



Phytochemical composition of cloves: new evidence from 2025

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1. ABSTRACT

The study examined an extract obtained from dried buds of *Syzygium aromaticum*. The authors measured several plant compounds, evaluated the ability to neutralize radicals in a test tube, and identified volatile molecules using GC-MS. The main finding is the predominance of eugenol in the analyzed sample. The authors' summary describes experimental laboratory research, not a study on humans. The extract showed activity in the DPPH test, a method that verifies how well a substance can neutralize an artificial radical in a test tube. In this test, a lower IC₅₀ (concentration required to reduce the signal by 50%) indicates greater activity in the analytical system. The IC₅₀ of the extract was 0.08 ± 0.01 mg/mL; in the same comparison, ascorbic acid and BHT had lower values, therefore showing greater activity in this specific test. Gas chromatography-mass spectrometry, known as GC-MS (a technique that separates and identifies volatile molecules), detected 21 components. Eugenol accounted for 58.86% of the relative area of the identified signals. The authors also applied molecular docking, a simulation that estimates whether the shape of a molecule can fit into a specific area of a protein. This part generates hypotheses about interactions but does not prove antimicrobial, insecticidal, or therapeutic effects in living organisms.

VIDEO ARTICLE



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2. WHAT THIS RESEARCH ANALYZED

The 2025 study by Abdelmuhsin and colleagues analyzed a sample of dried clove buds collected in Sudan. In practical terms, the question was whether the plant material retained measurable molecules capable of reacting with radicals in a test-tube assay. The authors quantified total phenols and flavonoids, two groups of plant substances that can contribute to the chemical behavior of the extract. They then used GC-MS, a technique that first separates volatile compounds and then compares their characteristics with reference databases. Finally, they performed molecular docking on 21 identified compounds. This simulation is used to estimate possible fits between a molecule and a protein, not to demonstrate that the interaction occurs in a bacterium, an insect, or the human body.

3. WHAT RESULTS EMERGE FROM THE STUDY

The most immediate result is that the sample was not chemically uniform. Eugenol, an aromatic molecule from the phenylpropanoid family, was the main volatile component, accounting for 58.86% of the relative area detected. A total of 21 compounds were identified. This describes the profile of the analyzed sample, not a mandatory composition for every commercial product. The extract neutralized the DPPH radical in a test tube with an IC_{50} of 0.08 ± 0.01 mg/mL. The practical significance is limited to the test: it indicates chemical reactivity toward that artificial radical. Since BHT and ascorbic acid had lower IC_{50} values in the same experiment, the extract was found to be less active than these references according to that measure. Docking data suggest theoretical affinities with selected proteins, but they do not replace microbiological, toxicological, or clinical tests.

4. WHY THIS STUDY IS RELEVANT

For those who want to understand the quality of the spice, this work is useful because it links a dried bud to concrete measurements: estimated quantities of plant compound groups, the footprint of volatile molecules, and performance in an anti-radical test. It also shows why eugenol is often used as a descriptive indicator of the aromatic profile of cloves. The relevance remains primarily analytical and preclinical. The research does

not evaluate dietary consumption, intestinal absorption, bioavailability (the portion of a substance that reaches the circulation), nor benefits or risks in people. It therefore helps to characterize the plant material, but does not allow for the deduction of health effects from the mere presence of eugenol or the value obtained in the DPPH test.

5. STUDY LIMITATIONS AND WHAT IT DOES NOT DEMONSTRATE

The study concerns a single plant sample and tests performed outside the organism. Harvesting, bud age, drying, storage, origin, and extraction technique can modify the final profile. There is no evidence available that the reported percentages represent all dried buds on the market. The DPPH test measures chemical capacity under controlled conditions; it does not directly measure oxidative stress in human tissues and is not equivalent to a preventive or therapeutic effect. Molecular docking is also a mathematical prediction: it can guide subsequent experiments, but it does not prove activity against bacteria nor efficacy as an insecticide. The 2025 study by Abdelmuhsin and colleagues is not a clinical trial and does not provide dietary doses or instructions for use.

6. INDEPENDENT SUPPORTING EVIDENCE

Initial confirmation concerns the biological variability of the bud. Alfikri and colleagues compared three developmental stages in young and mature plants: they collected buds from 9 young and 3 mature plants, with three replicates per condition. Using GC-MS, they found eugenol levels between 68.05% and 82.38%, while the DPPH IC_{50} varied from 15.80 to 108.85 μ g/mL [1]. This experimental study supports the transition from bud state to composition and analytical response. The confirmation is direct regarding the oil profile, but it does not coincide with the extract nor does it demonstrate effects in humans. A second experimental study identified eugenol as the major component of an essential oil, at 53.23%, and observed anti-radical activity in vitro for both the oil and isolated eugenol [2]. The chain supported is volatile composition eugenol contribution response in a chemical assay. The oil had an EC_{50} of 78.98 μ g/mL, while eugenol showed 12.66 μ g/mL. This is moderate-level confirmation for the analytical mechanism, with the limitation that

essential oil and bud extract are not equivalent. A third experiment identified eugenol at 60.5% in the oil obtained from buds and measured the ability to neutralize the ABTS radical, another artificial laboratory system [3]. The result reinforces the idea that a eugenol-rich profile may be associated with anti-radical reactivity in vitro. The confirmation is indirect compared to the 2025 study, because it uses a different method and includes synthetic derivatives; it does not clarify the effect of the spice in the diet.

7. CONFLICTING EVIDENCE

Available evidence indicates that activity and composition depend on the form examined. Politeo and colleagues compared volatile compounds released from sugar-bound forms with clove essential oil. Only eugenol was common to both profiles; the released fraction showed lower activity than the oil in both DPPH and FRAP tests, a method that measures

reducing power [4]. This does not negate the results of Abdelmuhsin and colleagues from 2025, but it shows that the matrix and preparation method change the outcome. Further evidence comes from an extraction experiment using pressurized carbon dioxide. Depending on pressure and temperature, the eugenol in the extracted oil ranged between 48.41% and 58.62%, with higher proportions of eugenyl acetate and beta-caryophyllene compared to the 2025 sample [5]. The model was a physicochemical system using ground buds, without biological tests and without a declared biological sample size. The discrepancy is relevant because it reduces the generalizability of a single GC-MS profile. No sufficiently relevant directly conflicting evidence regarding the identification of eugenol as an important component has been identified; this does not prove the absence of contrary results.

8. QUADRO COMPARATIVO E SINTESI DELLE EVIDENZE

The following research compares the consistency and limitations of the chemical profile and laboratory tests with respect to the 2025 publication.

Quadro comparativo

Publication	Model and main data	Relevant result	Relationship with the 2025 study
Alfikri et al., 2020 [1]	Buds at three stages; 9 young plants, 3 mature; GC-MS and DPPH	Eugenol 68.05–82.38%; variable DPPH activity	Direct confirmation of variability linked to bud development
Teles et al., 2021 [2]	Essential oil and eugenol; GC-MS and in vitro assays	Eugenol 53.23%; eugenol showed higher activity than the oil in the test used	Confirms the descriptive role of eugenol and its reactivity in test tubes
Gulcin et al., 2011 [3]	Bud oil and eugenol derivatives; GC-MS and ABTS	Eugenol 60.5%; antiradical activity measured in the laboratory	Indirect confirmation using a different analytical method
Politeo et al., 2010 [4]	Bound volatile fractions and essential oil; DPPH and FRAP	Bound fractions were found to be less active than the oil	Shows dependence of the outcome on the matrix and method
Zapata Noreña and Meireles, 1997 [5]	Ground buds; extraction with pressurized CO ₂	Eugenol 48.41–58.62% depending on operating conditions	Shows that the extraction technique can change the profile



9. SINTESI EDITORIALE E CONCLUSIONI

EDITORIAL CONCLUSION

The 2025 publication by Abdelmuhsin and colleagues describes an extract of dried *Syzygium aromaticum* buds as a mixture rich in plant compounds, dominated in the analyzed volatile fraction by eugenol. GC-MS identified 21 components, and the DPPH test documented an ability to neutralize an artificial radical in a test tube. This data is useful for characterizing the sample, but it does not equate to a demonstration of efficacy in the human body. Independent research supports two points: eugenol is often a major component of bud oil, and antiradical measurements change based on the harvest phase, matrix, solvent, and test adopted. The differences observed between studies do not invalidate the 2025 sample profile; instead, they indicate that there is no universal value for all cloves. The most rigorous interpretation is to consider these data as chemical-analytical information, not as proof of clinical benefits.

Aggiornato al 30/10/2026. 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.

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