7.84% for Guemmar and 7.73% for Ourmes.

Regarding carbohydrate content, the plant sample from the Ourmes region showed a higher concentration (23.4 mg/g dry matter) compared to the Guemmar region (20.95 mg/g dry matter).

The protein analysis revealed that the sample from Guemmar had a significantly higher protein content (260 mg/g dry matter) than the sample from Ourmes, which measured 95 mg/g dry matter.

As for lipid content, the highest value was recorded in the Ourmes sample at 0.175 mg/g dry matter, while the Guemmar sample had a slightly lower value of 0.164 mg/g dry matter.

Table 1. Nutritional Composition of *Lagenaria siceraria* from Guemmar and Ourmes Regions.

Lagenaria siceraria	**Ash (%)**	**organic matter(%)**	**Carbohydrates (mg/g)**	**Protein (mg/g)**	**Lipid (mg/g)**
Guemmar region	7.84%	92.16%	23.4 ± 0.7	260 ± 14	0.175 ± 0.023

Ourmes region	7.73%	92.27%	20.95 ± 0.8	95 ± 11	0.164 ± 0.030

Extraction Yield, Polyphenol, and Flavonoid Content

Following the maceration process with methanol, the extraction yield was calculated using the formula provided by Ben Ali *et al*. (2024). A dry matter sample of 50 g produced a substantial yield of 21.15% for the Guemmar region and 13.63% for the Ourmes region.

The total polyphenol content in *Lagenaria siceraria* was found to be 25.87±0.09 mg GAE/g extract for the Guemmar region sample, while the sample from the Ourmes region showed a lower polyphenol content of 5.43 ± 0.44 mg GAE/g extract.

The results indicated that the Guemmar sample had a higher flavonoid content of 7.63±0.12 mg QE/g extract compared to the Ourmes sample, which had a value of 3.42±0.23mg QE/g extract. These results are summarized in Table 2.

Table 2. Extraction Yield, Total Polyphenol, and Flavonoid Content of *Lagenaria siceraria* Extracts from Guemmar and Ourmes Regions.

Extract	**Yield (%)**	**Polyphenols** (mg of GAE/g of extract)	**Flavonoïds** (mg QE/g of extract)
Guemmar region	21.15%	25.87 ± 0.09	7.63 ± 0.12
Ourmes region	13.63%	5.43 ± 0.44	3.42 ± 0.23

Evaluation of antioxidant activity

The DPPH free radical scavenging results showed that the sample from the Ourmes region had an IC_{50} value of 15.13 ± 0.05 µg/mL, while the sample from the Guemmar region had a significantly lower IC_{50} value of 9.14 ± 0.18 µg/mL. This indicates that the antioxidant activity of the Guemmar sample is higher than that of the Ourmes sample. It is worth noting that the IC_{50} value of ascorbic acid was 5.41± 0.28 µg/mL.

Regarding total antioxidant capacity (TAC), the Guemmar sample exhibited a much higher value of 57.73 ± 0.93 mg GAE/g extract compared to the Ourmes sample, which had a significantly lower capacity of 2.15 ± 0.66 mg GAE/g extract.

For ferric-reducing antioxidant power (FRAP), the results showed that the iron-reducing ability increased with the concentration of the extracts. Both samples demonstrated lower iron-reducing capacity compared to ascorbic acid, which had a value of 0.91± 0.07 mg/mL. The EC_{50}

value for the Guemmar sample was 1.58 ± 0.06 mg/mL, while the sample from the Ourmes region had a higher EC_{50} value of 3.53 ± 0.19 mg/mL, confirming the stronger antioxidant power of the Guemmar sample (Table 3).

Table 3. Antioxidant Activity of *Lagenaria siceraria* Extracts from Guemmar and Ourmes Regions

Extract	DPPH (IC_{50} = µg/mL)	TAC (mg GAE/g extract)	FRAP (EC_{50} = mg/mL)
Guemmar region	9.14 ± 0.18	57.73 ± 0.93	1.58 ± 0.06
Ourmes region	15.13 ± 0.05	2.15 ± 0.66	3.53 ± 0.19
Ascorbic acid	5.41 ± 0.28		0.91 ± 0.07

Wound Healing Activity

The application of the formulated creams on Wistar albino rats showed accelerated wound healing, with complete closure occurring within 14-17 days in the treated groups, compared to 17-20 days in the negative control group. The increase in the concentration of the extract led to a higher percentage of wound healing across all cream-treated groups. Throughout the 17-day treatment period, the cream based on the Guemmar extract demonstrated the highest rate and speed of wound healing, nearly matching the performance of the positive control cream, Cicatryl Bio.

Additionally, the body weight of the control and treated groups gradually increased from day 1 to day 20. The creams formulated with varying concentrations of the methanolic extract from *Lagenaria siceraria* from both Guemmar and Ourmes regions resulted in a significantly enhanced healing rate and a notable reduction in wound area (Figure 2).

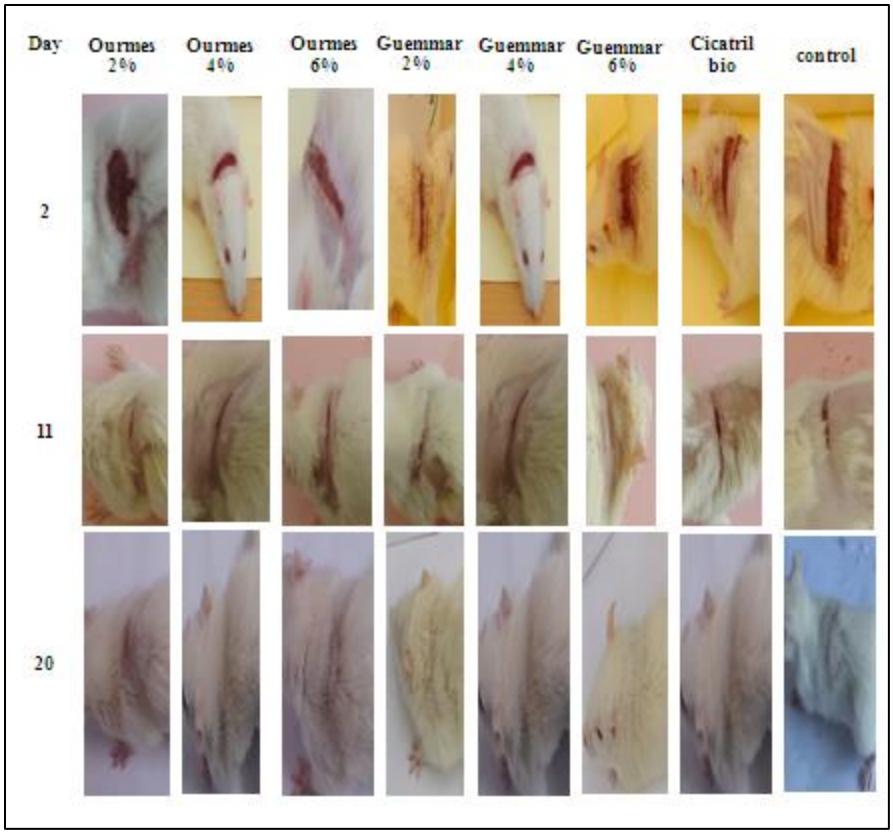

Figure 2. Photos of wounds on days 2, 11, and 20 after treatment.

DISCUSSION

There are different types of primary metabolites, such as ash, carbohydrates, proteins, and lipids (Adetunji *et al.*, 2021). The ash content for both samples studied was very similar, with results closely matching those reported by Pélagie *et al.* (2019), where the total ash values for *Lagenaria siceraria* seed cakes were 6.30±0.00% (Shahein *et al.*, 2022). They developed a yogurt made from watermelon seed powder (family Cucurbitaceae) and observed an ash content of 0.94±0.06%, which is lower than the values found in this study. Variations in mineral content observed by various authors are attributed to the origin of the substrates, including soil type, climate, maturity stage, and harvest season (Chehma, 2005).

The quantitative carbohydrate content varied between the two samples studied. The values reported by Rahman (2003) were higher than those obtained in our study, with carbohydrate levels of 178.1 mg/g and 33.9 mg/g found in seeds and fruits, respectively. In contrast, the study by Ogunbusola (2018) reported a carbohydrate content of 75.5 mg/g in *Lagenaria siceraria* seeds. Similarly, our results are close to those published by M. Saeed *et al.* (2022), which found 25 mg/g of carbohydrates in *Lagenaria siceraria* fruits. Comparatively, in a

different species from the Cucurbitaceae family, *Cucurbita moschata*, Achu *et al*. (2005) found a carbohydrate content of 89.7 mg/g in whole seeds in the High Savanna region of Cameroon. This disparity can mainly be attributed to genotype differences as well as various other environmental factors.

The total protein content we found for the sample from the Guemmar region is close to that reported by Okouango *et al*. (2019), which was 245 mg/g dry matter (DM). Our protein content is higher than that obtained by Gajera *et al*. (2017) in their study of *Lagenaria siceraria* fruit, where they found 1.20 g/100g, equivalent to 12 mg/g .

According to research conducted by Okouango *et a*l. (2019), the lipid content of *Lagenaria siceraria* leaves collected in Brazzaville (Congo) was 1.93 ± 0.15 g/100g DM, which exceeds our results of 0.1746 mg/g DM for the Guemmar region and 0.1638 mg/g DM for the Ourmes region. In a review by Ahmad *et al*. (2022), the total lipid content of *Lagenaria siceraria* fruit reached 20 mg, also higher than what we obtained. Similarly, Ogunbusola (2018) reported a lipid content of 46.88 ± 1.00 g/100g DM in whole pumpkin seed flour.

This variation in nutritional values can be explained by several factors. Fertilization management greatly influences crop quality in terms of marketability, nutritional value, and sensory properties. The application of different types of fertilizers affects the nutrient composition of plants and fruits (Rouphael *et al*., 2012). According to Singh *et al*. (2021), the disparity in protein proportions may be due to the composition of different cultivars, as well as genetics and growing conditions. The type of plant organ studied also influences the determination of primary metabolite concentrations (Loescher *et al*., 1990).

The yield of leaf extracts from *Cucurbita* Pepo has shown that the ethanolic and aqueous extracts obtained yields of 19.9% and 17.4%, respectively (Dar *et al*., 2017). These results are slightly lower than those we obtained in the Guemmar region but higher than those from the Ourmes region. A study by Mechernene (2014) on other species (*Bryonia dioica*) from the Cucurbitaceae family revealed that the methanolic extract yield from the underground part was 9.59%, which is lower than our result.

The yield can be influenced by various factors, such as the chemical composition and physical characteristics of the plant material, as well as experimental conditions and sample preparation methods (Lee *et al*., 2003). Moreover, variations in the yield percentage of each extract are caused by the properties and nature of the solvent used, particularly regarding

polarity, as well as the nature of the active compounds present in the plant (Daoudi *et al*., 2015). The phenolic content in a plant varies depending on several intrinsic (genetic) and extrinsic (cultivation practices, maturity at harvest, and storage conditions) factors (Monira *et al*., 2015).

The quantity of phenolic compounds varies depending on the growing and harvesting season, climatic and environmental conditions, geographical location, plant maturity, and storage duration. Additionally, the measurement method can also impact the estimation of total phenolic content (Lee *et al*, 2003).

Extraction time generally ranges from one minute to 24 hours, and longer extraction times increase the likelihood of phenolic oxidation unless reducing agents are added to the solvent system. This may result in unexpectedly low phenolic contents. Phenolic compounds can also interact with other plant components such as carbohydrates and proteins, forming complexes that may be highly insoluble. It is important to note that total polyphenol levels are not absolute measures of the amounts of phenols in the starting material (Naczk and Shahidi, 2006).

In a study by Saha *et al*. (2011), the flavonoid content in the methanolic extract of *Lagenaria siceraria* was 25.32 ± 1.48 mgEAQ/gEx, which was higher than what we found in both samples. The highest flavonoid level compared to our findings so far was detected in a study by Bishnoi *et al*. (2023), where 38.64 mgEAQ/gEx was reported in the seed extract of *Lagenaria siceraria*. According to Enneb *et al*. (2020), the flavonoid content and type vary depending on the plant organ and the solvent used. The highest concentrations of flavonoid compounds in methanolic extracts from *Cucurbita moschata* fruit fibers and pulp were 5.263 and 4.163 mg/100g for cirsiliol and luteolin, respectively.

The discrepancy in results can be explained by several factors influencing flavonoid and polyphenol concentrations: drying and extraction conditions, method, time, temperature, and solvent, as well as various plant conditions (Park and Cha, 2003). The distribution of secondary metabolites can vary throughout the plant's growth cycle. Unfavorable weather conditions (high temperature, sunlight exposure, drought, and salinity) may also contribute to this variation, as they promote the production of secondary metabolites such as polyphenols (Falleh *et al*., 2008).

In the DPPH test, the purification of active components could enhance the radical scavenging properties. According to Saha *et al*. (2011), the IC_{50} value of 25.70 ± 1.02 µg/mL for the methanolic extract of *Lagenaria siceraria* aerial parts was higher than ours, suggesting our results were better. On the other hand, Mohan *et al*. (2012) obtained IC_{50} values of 5.2 ± 0.5

µg/mL for the ethanolic extract of *Lagenaria siceraria*, which were lower than our values, meaning their extract showed superior antioxidant activity.

Research demonstrates that radical scavenging activity is related to the level of polyphenols and flavonoids in plant extracts (Mariod *et al*., 2009). This suggests that the antioxidant activity of our plant extracts may result from a synergy between polyphenols and other compounds. Comparing our results on the ferric ion reduction capacity of the crude methanolic extract to those obtained by Ahmed *et al*. (2014), who recorded 61.96 µg/ml and 45.56 µg/mL for the methanolic extract of the epicarp and mesocarp of *Lagenaria siceraria*, it can be said that their results exceeded ours. In a study by Badmanaban and Patel (2010), it was revealed that the ferric reducing capacity of aqueous and ethanolic leaf extracts of *Lagenaria siceraria* reached 53.76 ± 0.28 mgGAE/gEx and 66.53 ± 2.54 mgGAE/gEx, respectively, indicating that our results were better. Kendil (2020) reported that *Atractylis Gumifera* (Asteraceae family) showed that the bark extract had three times higher total antioxidant capacity than the pulp extract, with values of 7.91 mgGAE/g and 2.86 mgGAE/g, respectively.

Wound healing is a physiological process of tissue repair that restores the structure and function of tissue. It involves a dynamic process engaging cells, growth factors, and cytokines (Ching *et al*., 2011). The process includes several phases: the hemostatic phase (a few seconds), the inflammatory phase (Day 0 to Day 3), the proliferative phase and formation of new connective tissue (Day 3 to Day 15), and the remodeling phase (1 to 2 years) (Cooper, 2005).

Moreover, phytochemical analysis revealed the presence of polysaccharides, alkaloids, tannins, anthocyanins, leucoanthocyanins, and saponins. The wound-healing activity could be attributed to these chemical constituents. Several scientists have highlighted that these families of compounds possess biological activities that contribute to wound healing (Bahramsoltani *et al*., 2014). Tannins, for instance, have an astringent effect that can precipitate proteins and stop bleeding (Cooper, 2005). Additionally, they influence leukocyte migration and exhibit anti-inflammatory properties (Biaye, 2002).

Polysaccharides, besides their healing properties, are used as agents that control the release of active ingredients (Ribeiro *et al*., 2019). In particular, the flavonoid content in the leaves of *Tephrosia purpurea*, a tropical plant from the Fabaceae family, promotes wound healing by aiding wound contraction, enhancing tensile strength, collagen fiber production, fibroblast proliferation, and increasing angiogenic response (Lodhi *et al*., 2010).

Ethanolic extracts of the aerial parts of *Centella asiatica* (Apiaceae) contain terpenoid molecules that promote burn healing by increasing angiogenesis during tissue repair of skin wounds and stimulating the production of VEGF (Kimura *et al*., 2008).

The presence of flavonoids, tannins, and terpenoids in the methanolic extract of the aerial parts of *Lagenaria siceraria*, particularly from the Guemmar region, may explain the rapid wound-healing effect of this plant. This mechanism likely involves the stimulation of fibroblast production and/or collagen fibers or angiogenesis.

Different antioxidant, anti-inflammatory, antimicrobial, and angiogenic properties of compounds present in plant extracts support the wound healing process (Sasidharan *et al*, 2010; Sene *et al*, 2016). These properties further strengthen the wound-healing effect of the methanolic extract of *Lagenaria siceraria*.

CONCLUSION

The results of this study demonstrate that the methanolic extract from the aerial parts of *Lagenaria siceraria*, particularly from the Guemmar region, possesses strong wound healing properties and significant nutritional value. The extract from the Guemmar sample showed higher levels of total phenolic compounds, flavonoids, and antioxidant activity compared to the Ourmes sample, indicating that environmental and geographical factors may influence the concentration of bioactive compounds in the plant. The extract significantly accelerated wound healing, with complete tissue repair after 20 days, especially in the Guemmar sample. Given these therapeutic and nutritional properties, further research is needed to optimize cultivation practices to enhance the bioactive compound content in *Lagenaria siceraria*. Additionally, developing and commercializing products like creams and ointments based on the extract can contribute to wound healing, skincare, and anti-aging.

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Conflict of interest

There is no actual or potential conflict of interest in relation to this article.

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