



Origanum vulgare oil: composition and in vitro activity of four Mediterranean aromatic plants

Dr. A. Colonnese¹, R. Panzironi²

¹ Nutrition Biologist, Latina, Italy

² Independent Researcher, Latina, Italy

1. ABSTRACT

The research compared four essential oils obtained from Mediterranean aromatic plants. For *Origanum vulgare* oil, it measured volatile molecules and various test-tube activities. Carvacrol was found to be predominant, while the observed effects remain preclinical data and not evidence of benefit in humans. The authors' summary describes an experimental laboratory study on essential oils of oregano, rosemary, sage, and thyme. The oils were extracted by hydrodistillation and analyzed using GC/MS (gas chromatography coupled with mass spectrometry, a technique that separates and identifies volatile molecules). Nine compounds were identified in the oregano oil; carvacrol accounted for 85.78% of the measured profile. In two in vitro antioxidant assays, the oregano oil showed an EC₅₀ value of 1.69 ± 0.07 mg/mL in the reducing power test and 9.2 ± 0.6 mg/mL in the DPPH test. A lower EC₅₀ indicates that, in that specific test, less sample is needed to reach half of the measured effect. The oil also inhibited nitric oxide production in stimulated murine macrophages, with a GI₅₀ of 13.3 ± 0.5 µg/mL, and showed antibacterial and antifungal activity against selected microorganisms. These results indicate technical potential in controlled models. They do not demonstrate that the spice consumed in meals, nor the concentrated oil taken by people, prevents or treats diseases.

VIDEO ARTICLE



ARTICLE INFORMATION

Received: October 27, 2026

Revised: October 27, 2026

Accepted: October 27, 2026

Published: October 2026

DOI 10.5281/zenodo.placeholder

KEYWORDS

olio di *Origanum vulgare* composizione e attività in vitro

carvacrolo nell'olio di origano

profilo chimico dell'origano

attività antimicrobica in vitro

oli essenziali mediterranei

test di laboratorio sull'origano

MISSION

LIFE Science Hub – Journal of Science was founded with the aim of making scientific knowledge accessible without giving up methodological rigour, quality of sources and authoritativeness of content. The journal promotes the dissemination of knowledge in the health, nutrition, medical and longevity sciences, building a bridge between the world of research and society.

Through articles, reviews, in-depth analyses and expert contributions, the Journal champions evidence-based medicine and science, fostering a correct interpretation of scientific data and countering misinformation. Every piece of content is developed with the aim of translating the complexity of research into understandable, useful and applicable information, while keeping intact the principles of accuracy, transparency and scientific independence.

Free from political, industrial and commercial influence, the journal stands as an authoritative and independent editorial space, dedicated to promoting scientific culture, professional development and the growth of health awareness among the public.



2. WHAT THIS RESEARCH ANALYZED

The 2024 study by Spréa and colleagues compared essential oils from oregano, rosemary, sage, and thyme. An essential oil is a concentrated mixture of volatile molecules obtained from the plant; therefore, it is not the same as the aromatic herb used in cooking. The authors extracted the oils via hydrodistillation using a Clevenger apparatus and studied their composition using GC/MS. They then evaluated their antioxidant activity in vitro, their ability to reduce nitric oxide production in murine immune cells, their effect on tumor and non-tumor cells, and their action against bacteria and fungi. The experimental design allows for the comparison of samples under controlled conditions. It does not examine people, food consumption, or clinical outcomes. For oregano, the most straightforward result to interpret biologically is that the analyzed sample was dominated by carvacrol, an aromatic molecule belonging to phenolic monoterpenes. This composition may contribute to the responses measured in the laboratory, but the work does not isolate the effect of carvacrol alone, nor does it prove that it is the sole factor responsible. The next step, therefore, is to read the results without turning a technical test into a health effect.

3. WHAT RESULTS EMERGE FROM THE STUDY

O. vulgare oil showed a composition concentrated primarily in carvacrol: 85.78% of the detected volatile profile. Simply put, its aroma and part of its experimental behavior depend on a mixture in which this molecule is largely predominant. However, this data does not define all oregano oils, because species, harvesting, and processing can profoundly alter the composition. In antioxidant assays, oregano oil achieved 1.69 ± 0.07 mg/mL in reducing power and 9.2 ± 0.6 mg/mL in DPPH. These are chemical tests: they indicate the sample's ability to react in an artificial system, not the protection of a person's cells. In RAW264.7 cells, mouse macrophages used as a model for inflammatory response, the GI₅₀ was 13.3 ± 0.5 µg/mL for the inhibition of nitric oxide production. The value signals activity in the model, but does not demonstrate an anti-inflammatory effect in the human body. On a microbiological level, the oil showed the greatest antibacterial activity among the four samples

examined. It inhibited the growth of all tested bacteria and achieved a bactericidal effect on *Escherichia coli*, *Salmonella enterica*, *Yersinia enterocolitica*, and *Staphylococcus aureus* between 0.08% and 0.63% by volume. Conversely, it did not show bactericidal activity, up to 2.5%, against *Pseudomonas aeruginosa*, *Bacillus cereus*, and *Listeria monocytogenes*. This confirms that the effect depends on the microorganism and the test conditions.

4. WHY THIS STUDY IS RELEVANT

The value of this research is primarily comparative. It analyzes four oils obtained through a consistent procedure in the same experiment and links their chemical profile to multiple biological measurements. This helps to understand why it is incorrect to speak of essential oils from aromatic plants as if they were equivalent. In the oregano sample, the prevalence of carvacrol was associated with favorable results in various laboratory assays, while rosemary and sage showed different profiles and responses. The work is also useful for potential technical applications, for example in research on food preservation or cosmetic formulations. However, activity against bacteria in a culture broth does not demonstrate efficacy in a complex food, on the skin, or in the gut. Similarly, a reduction of nitric oxide in isolated cells does not equate to a therapy for inflammatory conditions. The relevance is therefore preclinical and industrial, not clinical.

5. STUDY LIMITATIONS AND WHAT IT DOES NOT DEMONSTRATE

The research is based entirely on in vitro evidence, meaning tests conducted outside the body in chemical systems, cell cultures, and microorganisms. This type of study is suitable for generating hypotheses and comparing samples, but it cannot establish safety, effective dosage, or benefits for people. There is no data available regarding absorption, metabolism, tissue distribution, or drug interactions. Furthermore, the effects depend on the specific product tested. An essential oil with 85.78% carvacrol does not automatically represent fresh oregano, dried oregano, or another batch of oil. The cancer cells used in the study are experimental models, and a reduction in their growth does not demonstrate anti-tumor activity in animals or patients. Finally, the oil did not act the



same way against all bacteria. Therefore, these results do not authorize the use of the essential oil as a substitute for antimicrobial, anti-inflammatory, or oncological therapies.

6. INDEPENDENT CONFIRMATORY EVIDENCE

A 2024 study on four commercial *O. vulgare* oils confirms the initial step of the chain: the oil's composition and its in vitro activity can be evaluated together, but they vary between samples. The experimental study used GC/MS, antioxidant assays, and antimicrobial tests on bacteria and fungi. It detected antimicrobial and antioxidant activity, with differences linked to the products' composition. This is a direct confirmation of the analytical approach used in the study by Spréa and colleagues, but it does not involve people nor does it demonstrate therapeutic efficacy [1]. A second experimental study compared eight samples from two oregano genotypes, one rich in carvacrol and one rich in thymol. The supported premise is that the volatile profile may be associated with different effects against microorganisms and in cellular intestinal models. The oils showed antimicrobial activity even in a food matrix test; however, no relevant anti-inflammatory effects emerged in Caco-2 cells. The confirmation of antimicrobial activity is therefore moderate, while that of the anti-inflammatory action remains weaker and dependent on the model [2]. A study on *O. vulgare* subsp. *hirtum* oil, HepG2 liver carcinoma cells, and human embryonic kidney HEK293 cells supports the cytotoxicity data observed by Spréa and colleagues. The model included cell cultures and bacteria, not animals or patients; the oil and some of its components reduced the viability of HepG2 cells and showed antibacterial activity. The relationship with the main research is direct at the preclinical level, but the substantial limitation is that selectivity in culture does not equate to an oncological treatment [3].

7. CONFLICTING EVIDENCE

Research on seven populations of *O. vulgare*, grown under similar conditions and observed over two years, shows why the sample used by Spréa and colleagues cannot represent the entire species. The essential oil content varied from 0.12% to 1.76% and carvacrol from 0.3% to 46.8%; four chemotypes were identified,

meaning groups of the same species with different chemical profiles. This does not refute the value of the carvacrol-rich sample, but it limits the ability to generalize these findings to other oreganos [4]. A further study on *O. vulgare* subsp. *glandulosum* found variations between the vegetative stage and flowering. Carvacrol levels fluctuated from 61.08% to 83.37%, oil yield changed, and the minimum inhibitory concentrations against five sensitive bacteria ranged between 125 and 600 µg/mL. The result supports the dependence of activity on the plant material and the harvesting phase. No directly conflicting evidence of sufficient relevance was identified; this does not prove the absence of contrary results [5].

8. QUADRO COMPARATIVO E SINTESI DELLE EVIDENZE

Independent research confirms the experimental activity of oregano oil, but also shows how much composition and response depend on the sample and the model used.

Quadro comparativo

Publication	Model and essential data	Main result	Relationship with the study by Spréa et al.
Walasek-Janusz et al. [1]	Four commercial <i>O. vulgare</i> oils; GC/MS, antioxidant and microbiological assays	Antioxidant and antimicrobial activity with differences between samples	Direct confirmation of the utility of linking composition and in vitro tests
Zinno et al. [2]	Eight samples from two genotypes; bacteria, food matrix, and Caco-2 cells	Antimicrobial activity; absence of significant anti-inflammatory effect in the intestinal model	Partial confirmation, dependent on the model
Fazio et al. [3]	<i>O. vulgare</i> oil and main components; HepG2 and HEK293 cells, bacteria	Reduction in cell viability and antibacterial activity in culture	Preclinical confirmation of the cytotoxicity observed in cell lines
Morshedloo et al. [4]	Seven populations cultivated over two years; GC-FID and GC/MS	Carvacrol between 0.3% and 46.8%; four chemotypes	Highlights that a single oil does not represent all oreganos
Béjaoui et al. [5]	Three vegetative stages of <i>O. vulgare</i> subsp. <i>glandulosum</i> ; five bacteria	Variable carvacrol and yield; MIC between 125 and 600 µg/mL in sensitive strains	Shows dependence on harvest and plant development stage

9. SINTESI EDITORIALE E CONCLUSIONI

EDITORIAL CONCLUSION

The study by Spréa and colleagues compared four essential oils obtained from Mediterranean aromatic plants, describing both their volatile composition and the responses in laboratory tests. In the *Origanum vulgare* oil, carvacrol was predominant, and the sample showed antioxidant activity, inhibition of nitric oxide production in murine macrophages, and activity against various microorganisms. These signals are consistent with other research on oregano oils, but the samples do not have a fixed composition: genetics, harvesting, vegetative stage, and extraction can change the yield and main molecules. The result therefore concerns a specific oil, not all spices or all products labeled as oregano. Furthermore, test tubes, cell cultures, and microorganisms do not represent the human body nor do they demonstrate a clinical benefit. The editorial value of the research lies in clarifying why seemingly similar ingredients require separate evaluations. The dietary use of oregano

remains distinct from the use of concentrated oils and therapeutic applications.

Aggiornato al 27/10/2026. Questo contenuto riflette una sintesi divulgativa delle evidenze scientifiche al momento della pubblicazione e non sostituisce il parere medico.

10. TRANSPARENCY AND SCIENTIFIC RESPONSIBILITY

Artificial Intelligence was used solely as a tool for editorial and documentary support. All content, interpretations, bibliographic citations and conclusions have been verified, reviewed and approved by the author, who assumes full scientific responsibility for them.

The manuscript was also subjected to independent peer review prior to publication.

To ensure the greatest transparency, the complete history of the article, including the dates of submission, revision, acceptance and publication, as well as information on the peer review process, is available on the dedicated Article History page.



11. RIFERIMENTI BIBLIOGRAFICI

- [1] **Chemical Composition, and Antioxidant and Antimicrobial Activity of Oregano Essential Oil**
Walasek-Janusz et al., 2024
Molecules
DOI: <https://doi.org/10.3390/molecules29020435>
- [2] **Chemical Composition and Biological Activities of Essential Oils from Origanum vulgare Genotypes Belonging to the Carvacrol and Thymol Chemotypes**
Zinno et al., 2023
Plants
DOI: <https://doi.org/10.3390/plants12061344>
- [3] **Cytotoxic Activity of Origanum Vulgare L. on Hepatocellular Carcinoma cell Line HepG2 and Evaluation of its Biological Activity**
Elshafie et al., 2017
Molecules
DOI: <https://doi.org/10.3390/molecules22091435>
- [4] **Essential oil profile of oregano (Origanum vulgare L.) populations grown under similar soil and climate conditions**
Morshedloo et al., 2018
Industrial Crops and Products
DOI: <https://doi.org/10.1016/j.indcrop.2018.03.049>
- [5] **Essential Oil Composition and Antibacterial Activity of Origanum vulgare subsp. glandulosum Desf. at Different Phenological Stages**
Béjaoui et al., 2013
Journal of Medicinal Food
DOI: <https://doi.org/10.1089/jmf.2013.0079>