



Botanicals from vertical farm: from tradition forward a sustainable future

Ph N óva
INGREDIENTS FOR HEALTH

VERTICAL FARMING

- The plant world represents the most important natural source of bio-active compounds for humans.
- Botanical species are as extraordinary as they are fragile.
- Climate change can pose a threat to botanical derivatives (availability, quality).
- Vertical Farm, or vertical cultivation, enables the cultivation of medicinal plants in a controlled environment, ensuring high quality standards, consistent performance and reducing the consumption of soil and natural resources such as water.



Monarda didyma



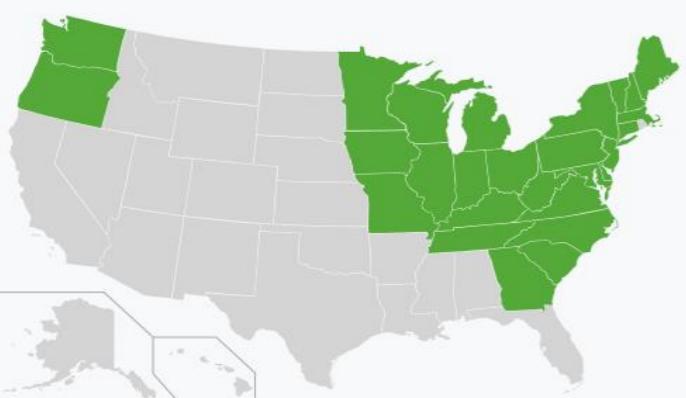
Scientific classification

Kingdom: Plantae
Clade: Tracheophytes
Clade: Angiosperms
Clade: Eudicots
Clade: Asterids
Order: Lamiales
Family: Lamiaceae
Genus: *Monarda*
Species: *M. didyma*

Binomial name

Monarda didyma

L.



U.S. distribution of *Monarda didyma*

LONGEVITY : THE SCARLET BEE BALM



Scarlet bee balm (*Monarda didyma* L.) is a perennial that blooms in late summer. A member of the mint family, it is known to contain didymin, a natural flavonoid glycoside, that has been reported to have anti-inflammatory and antioxidant benefits. (bgwalker/Getty Images)



Monarda (*Monarda didyma* L.), It is characterized by a phytocomplex rich in flavonoids, polyphenols, and other non-volatile phenolic compounds, mainly located in the leaves and aerial parts.

Among the phytochemical constituents identified in extracts obtained from the aerial parts of the plant, didymin is one of the main **characteristic glycosidic flavonoids**

Supplementation with an extract of scarlet bee balm may improve telomere length and stabilize DNA methylation age, according to a new study from the University of Padua (Italy) and Mibelle Group Biochemistry (Switzerland).

The study included 81 people between the ages of 45 and 65 with self-reported stressful jobs. Data published in *GeroScience* indicated that people consuming the extract of scarlet bee balm (*Monarda didyma* L.) showed an increase in biological age of only 0.3 years compared to 1.8 years for those in the placebo group.

The extract, which is marketed under the brand name *MonaJuventina* Nu by Mibelle, was also found to reduce cortisol levels by 25% and improve measures of Quality of Life (QOL), compared to placebo, after 12 weeks of supplementation.

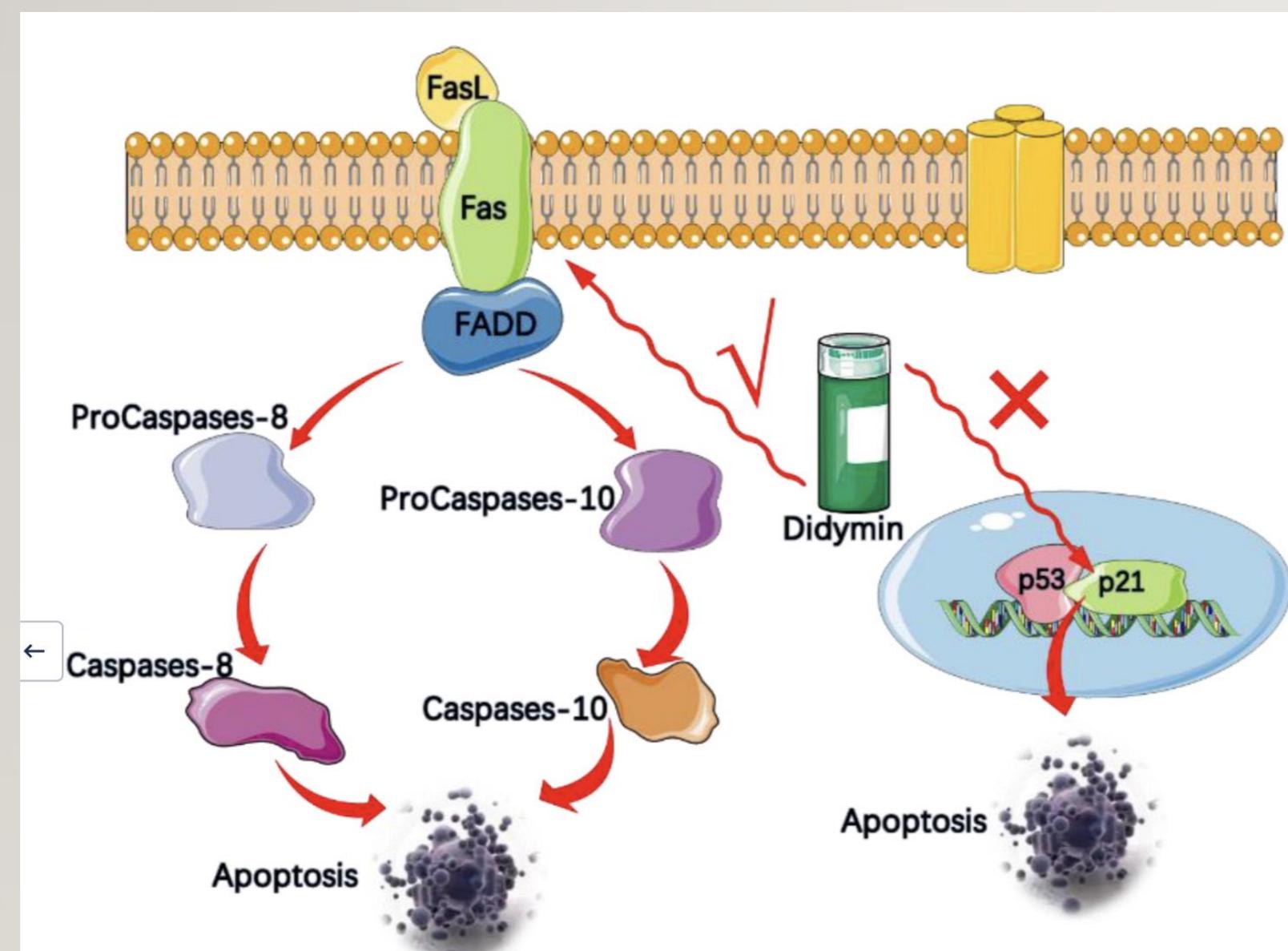
Il nuovo studio, condotto da alcune delle più prestigiose istituzioni scientifiche italiane, ha dimostrato che i risultati ottenuti sono stati ottenuti dall'ateneo e dalla Mibelle. Il test ha avuto per protagonista la *Monarda didyma*, una pianta aromatica del Nord America. Gli effetti anti-età di questo elisir sono stati rilevati grazie a un test condotto dal Bo in collaborazione con il Dipartimento di Scienze cardio-toraco-vascolari e sanità pubblica, che ha visto la professoressa Sofia Pavanello operare all'interno del Bio-AgingLab, per comprendere il potenziale dell'integratore ottenuto dai petali della pianta. Sono 81 le persone



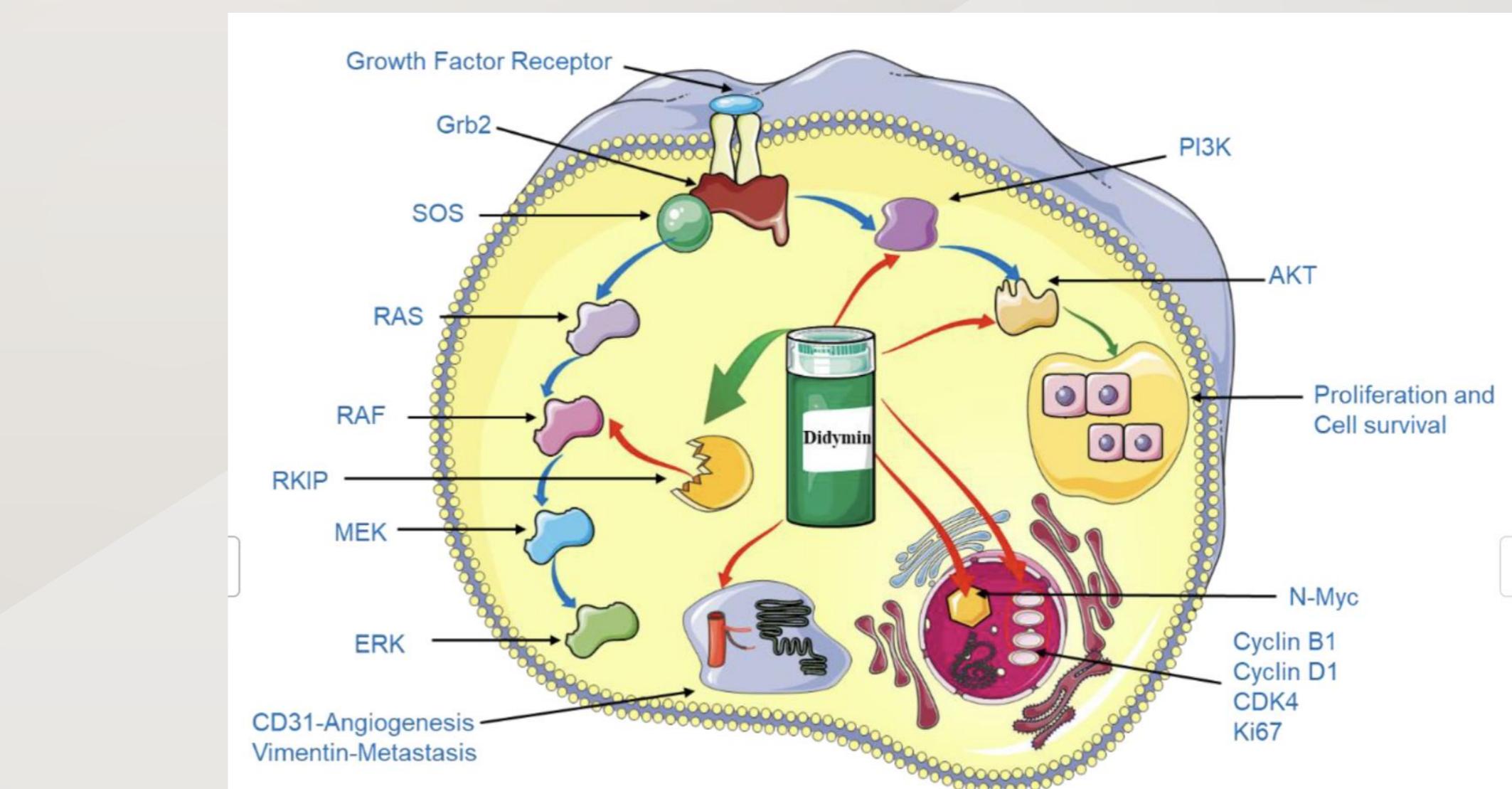
Le piante di *Monarda didyma*

nefici istantanei: immediato il miglioramento dei biomarcatori molecolari di invecchiamento biologico, della qualità di vita e dell'ambito fisico. «L'invecchiamento è un processo individuale, naturale e inesorabile, ma grazie a questi risultati possiamo dire di aver uno strumento in più per contrastarlo e far vivere meglio le persone», spiega la

Didymin is a glycosidic flavonoid naturally present in the leaves of *Monarda didyma* which, at a physiological level, can be transformed in the intestine, depending on the microbiota, into the relative **aglycone isosakuranetin**, a biologically active compound widely studied for its role in cell protection mechanisms.



Didymin is involved in lung cancer cell signaling pathways. The main pathway of apoptosis of A549 and H460 cells induced by didymin is the Fas/Fas ligand apoptotic system. Fas is a cell surface receptor when its ligand (FasL) recognizes and activates Fas; it leads to oligomerization of the intracellular death domain and recruitment of the intracellular adaptor Fas-associated death domain (FADD). After binding, FADD can activate procaspase-8 and procaspase-10 in the death-inducing signaling complex, causing A549 and H460 cells apoptosis or death without the mediation of p53 and p21/WAF1.



Didymin affects neuroblastoma signaling pathways. Stimulating the expression of RKIP is a key role for didymin to exert its efficacy. Also, didymin inhibits N-Myc transcription, on the other hand, didymin decreases the expression levels of PI3K, Akt, vimentin, and down-regulates cyclin D1, B1, and CDK4. By staining the pathological sections of the tumor tissue, didymin not only reduced the expression of the angiogenesis marker CD31 in vivo but also inhibited the expression of the proliferation markers Ki67 and N-Myc. The blue arrow indicates normal signal transduction, the green arrow indicates enhancement, and the red arrow represents inhibition.

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ORIGINAL ARTICLE



Unveiling the geroprotective potential of *Monarda didyma* L.: insights from in vitro studies and a randomized clinical trial on slowing biological aging and improving quality of life

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Abstract Aging is driven by fundamental mechanisms like oxidative stress, telomere shortening and changes in DNA methylation, which together prepare the ground for age-related diseases. Botanical extracts, rich in bioactive phytoconstituents, represent a promising resource for developing therapies that target these mechanisms to promote healthy aging. This study explores the geroprotective potential of *Monarda didyma* L. extract. In vitro analyses revealed the extract's strong antioxidant activity, ability to reduce telomere shortening, and capacity to protect against DNA damage, thereby decreasing cellular senescence and improving endothelial function. The randomized, double-blind clinical trial demonstrated

that daily oral supplementation with the extract significantly improved leukocyte telomere length (LTL) and stabilized DNA methylation age (DNAmAge) in the intervention group, while the placebo group experienced accelerated epigenetic aging and hypermethylation of critical age-related genes (ELOVL2 and FHL2). The intervention group also reported enhanced quality of life, particularly in the physical domain, along with improved movement and quality sleep indices detected by questionnaire and wearable sensors. These compelling findings position *Monarda didyma* L. extract as a powerful candidate for future geroprotective therapies, with the potential to significantly impact healthy aging.

Manuela Campisi and Luana Cannella contributed equally to this work.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s11357-025-01580-2>.

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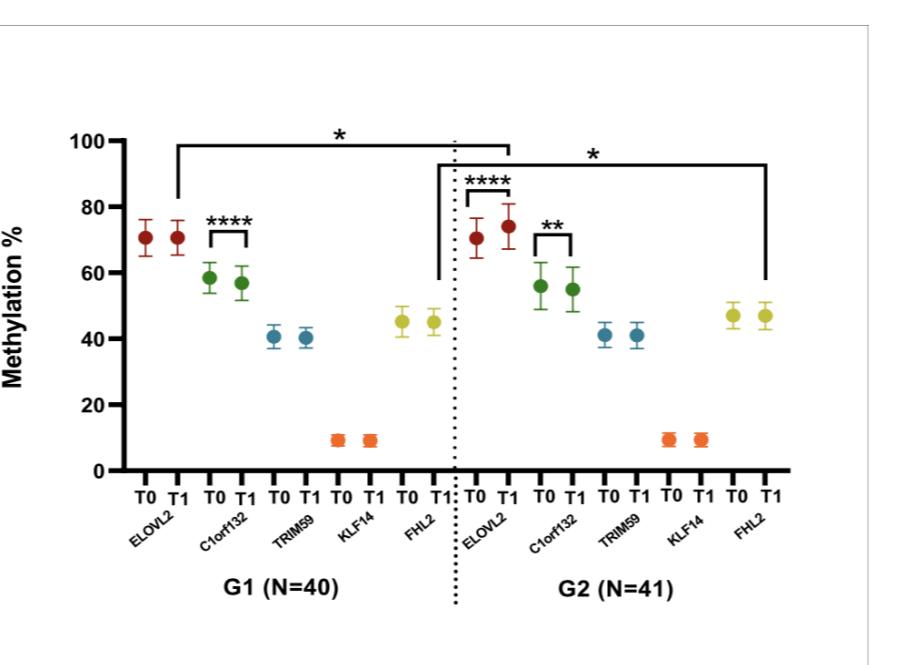
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At the preclinical level, **isosakuranetin** has been studied for its role in modulating the main mechanisms of response to oxidative stress. In particular, it has been associated with the activation of the Nrf2/Keap1 pathway, an endogenous defense system that regulates the expression of antioxidant and phase II detoxifying enzymes. The activation of Nrf2 promotes an increase in the cell's ability to neutralize reactive oxygen species (ROS) and maintain redox balance, contributing to the protection of lipids, proteins, and DNA from oxidative damage.

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Fig. 5 Clinical trial on *Monarda didyma* L. extract: DNA methylation status at the CpG sites of five genes analyzed. DNA methylation status at the CpG sites of each of the five genes (ELOVL2, C1orf132, KLF14, TRIM59, and FHL2) analyzed for DNAmAge determination, reported as methylation %, before (T0) and after (T1) treatment of the G1 (intervention group, $N=40$) and G2 (placebo group, $N=41$). Data presented are reported as mean \pm SD. Student's *T*-test and Mann–Whitney *U* test were used for statistical analyses; *, $p < 0.05$



TAKE HOME MESSAGE

Botanicals obtained in Vertical Farm contain a high content of bio-active compounds, an unaltered, complete phytocomplex, and are free of contaminants.

Vertical Farm - innovative cultivation technology - optimizes the use and consumption of natural resources.

Botanicals from Vertical Farm stand out as viable solutions capable of carrying the tradition of botanical preparations into a sustainable future.

SPECIFICHE ANALITICHE		
VALORI QUANTITATIVI PRINCIPALI		
PARAMETRO	METODO	VALORE
Didimina	HPLC-DAD	≥ 2,00 % p/p



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THANK YOU
