



Tagetes spp.: a source of biologically active substances

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Introduction

Marigold (*Tagetes* spp.), belonging to the Asteraceae family, is a well known ornamental plant widespread all over the world with numerous species. In recent years, the interest in natural substances contributed to the re-evaluation of the *Tagetes*. This genus is recognized as a source of very interesting biologically active products i.e. carotenoids used as food colorants and feed additives (Timberlake and Henry, 1986) and possessing anticancer and antiageing effects (Block et al., 1992); essential oils known for their antibacterial and insecticidal properties (Piccaglia et al., 1996); thiophenes with a marked biocidal activity (Hulst et al., 1989) and flavonoids having pharmacological properties (Terschuk et al., 1997).

Aim of the research was to study several *Tagetes* species cultivated in North Italy, to evaluate the yields and the contents of secondary metabolites extracted from different parts of the plant.



Materials and methods

Plant material

Six *Tagetes* species (*T. erecta*, *T. filifolia*, *T. lucida*, *T. minuta*, *T. patula* and *T. tenuifolia*), were grown from seeds in a farm of the University of Bologna located in the Po valley. The experimental design was a randomized block with three replications. The species were harvested at full flowering stage with the exception of *T. filifolia* whose biological cycle finished at the vegetative stage and *T. minuta* which reached only a partial flowering.

Characterization

Carotenoids were extracted from petals and calyces of fresh flower heads with hexane and characterized by HPLC with detection at 450 nm.

Essential oils were steam-distilled from fresh flower heads (flowering tops for *T. minuta*) and leaves and analysed by GC/MS.

Thiophenes were extracted from roots with ethyl alcohol and determined by HPLC with detection at 340 nm. **Flavonoids** were obtained from flower heads and leaves by extraction with methyl alcohol and separated by HPLC with detection at 360 nm.

Petal color was defined by measuring the L*, a* and b* values using a Chroma Meter.

Tab. 1. Lutein and lutein esters (mg 100g⁻¹) in marigold petals.

Species and petal color	Lutein	Lutein esters	Total
<i>T. patula</i>			
Yellow	18.7	75.6	94.4
Deep orange	-	569.9	569.9
Golden yellow	1.1	97.8	98.9
<i>T. erecta</i>			
Green yellow	1.8	16.2	18.0
Pale yellow	0.3	42.5	42.9
Orange	-	285.3	285.3
Striped	4.9	171.1	176.0
Striped	-	305.0	305.0
Striped	4.0	94.7	98.7
Striped	4.3	12.5	16.8
Mean	3.5	167.1	170.6

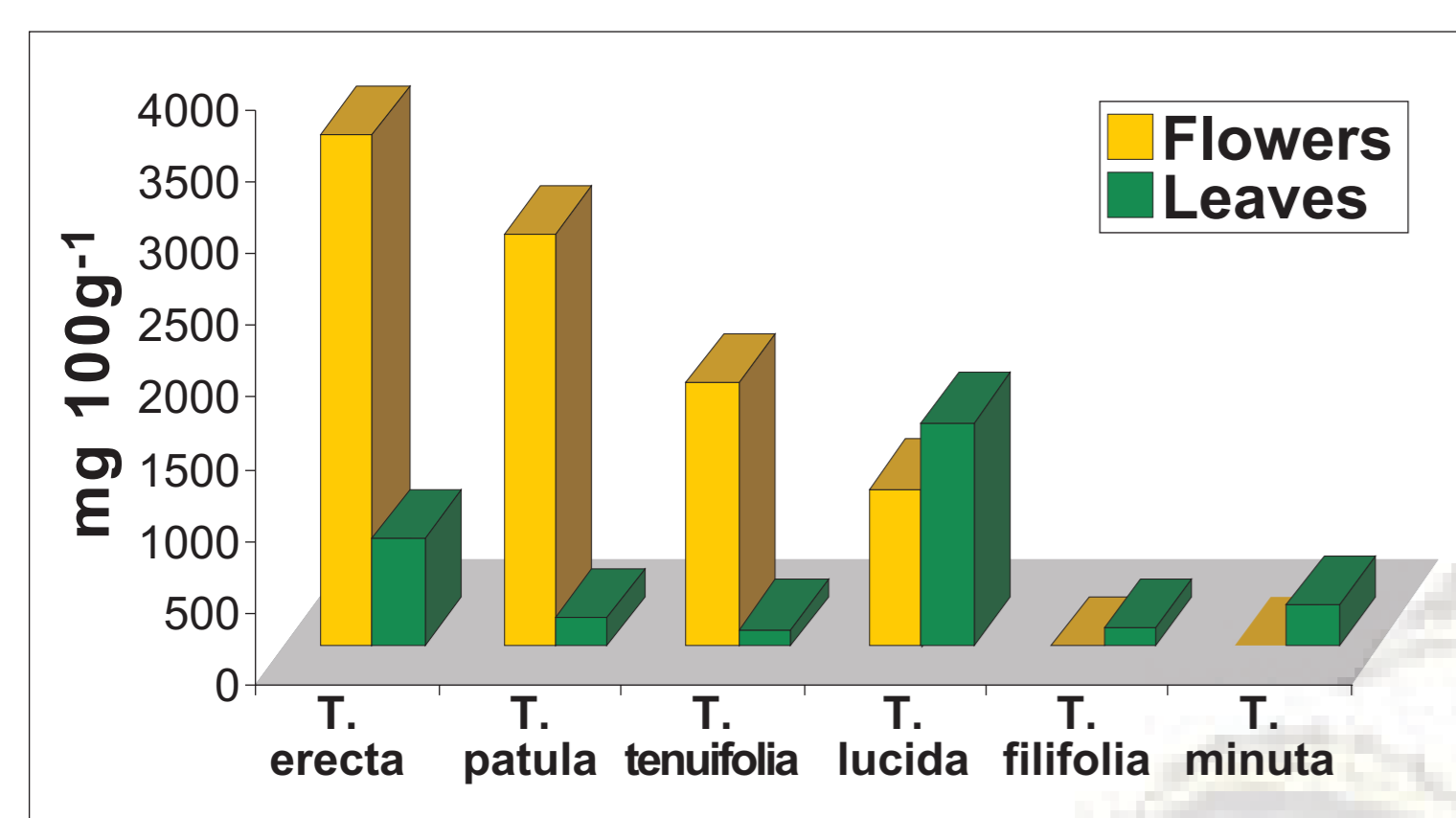


Fig. 3. Flavonoid distribution in flowers and leaves.

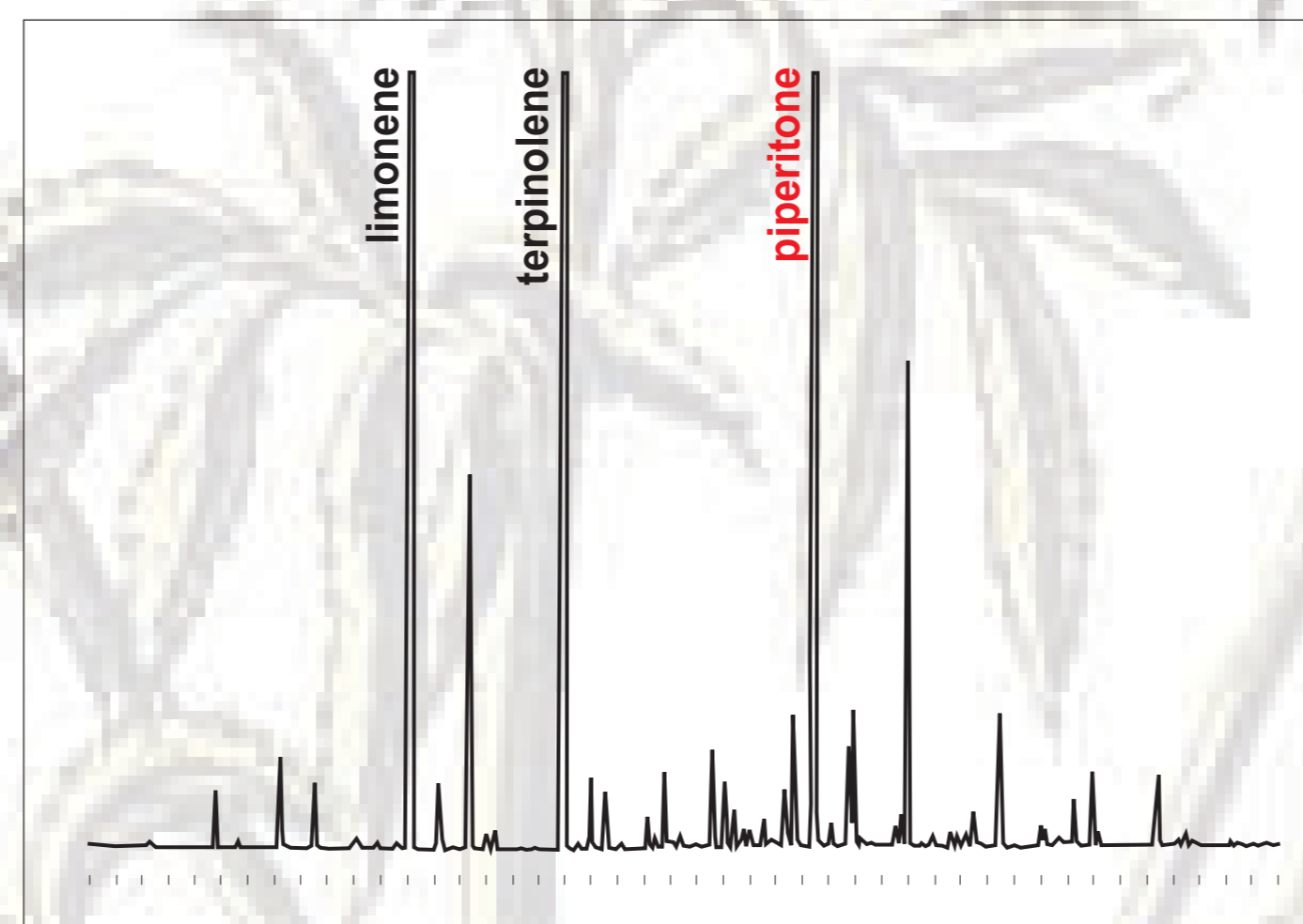


Fig. 1. Cromatographic profile of *T. erecta* oil.

Tab. 2. Petal color, pigment content (mg 100g⁻¹) and chroma meter values.

Petal color	Pigment content	Chroma meter values		
		L*	a*	b*
Green yellow	18.0	67.6	0.1	39.7
Pale yellow	42.8	64.8	2.7	44.4
Yellow	94.4	65.1	4.0	49.1
Golden yellow	98.9	63.4	2.8	43.4
Orange	285.3	59.9	12.3	48.3
Deep orange	569.9	55.5	15.7	43.6

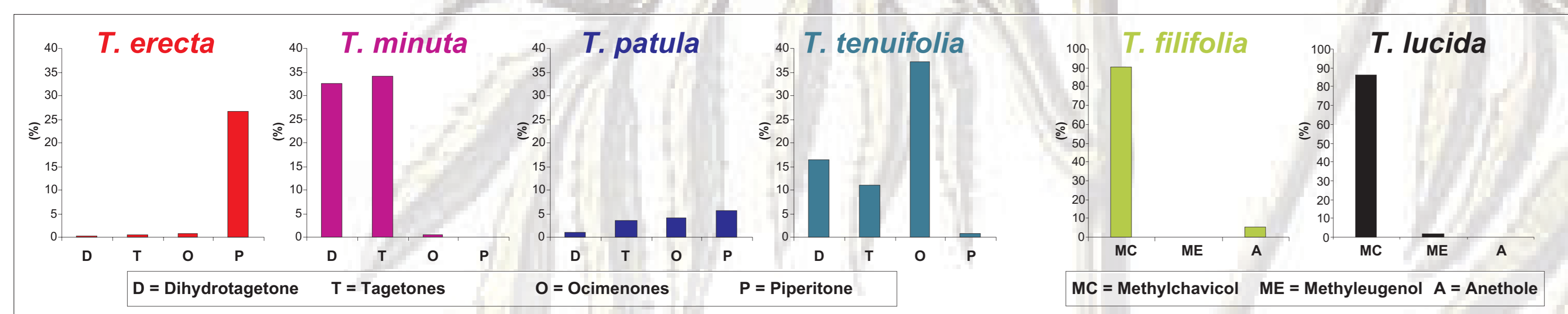


Fig. 2. Typical compounds of the essential oils from whole plant of *Tagetes* species.

Tab. 3. Thiophene content (mg 100 g⁻¹) of fresh roots.

Compound	Erecta	Filifolia	Lucida	Minuta	Patula	Signata	Tenuifolia
α-ter	11.44	0.01	0.31	20.14	17.64	21.92	26.04
BBT	13.5	8.15	224.06	85.21	90.46	151.1	163.09
BBTOAc	16.98	2.15	3.65	15.17	3.33	3.74	3.29
BBTOH	0.59	1.55	1.35	6.07	0.5	2.65	1.12
Totale	42.51	11.86	229.67	126.59	111.93	179.41	193.54

Results and discussion

The most important carotenoids, lutein and lutein fatty acid esters, showed relevant quantitative differences among the marigold types which had a total content of pigments ranging from 17 to 570 mg 100 g⁻¹ in the petals (Tab. 1) and scanty amounts (0.4-18.6 mg 100 g⁻¹) in the remaining part of the flower heads (calyces). Differences in petal colour were well related to the pigment contents and with L* and a* values (Tab. 2).

The essential oils, evidenced a typical profile for each species (Fig. 1). In particular *T. filifolia* and *T. lucida* were characterized by methylchavicol as main compound whereas *T. erecta* showed a high amount of piperitone and *T. minuta* had relevant concentrations of dihydrotagetone and tagetones (Fig. 2). Leaves were richer in oil than flowers. Thiophenes were found, as total content, in a range from 12 to 230 mg 100g⁻¹ in the different species and with the highest amount in *T. lucida* (229.67 mg 100g⁻¹) (Tab. 3).

Flavonoids showed quali-quantitative differences between flowers and leaves and among the species (Fig. 3). The highest values of total flavonoids were found in the flowers of *T. erecta* (3560 mg 100g⁻¹) and in the leaves of *T. lucida* (1550 mg 100g⁻¹).

References

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Conclusions

Carotenoids of marigold petals are mainly made up of lutein and its esters.

Flowers and leaves were characterized by essential oils having a typical composition for each species and leaves were richer in oils than flowers.

T. lucida roots had the highest amount of thiophenes among marigold types.

In general, flowers showed higher content of flavonoids than leaves.

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