THE LIBYAN JOURNAL OF AGRICULTURE
Volume (31): No. (2), 2026: 64 - 77

Original Article

Comparative Phytochemical Analysis and Allelopathic Potential of *Juniperus phoenicea* L. in Ashnishan and Satlunah Sites, Al-Jabal Al-Akhdar, Libya

Khadiga Alhadead[1], Hameda Faraj [2] and Heba Al-Zawi[1]

1- Department of Environmental Sciences, Faculty of Natural Resources and Environmental Sciences, University of Omar Al-Mukhtar.

2- Department of Forestry, Faculty of Natural Resources and Environmental Sciences, University of Omar Al-Mukhtar.

ABSTRACT

This study compared the ecological and phytochemical status of *Juniperus phoenicea* in two areas of Al Jabal Al Akhdar, Libya: Ashnishan (monospecific stands) and Satlunah (mixed maquis), and evaluated the allelopathic activity of aqueous leaf extracts on seed germination. Composite leaf samples from each site were analyzed for flavonoids, total alkaloids, total phenolics, and protein content. Aqueous extracts at concentrations of 0, 5, 10, 20, 50, 75, and 100% were tested in a completely randomized design with three replicates to assess germination percentage, germination inhibition, shoot length, root length, fresh weight, dry weight, and water content. Phytochemical analysis revealed higher concentrations of all measured constituents in the Ashnishan population than in Satlunah: flavonoids (2.17 vs. 1.81 mg/100 g), alkaloids (129.80 vs. 114.30 µg ml^{-1}), total phenolics (393.80 vs. 369.10 µg GAE/100 g), and protein (5.10% vs. 4.72%). Bioassay results showed that increasing extract concentration significantly ($P \leq 0.05$) reduced seed germination. In Ashnishan extracts, germination declined from 90% (control) to 20% at ≥20% concentration, with inhibition reaching 78%. In Satlunah extracts, germination dropped from 100% to 20% at 75–100% concentration, with inhibition up to 80%. Root growth was the most sensitive parameter; complete inhibition occurred at ≥50% Ashnishan extract and ≥75% Satlunah extract. Fresh weight, dry weight, and water content also decreased significantly with rising extract concentration. The results indicate that the allelopathic activity of *J. phoenicea* is concentration dependent and varies between populations. The stronger phytotoxic effect of the Ashnishan extract corresponded with its higher phenolic, flavonoid, and alkaloid content, suggesting that geographical variation in phytochemical composition may influence the allelopathic potential of *J. phoenicea* in Mediterranean ecosystems.

Keywords: *Juniperus phoenicea*, Allelopathy, Al-Jabal Al-Akhdar, Secondary Metabolites.

Corresponding Author: Hameda Faraj **Department of Forestry, Faculty of Natural Resources and Environmental Sciences, University of Omar Al-Mukhtar.**

Phone: +218 924988510 **Email: hameda.faraj@omu.edu.ly**

Received: 12/05/2026 **Accepted: 13 /08/ 2026**

INTRODUCTION

In conservation biology, significant emphasis is placed on protecting isolated plant communities and accurately mapping their distribution (Scott et al., 2001). This priority is driven by escalating climatic threats to biodiversity. Safeguarding fragmented populations is essential for preserving genetic variation and mitigating risks posed by unpredictable environmental disruptions to limited resources (Jones *et al.*, 2001). Populations at range peripheries may harbor significant genetic variability, making them resilient to anthropogenic or natural disturbances (Lloret and García, 2016). Consequently, identifying relict populations and refugia is vital for conserving plant species. A key mechanism in plant survival and community structure is allelopathy—the mediation of competition through release of plant metabolites. This allelopathic interaction is mediated by the release of bioactive secondary metabolites through root exudation and the subsequent decomposition of plant biomass (Alagesaboopathi, 2010). These phytotoxic compounds disrupt neighboring plants' physiological equilibrium, affecting photosynthesis, respiration, and protein synthesis (Algandaby *et al.*, 2021). Beyond inhibition, they play roles in signaling, nutrient uptake, and defense against microorganisms (Bertin *et al.*, 2003).

Allelochemical release is often tied to environmental conditions. Many identified allelochemicals, such as terpenoids and phenolics, are secondary metabolites. Plant stressors—including elevated temperatures, herbivory, and reduced water availability—can significantly increase their release. Such mechanisms are crucial for invasive species establishment and wild species dominance in changing environments (Hierro and Callaway, 2003; Othman *et al.*, 2018). The Juniper genus has extensive historical distribution, deep roots in folklore, and broad ethnobotanical applications from therapeutic to culinary practices. Ecologically, Juniper thrives across diverse conditions, colonizing various soils and altitudes in open canopies (Alhadead and Almesmari, 2021). The current body of research provides compelling evidence that *Juniperus phoenicea* exhibits a strong allelopathic capacity, underpinned by its phytochemical profile, which is notably abundant in terpenes and aromatic substances. These bioactive compounds have been shown to suppress seed germination and hinder the growth of various plant species, thereby interfering with their fundamental physiological functions. Considering the widespread occurrence of this species across Mediterranean ecosystems, such allelopathic traits are likely to play a significant role in shaping the structure and composition of plant communities (M'barek and Haouala 2024).

Objectives of the Study

- To examine the phytochemical and environmental characteristics of *Juniperus phoenicea* in Al-Jabal Al-Akhdar by comparing two contrasting habitats:

- To evaluate the allelopathic potential of aqueous extracts of *J. phoenicea* through their effects on seed germination and seedling growth.
- To conduct a comparative phytochemical screening to quantify the major bioactive compounds, including proteins, alkaloids, phenolic compounds, and flavonoids.
- To elucidate how environmental variation and plant community structure influence secondary metabolism and adaptive mechanisms in *J. phoenicea* under current ecological pressures.

Materials and Methods

Experimental Section

Plant sampling and processing in February 2026, the aerial parts of *Juniperus phoenicea* were collected from two sites in the Al-Jabal Al-Akhdar region, Libya: Ashnishan and Satlunah. In Ashnishan, *J. phoenicea* occurs as scattered, isolated individuals, whereas in Satlunah the species grows in association with mixed Maquis vegetation. Two composite samples were prepared, one representing the Ashnishan site and the other representing the Satlunah site, by pooling plant material collected from several individual plants within each site to ensure representative sampling. All phytochemical and biochemical analyses were performed in triplicate (n = 3) for each composite sample. The collected plant material was thoroughly rinsed to remove impurities and air-dried on laboratory benches for 15 days at room temperature (24–25 °C). After drying, the plant tissues were ground into a fine, homogeneous powder. Approximately 50 g of the powdered material was stored in airtight containers until further phytochemical and biochemical analyses were conducted.

Phytochemical screening

A qualitative screening was conducted to identify the primary groups of secondary metabolites within *Juniperus phoenicea* extracts. Utilizing standard analytical protocols, the presence of alkaloids, flavonoids, phenolic compounds, and proteins.

The quantification of total phenolic content (TPC) was performed using the Folin–Ciocalteu colorimetric assay, following the protocol established by Singleton and Rossi (1965), 100 µl aliquot of the plant extract was combined with an equal volume of Folin-Ciocalteu reagent. After a 5-minute initial incubation period at ambient temperature, the reaction was neutralised by adding 800 µl of 7.5% sodium carbonate (Na_2CO_3) and diluted with 1 ml of deionized water. The resulting mixture was then incubated in total darkness for 120 minutes. Subsequently, the absorbance was recorded at a wavelength of 750 nm employing a UV/Vis Spectrophotometer (Onda, P.R.C). To determine the phenolic concentration, a standard curve was generated using Gallic acid (40–125 µg/ml). The final TPC results were normalised and expressed as milligrams of Gallic acid equivalents (mg GAE) per 100 grams of dry weight (DW) of the sample. The total flavonoid content (TFC) was quantified using a modified colorimetric technique based on Yoo *et al.* (2008), 250 µl of the sample was

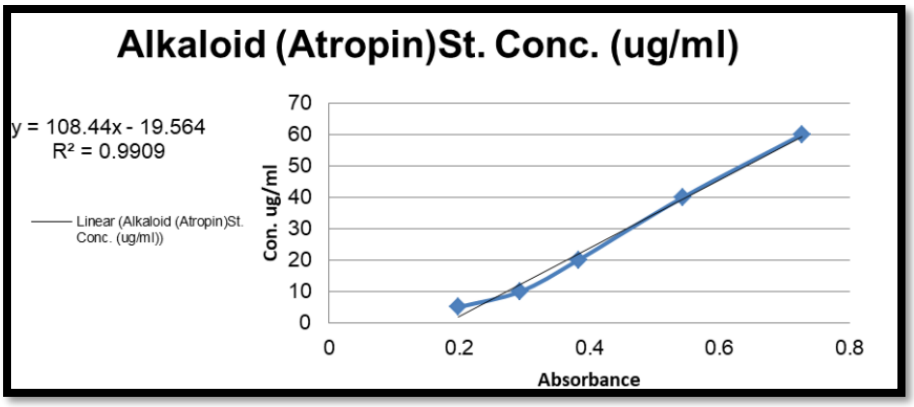

Figure 1: Calibration Curve for Total Alkaloid Content.

combined with 1.25 ml of deionized water and 75 µl of 5% NaNO2. Following a 6-minute reaction, 150 µl of 10% AlCl3·6H2O was incorporated into the mixture. After a further 5-minute incubation at ambient temperature, the reaction was terminated by adding 0.5 ml of 1 M NaOH and 2.5 ml of deionized water. The solution was vortexed rigorously, and the absorbance of the resulting pink chromophore was recorded at 510 nm (Aqua mate Plus UV/V is Spectrophotometer, England). TFC values were extrapolated from a (+) catechin standard curve (5-80 µg/ml) and reported as mg catechin equivalents (CAE) per 100 g of dry weight (DW).

Crude protein content: The crude protein content (N X 6.25) of the samples was measured using the macro Kjeldahl method on a dry weight basis according (AOAC, 1997).

The quantification of total alkaloid content was executed following the protocol established by Shamsa et al., (2008), 5 g of the powdered plant material underwent a 24-hour continuous extraction using methanol at a controlled temperature of 26°C. The resulting filtrate was concentrated to dryness using a rotary evaporator under vacuum at 45°C. The obtained residue was subsequently reconstituted in 2N HCl and filtered. A 1 ml aliquot of this acidic solution was transferred to a separating funnel and subjected to a purification step by washing with 10 ml of chloroform (triplicate washes) to remove non-alkaloidal impurities before the final alkaloid determination.

Germination bioassay

To evaluate the allelopathic influence of *J. phoenicea* aqueous extracts, a bioassay was conducted using *Triticum aestivum* L. as a test model. The parameters monitored included germination percentage (GP). Seed surface sterilization was performed by immersing them in 2% sodium hypochlorite for 2 minutes,

followed by multiple rinses with distilled water and a 24-hour soaking period in aerated distilled water. Subsequently, ten seeds were placed in 9 cm Petri dishes lined with Whatman No. 1 filter paper, with each treatment replicated three times (n=10 seeds per concentration). The seeds were treated with 10 ml of the extract at varying concentrations (5%, 10%, 20%, 50%, 75%, and 100%), while distilled water served as the control. The experiment was maintained under controlled laboratory conditions (midday temperature of 25°C and diffused light) for seven days. To prevent dehydration, equal volumes of distilled water were added as needed. Upon completion of the incubation period, germination counts were recorded, and the lengths of the roots and shoots were precisely measured

Data analysis by (Chung et al., 2001):

Seedling growth was evaluated by the use of the following indicators:

Percentage of germination (G %) =

number of seeds germinated in extract \ number of seeds germinated in control * 100.

Percentage of inhibition (I %) =

(control - sample extracts) \ control * 100

Root/shoot ratio: is an indicator of relative growth of the root and shoot in a plant

Statistical analysis:

Statistical analysis was performed using STATISTICA software. Data from triplicate samples were expressed as means ± standard deviation (SD). Significant differences among treatment means were determined by one way analysis of variance (ANOVA) followed by Tukey's honestly significant difference (HSD) post hoc test at a significance level of $P < 0.05$.

RESULTS AND DISCUSSION

Phytochemical screening

The phytochemical analysis of *Juniperus phoenicea* revealed a consistent variation in the concentration of bioactive compounds between the two study sites. As shown in Table 1, the samples collected from Ashnishan exhibited higher levels of all measured parameters compared to those from Satlunah.

Table 1: Phytochemical screening results

Sites	Flavonoids Mg/100g	Alkaloids ug /1ml	Phenols ug GAE/100g	Proteins mg/g
Ashnishan	2.17	129.80	393.80	5.10
Satlunah	1.81	114.30	369.10	4.72

The qualitative analysis presented in Table 1 confirms the presence of several bioactive constituents in *Juniperus phoenicea*, including alkaloids, phenols, flavonoids, and proteins. Our findings are largely consistent with the existing

literature; for instance, Hamzal et al., (2016) identified a similar profile containing flavonoids, alkaloids, tannins, and saponins. While Amalich *et al.*, (2016) did not detect alkaloids or saponins in the foliage, their results aligned with ours regarding the abundance of phenolic compounds and flavonoids. Despite these minor variations in chemical composition, there is a consensus across studies including the work of Zouari Bouassida *et al.*, (2018) on the prevalence of terpenes, glycosides, and tannins in this species. These slight discrepancies in phytochemical profiles are likely attributable to differences in environmental conditions and the specific plant parts analyzed.

The total alkaloid content of *Juniperus phoenicea* was determined spectrophotometrically using an atropine standard calibration curve (Figure 1). The calibration curve was established by plotting absorbance against atropine concentrations ranging from 5 to 60 µg/ml. The standard curve exhibited excellent linearity and was described by the regression equation $y = 108.44x - 19.564$, where y represents the alkaloid concentration (µg/ml) and x represents the absorbance. The coefficient of determination ($R^2 = 0.9909$) confirmed the high linearity and reliability of the calibration curve for quantitative alkaloid determination.

This equation was subsequently employed to calculate the alkaloid concentration in the plant samples collected from both study sites (Ashnishan and Satlunah), providing a biochemical basis for the species' adaptive and Allelopathic characteristics. The quantitative determination of total alkaloid content in *J. phoenicea* in the present study revealed higher concentrations compared to several regional assessments of the *Cupressaceae* family. For instance, investigations conducted in Jordan by Al-Mustafa *et al.*, (2021) and Bajes *et al.*, (2021) reported alkaloid levels of 0.9% and 0.7%, respectively both of which are notably lower than our current findings. Furthermore, even within the Libyan context, Shaboun *et al.*, (2021) recorded a concentration of 0.8%, suggesting that the populations in our study area (Al-Jabal Al-Akhdar) may possess a superior capacity for alkaloid biosynthesis, likely driven by specific local environmental stressors or genetic variations.

Protein Content and its Relation to Allelopathic

Statistical analysis revealed significant variations in protein levels between the two study sites, which differ fundamentally in their vegetative structure. In Ashnishan, where *Juniperus phoenicea* forms a pure, monospecific stand of scattered individuals, the protein content was higher at 5.10 mg/g. Conversely, in Satlunah, where *J. phoenicea* grows in a mixed forest associated with maquis vegetation, a lower value of 4.72 mg/g was observed. This variation is noteworthy as proteins are not only essential macromolecules for plant growth and development but also serve as crucial components in the plant's biochemical response to environmental stressors. The elevated protein

levels in the isolated Ashnishan stands may reflect a metabolic adaptation to the more exposed conditions of a single-species habitat. This elevation may be attributed to the up-regulation of enzymes and stress-related proteins involved in the Allelopathic pathway; plant stressors often trigger the release of secondary metabolites (Alhadead *et al.*, 2025). Thus, the higher protein concentration in Ashnishan may be an indicator of enhanced biochemical activity aimed at maintaining dominance and survival through allelopathic interference in an environment with limited interspecific support. In summary, the higher concentrations of proteins and secondary metabolites (such as phenols and alkaloids) observed in the Ashnishan site reflect the physiological plasticity of *Juniperus phoenicea.* This biochemical upregulation suggests an adaptive response to a monospecific environment, likely characterized by higher abiotic stress, such as water scarcity or thermal fluctuations. Conversely, the lower values recorded at the Satlunah site indicate that interspecific competition and the presence of diverse maquis vegetation may modulate the plant's metabolic pathways, potentially reducing the energetic investment in defensive secondary metabolites in favour of other growth-related processes.

Table 2. Mean germination percentage % and inhibition percentage % of seeds treated with different concentrations of *Juniperus phoenicea* aqueous extracts.

Treatment (%)	Ashnishan		Satlunah	
	germination % ±SD	Inhibition % ± SD	germination % ± SD	inhibition % ± SD
0	$90^{a} \pm 0.84$	$0^{c} \pm 0.0$	$100^{a} \pm 0.89$	$PP0^{e} \pm 0.0$
5	$90^{a} \pm 0.84$	$0^{c} \pm 0.0$	$80^{b} \pm 0.60$	$20^{d} \pm 1.0$
10	$40^{b} \pm 0.76$	$56^{b} \pm 0.67$	$60^{c} \pm 0.25$	$40^{c} \pm 0.76$
20	$20^{c} \pm 1.01$	$78^{a} \pm 0.55$	$60^{c} \pm 0.25$	$40^{c} \pm 0.76$
50	$20^{c} \pm 1.01$	$78^{a} \pm 0.55$	$50^{d} \pm 0.74$	$50^{b} \pm 0.76$
75	$20^{c} \pm 1.01$	$78^{a} \pm 0.55$	$20^{e} \pm 1.0$	$80^{a} \pm 0.81$
100	$20^{c} \pm 1.01$	$78^{a} \pm 0.55$	$20^{e} \pm 1.0$	$80^{a} \pm 0.81$

ANOVA test, Significance between groups was done using, Test (Tukey)

Means in same column with common letters are not significant

Means in same column with different letters are significant

Statistically significant at $p \leq 0.05$. Data was expressed by using Mean

The results presented in Table 2 demonstrate a significant inhibitory effect of *J. phoenicea*

aqueous extracts on seed germination. In Ashnishan, maximum inhibition (78%) was achieved at a concentration of 20%, while in Satlunah, the highest inhibition (80%) was observed at concentrations of 75% and 100%, indicating that the Allelopathic potency varies according to the source site and extract concentration.

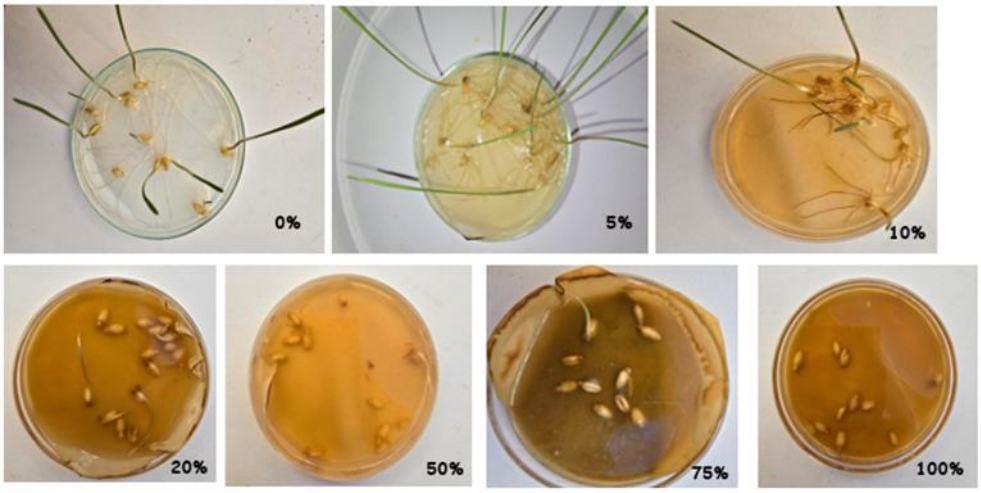

Figure 2: Growth parameters Ashnishan site

Table 3: Effects of different concentrations of *Juniperus phoenicea* aqueous extracts (Ashnishan site) on shoot length (SHL), root length (RTL), fresh weight (FW), dry weight (DW), and water content (WC%) of treated seedlings.

Ashnishan site Treatment (%)	Length(cm)		Weight(g/plant)		Water content %
	SHL ±SD	RTL±SD	FW	DW	
0	11.93^{ab}± 0.66	14.21^{a}± 0.93	4.685^{a}	0.719^{a}	5.5^{a}
5	12.86^{a}± 0.32	10.75^{b}± 0.80	3.143^{b}	0.52^{b}	5.0^{a}
10	9.18^{c}± 0.81	2.68^{c}± 0.71	1.748^{c}	$0.63a^{b}$	1.8^{b}
20	4.79^{d}± 1.01	1.07^{d}± 0.22	1.117^{c}	$0.60a^{b}$	0.8^{d}
50	1.18^{e}± 0.19	0.00^{e}± 0.0	0.513^{d}	0.57^{b}	0.0^{f}
75	1.39^{e}± 0.19	0.00^{e}± 0.0	0.936^{d}	0.26^{c}	2.6^{c}
100	0.64^{f}± 0.11	0.00^{e}± 0.0	0.525^{f}	0.33^{c}	0.6^{e}

ANOVA test, Significance between groups was done using, Test (Tukey)

Means in same column with common letters are not significant

Means in same column with different letters are significant

Statistically significant at $p \leq 0.05$. Data was expressed by using Mean.

(Figure 2; Table 3) A clear concentration-dependent inhibitory effect was observed for all measured growth parameters, including shoot length (SHL), root length (RTL), fresh weight (FW), dry weight (DW), and water content (WC%).

The control treatment (0%) produced the highest seedling growth, with shoot and root lengths reaching 11.93 ± 0.66 cm and 14.21 ± 0.93 cm,

Table 4: Effects of different concentrations of *Juniperus phoenicea* aqueous extracts (Satlunah site) on shoot length (SHL), root length (RTL), fresh weight (FW), dry weight (DW),

Satlunah site Treatment (%)	Length(cm)		Weight(g/plant)		Water content %
	SHL±SD	RTL±SD	FW	DW	
0	11.90^{a}± 1.25	14.2^{a}± 0.30	4.7^{a}	0.72^{a}	5.52^{a}
5	11.0^{b}± 0.75	7.0^{b}± 0.20	2.7^{b}	0.57^{c}	5.01^{a}
10	11.7^{ab}± 0.92	4.9^{c}± 0.15	2.9^{b}	0.62^{b}	1.77^{c}
20	9.4^{c}± 0.67	1.6^{d}± 0.10	2.3^{b}	0.31^{d}	0.85^{d}
50	6.4^{d}± 1.0	1.1^{d}± 0.10	1.9^{c}	0.20^{e}	0.03^{e}
75	0.96^{e}± 0.82	0.0^{e}± 0.0	0.7^{d}	0.39^{d}	2.60^{b}
100	0.82^{e}± 0.82	0.0^{e}± 0.0	0.8^{d}	0.27^{e}	0.58^{d}

ANOVA test, Significance between groups was done using, Test (Tukey)

Means in same column with common letters are not significant

Means in same column with different letters are significant

Statistically significant at $p \leq 0.05$. Data was expressed by using Mean.

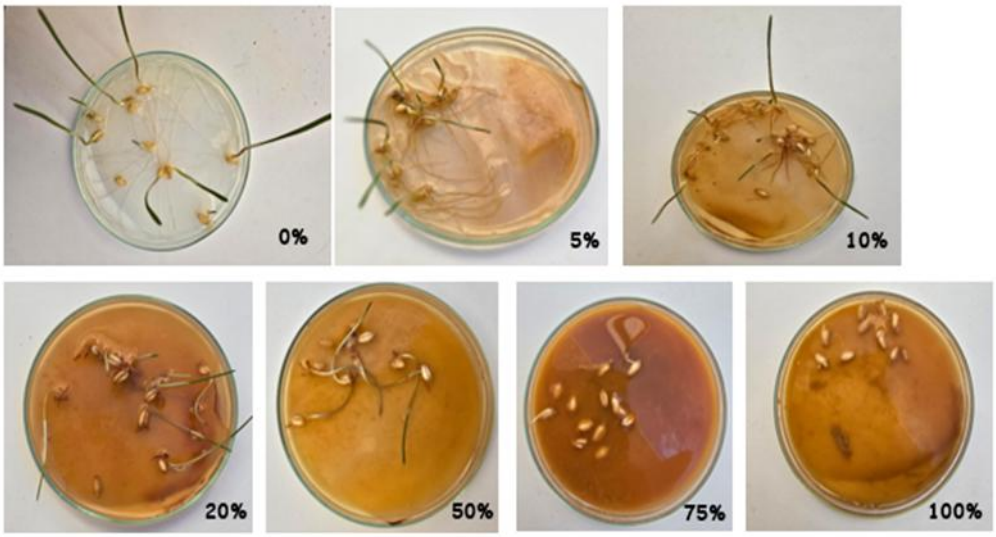

Figure 3: Growth parameters Satlunah site

respectively. Likewise, fresh and dry weights attained their maximum values (4.68 ± 0.71 g and 0.719 ± 0.00 g, respectively), while water content reached 5.5%. A gradual reduction in growth was evident as the extract concentration increased. At 5% and 10%, shoot length remained relatively high (12.86 ± 0.32 cm and 9.18 ± 0.81 cm, respectively), whereas root elongation declined markedly to 10.75 ± 0.80 cm and 2.68 ± 0.71 cm, indicating that root growth was more sensitive to the extract than shoot growth. Fresh weight also decreased from 4.68 g in the control to 3.14 g and 1.75 g at 5% and 10%, respectively.

(Figure 3 ;Table 4) The control treatment (0%) produced the highest seedling growth, recording shoot and root lengths of 11.90 ± 1.25 cm and 14.20 ± 0.30 cm, respectively. Fresh and dry weights also reached their maximum values (4.70 ± 0.72 g and 0.72 ± 0.00 g, respectively).

As extract concentration increased, all measured growth parameters progressively declined. At 5–20%, seedling growth was reduced, with root length showing greater sensitivity than shoot length. Root length decreased from 14.20 cm in the control to 7.00, 4.90, and 1.60 cm at 5, 10, and 20% extract concentrations, respectively, while shoot length declined from 11.90 cm to 11.00, 11.70, and 9.40 cm over the same concentration range.

The inhibitory effect became more pronounced at higher concentrations. At 50%, shoot and root lengths were reduced to 6.40 ± 1.00 cm and 1.10 ± 0.10 cm, respectively. Complete inhibition of

The inhibitory effect became more pronounced at concentrations of 20% and above. Shoot length decreased to 4.79 ± 1.01 cm at 20% and further declined to 1.18 ± 0.19 cm, 1.39 ± 0.19 cm, and 0.64 ± 0.11 cm at 50%, 75%, and 100%, respectively. Root growth was completely inhibited at concentrations of 50%, 75%, and 100%, where no measurable root elongation was recorded (0.00 cm). Similarly, fresh and dry weights declined substantially with increasing extract concentration, reaching 0.51–0.94 g and 0.26–0.57 g, respectively, at the highest concentrations. Water content also showed a marked reduction compared with the control.

root elongation was observed at 75% and 100%, where root length reached 0.00 cm, while shoot length was restricted to 0.96 ± 0.82 cm and 0.82 ± 0.82 cm, respectively. Fresh weight also decreased markedly from 4.70 g in the control to 0.70 g and 0.80 g at 75 and 100%, respectively. Similarly, dry weight declined to 0.39 g and 0.58 g at the two highest concentrations.

Measurements of *Triticum aestivum* L. with varying concentrations of *Juniperus phoenicea* aqueous extracts from two distinct sites (Ashnishan and Satlunah) revealed a significant, dose-dependent inhibition across all measured growth parameters (Tables 3 & 4). Statistical analysis (ANOVA, $p \leq 0.05$) confirmed that Root Length (RTL) exhibited higher sensitivity to the phytotoxic effects of the extracts compared to Shoot Length (SHL). This differential response suggests that the root system, being in direct contact with the allelochemicals, serves as a

primary indicator of the extract's inhibitory potential. This root level inhibition is primarily attributed to the direct exposure of the apical meristem to phytotoxic phenols and alkaloids, which disrupt cell division and auxin regulation. Furthermore, the simultaneous decline in Fresh/Dry Weight and Water Content (WC %) suggests that the allelochemicals induce a physiological drought' by impairing membrane permeability and root absorption efficiency. Notably, the Ashnishan extracts exhibited a more potent inhibitory effect at lower concentrations than those from Satlunah, confirming that the monospecific stand conditions in Ashnishan stimulate a higher synthesis of secondary metabolites. This dual-action strategy suppressing both germination and subsequent seedling development underscores the plant's robust chemical defense mechanism, which is intensified in isolated habitats to ensure ecological dominance.

Souto (2021) reported that allelochemicals, particularly phenols and alkaloids, can penetrate root tissues and inhibit cell division in the apical meristem by disrupting the mitotic index. The greater phytotoxic effect observed at the Ashnishan site compared to Satlunah is consistent with the findings of Al-Hwaiti (2023) and Kato-Noguchi and Kato (2022), who demonstrated that plants under environmental stress or in monospecific stands tend to overproduce allelochemicals as a competitive mechanism to suppress neighboring species.

RECOMMENDATIONS

Based on the study's findings, several strategic recommendations are proposed to enhance the sustainable utilization and conservation of *Juniperus phoenicea*. Firstly, for medicinal and pharmacological purposes, it is recommended to prioritize harvesting from monospecific stands, such as the Ashnishan site, to ensure maximum yields of bioactive flavonoids and alkaloids; however, non-destructive harvesting protocols must be established to preserve tree health. Secondly, the potent allelopathic properties of *J. phoenicea* aqueous extracts—particularly from Ashnishan should be explored for agricultural applications as eco-friendly bio-herbicides, providing a natural alternative to synthetic chemicals. Furthermore, this species could be utilised as a 'Nurse Plant' in reforestation projects, leveraging its chemical inhibitory capacity to suppress weed competition around newly planted seedlings. From a conservation perspective, the Ashnishan region should be designated as a Protected Area, serving as a high-quality seed source to maintain metabolically efficient strains.

REFERENCES

Alagesaboopathi, C. (2010). Allelopathic effects of *Centella asiatica* aqueous extracts on pearl millet *Pennisetum typhoides* L. and cowpea (*Vigna unguiculata* walp.). Pakistan Journal of Weed Science Research 16: 67-71.

Algandaby, M. M., Al-Hadead, K. M., and El-Darier, S. M. (2021). Detoxification capacity and protective effects of medicinal plants against heavy metals in polluted human systems. Journal of Agricultural Science and Crop Research, 2(1), 105.

Alhadead, K. M., Abu-Agila, A. S., and Abdel-Mawli, K. F. (2025). Distinguishing between ecological habitats of *Myrtus communis* through Vegetative Storage Protein Electrophoresis. Al-Mukhtar Journal of Agricultural, Veterinary and Environmental Sciences, 3(3), 228-237.

Alhadead, K. M., Almesmari NM. (2021). Ecological and ethnobotanical study of *Myrtus communis* L.(*Myrtaceae*) in Al-Jabal Al-Akhdar, Libya. Libyan: J Ecol & Environ Sci Technol. (LJEEST) 2021;3(2): 10–18.

Al-Hwaiti, M. (2023). Chemical defense mechanisms in Mediterranean conifers: Role of secondary metabolites in allelopathic interference. Journal of Arid Environments, 208, 104-115.

Al-Mustafa A, Al-Tawarah M, Al-Sheraideh MS, and AlZahrany FA. (2021). Phytochemical analysis, antioxidant and in vitro β-galactosidase inhibition activities of *Juniperus phoenicea* and *Calicotome villosa* methanolic extracts. BMC Chem. 15(1):55

Amalich S, Fadili K, Fahim M, Hilali FE, and Zaïr T. (2016). Polyphenols content and antioxidant power of fruits and leaves of *Juniperus phoenicea* L. from Tounfite (Morocco). Mor J Chem. 4(4):2177-2186.

AOAC. (1997). Official methods of analysis of AOAC international (Sixteenth Edition, 3rd Revision). Gaithersburg, MD, USA: Association of the Official Analytical Chemists (AOAC) International.

Bajes HR, Oran SA, Bustanji YK, and Al-Zahrany FA. (2021). Chemical composition and antiproliferative and antioxidant activities of essential oil from *Juniperus phoenicea* L. *Cupressaceae*. Res J Pharm Technol. 14(8):4464-4470.

Bertin, C., Yang, X., and Weston, L. A. (2003). The role of root exudates and allelochemicals in the rhizosphere. Plant and soil, 256(1), 67-83.

Chung, I. M., Ahn, J. K., and Yun, S. J. (2001). Identification of allelopathic compounds from rice (*Oryza sativa* L.) straw and their biological activity. Canadian Journal of Plant Science, *81*(4), 815–819.

Hamzal A, Bouzidi N, Bekhechi C, and Fernandez X. (2016). Phytochemical screening and antioxidant activity of Algerian *Juniperus phoenicea* L. extracts. J Appl Pharm Sci. 6(1):87-96.

Hierro, J. L. and Callaway, R.M. (2003). Allelopathy and exotic plant invasion. Plant and Soil 256: 29-39.

Jones, B., Gliddon, C. and Good, J.E., 2001. The conservation of variation in geographically peripheral populations: *Lloydia serotina* (*Liliaceae*) in Britain. Biol. Conserv. 101, 147–156

Kato-Noguchi, H., and Kato, M. (2022). Allelopathy and allelochemicals of *Solidago canadensis* L. and *S. altissima* L. for their naturalization. Plants, 11(23), 3235.

Lloret, F., and García, C. (2016). Inbreeding and neighbouring vegetation drive drought-induced die-off within juniper populations. Functional Ecology, 30(10), 1696-1704.

M'barek, K., and Haouala, R. (2024). Effects of allelochemicals from *Juniperus phoenicea* L. needles on the germination and growth of chosen agricultural crops. South African Journal of Botany, 164, 100-110.

Othman, K. M., Assaadi, O. R., and Lamlom, S. H. (2018). Response of *Arbutus pavarii* Pamp. Seedlings to Water Stress. International Journal of Multidisciplinary Innovative Research (IJMIR), 1(4), 19-30.

Scott, J. M., Murray, M., Wright, R.G., Csuti, B., Morgan, P., and Pressey, R.L., 2001. Representation of natural vegetation in protected areas: capturing the geographic range. Biodiv. Conserv. 10, 1297–1301

Shaboun S, Almajbri MM, Elmshiti BM, El Aali NM., and Towier NH.(2021). The contents of total phenolic, flavonoid and antioxidant activity of ethyl acetate extract of *Juniperus phoenicea* L.(*Cupressacees*) leaves growing in East Libya. Lebda Med J. 8:292-297.

Shamsa, F., Monsef, H., Ghamooshi, R., and Verdian-Rizi, M. (2008). Spectrophotometric determination of total alkaloids in some Iranian medicinal plants. The Thai Journal of Pharmaceutical Sciences, 32(1), 17-20.

Singleton, V. L., and Rossi, J. A. (1965). Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. American Journal of Enology and Viticulture, 16(3), 144.

Souto, C. (2021). Root growth dynamics and mitotic disruption under allelopathic stress: A review. Frontiers in Plant Science, 12, 658-672.

Yoo, K., Lee, C., Lee, H., Moon, B., and Lee, C. (2008). Relative antioxidant and cytoprotective activities of common herbs. Food Chemistry, 106(3), 929-936.

Zouari Bouassida K, Makni S, Tounsi A, Jlaiel L, Trigui M., and Tounsi S. (2018). Effects of *Juniperus phoenicea* hydroalcoholic extract on inflammatory mediators and oxidative stress markers in carrageenan-induced paw oedema in mice. Bio. Med Res Int. 2018:3069487.

المجلة الليبية للعلوم الزراعية
المجلد (31): العدد (2): 64 - 77
ورقة أصيلة

التحليل الكيميائي النباتي المقارن والقدرة الأليلوپاثية للعرعر الفينيقي *Juniperus phoenicea* L. في موقعي أشنيشن وستلونة، الجبل الأخضر، ليبيا

خديجة محمد الحداد [1]، حميدة عبدالنبي فراج [2] و هبة بلقاسم الزوي [1]

1 - قسم العلوم البيئية، كلية الموارد الطبيعية والعلوم البيئية، جامعة عمر المختار

2 - قسم الغابات، كلية الموارد الطبيعية والعلوم البيئية، جامعة عمر المختار.

المستخلص

قدمت هذه الدراسة تقييماً مقارناً للحالة البيئية والكيميائية النباتية للعرعر الفينيقي *Juniperus phoenicea* L. في منطقتين من الجبل الأخضر بليبيا، هما أشنيشن (التجمعات الأحادية النوع) وستلونة (الماكي المختلط)، كما قيمت النشاط الأليلوباثي للمستخلصات المائية للأوراق على إنبات البذور. حُللت عينات الأوراق المركبة الممثلة لكل موقع لتقدير محتواها من الفلافونويدات، والقلويدات الكلية، والفينولات الكلية، والبروتين. اختُبرت المستخلصات المائية بتركيزات (0، 5، 10، 20، 50، 75، و100%) في تصميم عشوائي كامل بثلاثة مكررات، لتقييم نسبة الإنبات، وتثبيط الإنبات، وطول المجموع الخضري، وطول الجذر، والوزن الطازج، والوزن الجاف، والمحتوى المائي.

أظهر التحليل الكيميائي النباتي تركيزات أعلى لجميع المكونات المقاسة في عينات أشنيشن مقارنة بستلونة، حيث بلغت الفلافونويدات 2.17 و1.81 ملغم/100 غم، والقلويدات 129.80 و114.30 ميكروغرام/مل، والفينولات الكلية 393.80 و369.10 ميكروغرام مكافئ حمض الغاليك/100 غم، ومحتوى البروتين 5.10% و4.72% على التوالي. أظهرت نتائج الاختبارات الحيوية أن زيادة تركيز المستخلص أدت إلى انخفاض معنوي ($P \leq 0.05$ في إنبات البذور. في مستخلص أشنيشن، انخفض الإنبات من 90% في الشاهد إلى 20% عند تركيزات ≥20%، وبلغ تثبيط الإنبات 78%. بينما في مستخلص ستلونة، انخفض الإنبات من 100% إلى 20% عند تركيزات 75-100%، وبلغ التثبيط 80%. كان نمو الجذر أكثر المتغيرات حساسية، حيث توقف نمو الجذور تماماً عند التركيزات ≥50% في مستخلص أشنيشن و≥75% في مستخلص ستلونة. كما انخفض الوزن الطازج والوزن الجاف والمحتوى المائي بشكل معنوي مع زيادة تركيز المستخلص.

تشير النتائج إلى أن النشاط الأليلوباثي للعرعر الفينيقي يعتمد على التركيز ويختلف بين المجموعتين السكانيتين. ارتبط التأثير السمي النباتي الأقوى لمستخلص أشنيشن بارتفاع محتواه من الفينولات والفلافونويدات والقلويدات، مما يشير إلى أن التباين الجغرافي في التركيب الكيميائي النباتي قد يؤثر في الإمكانات الأليلوباثية للعرعر الفينيقي في النظم البيئية المتوسطية

الكلمات المفتاحية: العرعر الفينيقي، التضاد الكيميائي، الجبل الأخضر، المستقلبات الثانوية.

للاتصال: د. حميدة عبدالنبي فرج قسم الغابات – كلية الموارد الطبيعية والعلوم البيئية – جامعة عمر المختار

هاتف: 0924988510 البريد الإليكتروني h.faraj@omu.edu.ly

استلمت بتاريخ: 2026/05/12 أجيزت بتاريخ: 2026/08/13