

## Article

## Chemical Composition, Antioxidant and Antimicrobial Potential of the Essential Oils from Aerial Parts of *Tagetes patula* L. at Different Phenological Stages

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**Abstract:** The current study aims at determining the variability in composition, antibacterial and antioxidant properties of the essential oils extracted from aerial parts of *Tagetes patula* at different phenological stages of plant growth i.e., the vegetative, full blooming and seed setting stages. The maximum average yield of hydrodistilled essential oils was obtained as 0.083 ± 0.003% (seed setting), 0.068 ± 0.007% (full flowering) and 0.059 ± 0.005% (pre flowering). (*Z*)- $\beta$ -ocimene was found to be most abundant compound of essential oil of *T. patula*, and  $\alpha$ -terpinolene, piperitenone, limonene and propanedinitrile, dicyclohexyl were found as major compounds in oil extracted at different phenological stages of plant. Contribution of (*Z*)- $\beta$ -Ocimene was highest in full flowering stage (18.27 ± 3.14%) as compared to other two stages where its amount ranged from 12.03-17.17%.  $\alpha$ -Terpinolene the second major component was found highest in the pre-flowering stage (13.86 ± 1.15%) compared to other stages. Significant variation was observed in the percent content of piperitenone during all three phenological stages. The antioxidant (DPPH radical scavenging) assay showed that *T. patula* oils have maximum activity at the pre-flowering stage. Antibacterial activities of the essential oils were observed at the pre-flowering stage against different bacteria; i.e., *Bacillus* sp., *Escherichia coli*, *Listeria monocytogenes*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and exhibited promising values of MIC (0.125% v/v - 0.5% v/v) and MBC (0.25 v/v to 1% v/v) against bacterial cultures.

**Keywords:** *Tagetes patula* L., Essential oil, Phenological stages, (*Z*)- $\beta$ -Ocimene, Antibacterial, Antioxidant.

### Introduction

*Tagetes patula* L. (Asteraceae), commonly known as 'French Marigold' or 'Genda' is a well-known member of genus *Tagetes* <sup>1</sup>. In India, major states growing genus *Tagetes* are

Maharashtra, Karnataka, Gujarat, Haryana, Uttar Pradesh, Jammu and Kashmir, Andhra Pradesh, Chhattisgarh, Puducherry, Andaman Nicobar, Arunachal Pradesh, West Bengal, and Tamil Nadu <sup>2</sup>. The plant is herbaceous, branched, glabrous,

Article

**Phenological Stage Specific Variations in Chemical Composition, Antioxidant and Antimicrobial Properties of the Essential Oils of Aerial Parts of *Monarda didyma* L. Cultivated Under Doon Valley Climatic Conditions of Uttarakhand, India**

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**Abstract:** This study aims to evaluate the variations in yield of essential oil, chemical constituents, antimicrobial and antioxidant potential of *Monarda didyma* L. (aerial parts) at three different phenophases, namely vegetative stage, full blooming and maturity (seed setting) stages. The essential oil content ranged from 0.62-0.75% in whole aerial parts, with the highest yield in the full flowering (0.75 ± 0.042%), followed by pre flowering (0.70 ± 0.033%) and seed setting (0.62 ± 0.052%) stages. Linalool was found as the major compound followed by  $\gamma$ -terpinene, thymol methyl ether, p-cymene and thymol in the oils during different phenophases of plant. Linalool was maximum in vegetative (pre flowering) stage (60.15 ± 1.56%) as compared to full blooming (44.32 ± 2.55%) and seed setting (46.49 ± 1.63%) stages respectively.  $\gamma$ -Terpinene, the second major constituent was found to be maximum in full blooming stage (21.06 ± 3.06%) as compared to the other stages, and showed cogent variations in percent composition of  $\gamma$ -terpinene during different phenological stages. In thymol methyl ether content, significant variation was observed during all three phenophases of plant. The antioxidant (DPPH assay) activity showed that *M. didyma* oil has maximum activity at seed setting stage. The maximum antimicrobial activities in oil was active at vegetative phase of plant against bacteria and yeast i.e., *Bacillus* sp., *E. coli*, *L. monocytogenes*, *P. aeruginosa*, *S. aureus*, *C. albicans* and revealed favourable values of MIC (0.5% to 1% v/v) and MBC/MFC (0.5 to 2% v/v) against bacterial and yeast cultures.

**Keywords:** *Monarda didyma* L., essential oil, phenological stages, linalool,  $\gamma$ -terpinene, thymol, antimicrobial, antioxidant.