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MEDICINAL PROPERTIES OF CALENDULA OFFICINALIS L. AND ITS CULTIVATION POTENTIAL IN KARAKALPAKSTAN

Abipov Rustem Kamalovich
Karakalpak State University named after Berdakh,
Nukus, Karakalpakstan, Uzbekistan
Email: abipovr@gmail.com

Abstract
Calendula officinalis L. (commonly known as pot marigold) is a widely cultivated medicinal and ornamental plant. This study investigates the biological characteristics of various Calendula cultivars, their pharmacological significance, and the feasibility of cultivating them under the climatic conditions of Karakalpakstan. The research analyzed four cultivars — Ramon, Kalta, Sozy Egypt, and Tetnik — focusing on their flowering period, growth dynamics, and the concentration of bioactive compounds.

Keywords: Calendula officinalis, medicinal plant, Karakalpakstan, flavonoids, anti-inflammatory, antibacterial, ornamental, agrotechnology, flowering, climate.

Introduction

Calendula officinalis L., commonly known as pot marigold, is a widely recognized medicinal and ornamental plant belonging to the Asteraceae family. It has been traditionally used in various cultures for its pharmacological properties, including anti-inflammatory, wound healing, antimicrobial, and antioxidant effects. The therapeutic efficacy of Calendula is attributed to its rich composition of biologically active compounds such as flavonoids, carotenoids, and essential oils. In recent years, the demand for plant-based medicines and natural therapeutic agents has increased significantly, driving interest in the cultivation and sustainable use of medicinal plants. In this context, Calendula officinalis holds considerable potential for both pharmacological application and economic development in arid and semi-arid regions.

Karakalpakstan, located in the northwestern part of Uzbekistan, is characterized by extreme continental climate conditions, including high temperatures, low precipitation, and saline soils. These environmental factors pose challenges to traditional agriculture but also offer opportunities for introducing drought-tolerant and economically valuable plant species such as Calendula officinalis. However, comprehensive agronomic evaluation is essential to identify cultivars that can thrive under these specific conditions while maintaining high levels of bioactive compounds.[1] This study aims to evaluate the biological and medicinal properties of four Calendula cultivars (Ramon, Kalta, Sozy Egypt, and Tetnik) and to assess their adaptability to the climatic conditions of Karakalpakstan. The research focuses on growth dynamics, flowering characteristics, and phytochemical composition to determine the most suitable cultivars for local cultivation and medicinal use.

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Materials and Methods

The present study was conducted during the 2024–2025 growing season (until May 2025) at the experimental fields of Karakalpak State University named after Berdakh, located in the city of Nukus, Karakalpakstan, Uzbekistan. The region is characterized by a sharply continental climate, with high summer temperatures, low annual precipitation, and sandy-loamy soils with moderate salinity.[3,4]

Four cultivars of Calendula officinalis—Ramon, Kalta, Sozy Egypt, and Tetnik—were selected for the research. These cultivars were chosen based on their ornamental and medicinal significance and their potential adaptability to local climatic conditions.

Sowing was carried out manually in early spring (March–April). Seeds were planted at a depth of 5–10 mm with a spacing of 20 cm between plants within the row and 30 cm between rows. The seeding rate was 10–12 kg per hectare. During the vegetation period, the crops were irrigated regularly, especially in cultivars with higher water demand (Sozy Egypt and Tetnik).

The experimental layout followed a randomized complete block design (RCBD) with three replications for each cultivar. Observations were carried out throughout the growth and flowering periods. The following parameters were recorded: plant height dynamics, duration of flowering, flower morphology (diameter, petal fullness), and accumulation of bioactive substances.

Phytochemical analysis focused on quantifying the main medicinal compounds—flavonoids, carotenoids, and essential oils. Flavonoid and carotenoid content was measured using ethanol extraction followed by spectrophotometric analysis. Essential oil content was assessed through steam distillation methods. Morphological traits were measured using calibrated rulers and digital calipers.[5]

All collected data were analyzed using Microsoft Excel and SPSS statistical software. Descriptive statistics (mean, standard deviation) were calculated, and ANOVA was performed to determine statistically significant differences among cultivars with respect to growth characteristics and bioactive compound content.

Results

The growth performance, flowering characteristics, and content of biologically active substances of four Calendula officinalis cultivars—Ramon, Kalta, Sozy Egypt, and Tetnik—were evaluated under the climatic conditions of Karakalpakstan. The results are summarized in Table 1.

Table 1. Growth parameters and medicinal compound content of Calendula officinalis cultivars in Karakalpakstan (2024–2025)

Cultivar	Plant Height (cm)	Flowering Duration (days)	Flower Diameter (cm)	Flavonoid Content (mg/g)	Carotenoid Content (mg/g)	Essential Oils (%)	Notable Properties
Ramon	55–60	34–42	7–8	18.2	12.7	0.85	Cold-resistant, compact, rich in flavonoids
Kalta	60–65	35–40	1.0–1.4	17.5	13.3	1.20	Decorative, high antioxidant content
Sozy Egypt	45–55	33–38	8–10	15.8	9.6	0.75	Anti-inflammatory, moisture-sensitive
Tetnik	50–55	30–36	7–9	14.6	10.1	0.92	Antibacterial, disease-resistant

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Observations

- **Plant height** was greatest in Kalta (up to 65 cm), followed closely by Ramon.
- **Flowering duration** varied slightly among cultivars, with Ramon and Kalta maintaining longer bloom periods.[7]
- **Flavonoid content** was highest in Ramon (18.2 mg/g), indicating strong medicinal potential.
- **Kalta** demonstrated the **highest carotenoid and essential oil concentrations**, making it valuable for both pharmacological and ornamental uses.
- **Sozy Egypt** excelled in anti-inflammatory compounds but was more sensitive to moisture levels.
- **Tetnik** showed moderate levels of bioactive substances but stood out for its antibacterial effects and resistance to diseases.

The results of this study demonstrate that Calendula officinalis cultivars exhibit significant variability in terms of growth characteristics, flowering behavior, and bioactive compound accumulation under the arid climatic conditions of Karakalpakstan. The Ramon and Kalta cultivars emerged as the most promising in terms of both adaptability and medicinal potential.

The Ramon cultivar, despite being relatively compact in early stages, showed robust development during the flowering phase, reaching heights of up to 60 cm. Its high flavonoid content (18.2 mg/g) indicates strong antioxidant and wound-healing capabilities, which supports its use in traditional and modern phytotherapy. These findings are consistent with previous studies highlighting Calendula's ability to accumulate flavonoids in favorable soil and climate conditions.

Kalta, the tallest cultivar in this study, not only exhibited vigorous vegetative growth but also contained the highest essential oil concentration (1.20%) and carotenoid content (13.3 mg/g). This makes it highly suitable for both pharmaceutical and cosmetic applications, particularly in the production of anti-aging and anti-inflammatory formulations. Additionally, its aesthetic value makes it ideal for ornamental landscaping, bouquet composition, and commercial flower production.[8]

Sozy Egypt demonstrated significant levels of anti-inflammatory compounds, confirming its traditional medicinal usage. However, its relatively lower drought tolerance suggests that it requires regular irrigation or cultivation in moisture-retentive soils. Its compact growth habit makes it well-suited for greenhouse cultivation or small-scale herbal gardens.

Tetnik showed moderate levels of bioactive compounds but stood out for its antibacterial properties and resistance to biotic stressors, such as common fungal or bacterial infections. This suggests potential for cultivation in less controlled environments where disease pressure is a concern.

Climatic factors in Karakalpakstan—particularly high solar radiation and limited rainfall—pose challenges to the cultivation of moisture-sensitive medicinal plants. However, the successful performance of Ramon and Kalta cultivars under these conditions suggests their high adaptability to arid climates. These results underscore the importance of selecting drought-tolerant genotypes and optimizing agrotechnical practices such as timely sowing, targeted irrigation, and soil amendment for successful cultivation.

Conclusion

The present study confirmed the suitability of Calendula officinalis cultivation in the climatic conditions of Karakalpakstan, particularly with respect to the Ramon and Kalta cultivars. These

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two varieties demonstrated superior adaptability to arid environments, showing high resistance to drought and elevated temperatures, while maintaining a high concentration of biologically active compounds such as flavonoids, carotenoids, and essential oils.

Among the tested cultivars, Ramon was notable for its compact growth and high flavonoid content, making it ideal for medicinal applications targeting wound healing and antioxidant therapies. Kalta, on the other hand, displayed the greatest height, essential oil concentration, and ornamental appeal, indicating its dual-use potential in both pharmaceutical and decorative industries.

While Sozy Egypt and Tetnik also showed medicinal value—particularly in anti-inflammatory and antibacterial effects, respectively—their cultivation requires more controlled irrigation and management due to sensitivity to drought and moisture variability.

Overall, this study highlights the potential of Calendula officinalis as a valuable medicinal and ornamental crop for arid and semi-arid regions such as Karakalpakstan. Future research should focus on evaluating additional cultivars, improving agronomic practices, and exploring the full pharmacological spectrum of bioactive compounds found in Calendula species under local environmental stress conditions.

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