

Title:**Antioxidant Potential of Cymbopogon citratus Leaf Extracts in the Prevention of Oxidative Stress Involved in Cancer****Corresponding Author****MULONSO HYGIN** hyginmulonso@gmail.com +243 815962836**Co-authors****Ndenga Lumbu Barack (Alias BarackEinstein97)****Independent Scientific Researcher** ndengabarack@gmail.com +243 837 767 430**Kabena Ilunga Maria** kabenamaria85@gmail.com +243 822913081**Abstract**

This study comprehensively evaluates the nutritional composition and antioxidant potential of methanolic and chloroformic extracts derived from the leaves of *Cymbopogon citratus*, a medicinal plant extensively utilized in traditional phytotherapy. The research primarily focused on assessing the extracts' capability to scavenge free radicals, a vital process in mitigating oxidative stress linked to the etiology of various chronic conditions, particularly cancer. The

antioxidant capacity was quantified using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical assay, a well-established method to measure the ability of antioxidants to neutralize free radicals. Results revealed a significantly higher antioxidant activity index (AAI) in the methanolic extract (AAI = 5.2) compared to the chloroformic extract, underscoring its potent free radical scavenging efficacy.

Complementary metabolomic profiling using nuclear magnetic resonance (NMR) spectroscopy and chromatographic techniques identified an abundance of terpenoids within the extracts. Terpenoids are a class of bioactive secondary metabolites widely acknowledged for their diverse pharmacological properties, including antioxidant, anti-inflammatory, and anticancer effects. The presence of these compounds supports the extracts' therapeutic value and emphasizes the potential of *Cymbopogon citratus* as a natural source for developing antioxidant agents aimed at preventing oxidative stress-related pathologies, especially malignancies. This investigation thus advances the understanding of *Cymbopogon citratus* leaf extracts' bioactive profile and paves the way for future studies focusing on their application in cancer prophylaxis and complementary therapy.

Introduction

Oxidative stress arises from an imbalance between the generation of reactive oxygen species (ROS) and the capacity of the body's antioxidant defense mechanisms to neutralize these harmful free radicals. This imbalance triggers cellular damage that is implicated in the pathogenesis and progression of various chronic diseases, including neurodegenerative disorders, cardiovascular diseases, diabetes, and notably, certain forms of cancer. The molecular damage caused by oxidative stress involves lipid peroxidation, protein modification, and DNA strand breaks, which may promote carcinogenesis by inducing mutations and genomic instability.

In light of these pathological consequences, the exploration of natural antioxidants that can effectively scavenge free radicals is of paramount importance for developing preventive and therapeutic strategies against oxidative stress-related diseases. Medicinal plants have historically been and continue to be a rich source of bioactive compounds with antioxidant properties, offering promising alternatives or complements to synthetic antioxidants. *Cymbopogon citratus*, commonly known as lemongrass, is a perennial aromatic herb widely used in traditional medicine across diverse cultures. Its essential oils have been extensively studied and demonstrated to possess antimicrobial, anti-inflammatory, and antioxidant activities. However, the non-volatile constituents of *Cymbopogon citratus*, particularly those present in leaf extracts other than essential oils, have received comparatively less attention. These extracts may contain a complex mixture of phytochemicals, including phenolics, flavonoids, and terpenoids, which contribute significantly to the plant's therapeutic potential. Given the recognized role of oxidative stress in cancer pathophysiology, a deeper understanding and comprehensive analysis of the antioxidant capacity of *Cymbopogon citratus* leaf extracts is warranted. This study aims to fill this knowledge gap by evaluating the antioxidant potential of

methanolic and chloroformic leaf extracts, specifically their ability to neutralize free radicals implicated in oxidative stress, thereby laying foundational groundwork for considering these extracts as natural agents in cancer prevention and complementary therapy.



Figure 1. Citratus

Given the recognized role of oxidative stress in cancer pathophysiology, a deeper understanding and comprehensive analysis of the antioxidant capacity of Cymbopogon citratus leaf extracts is warranted. This study aims to fill this knowledge gap by evaluating the antioxidant potential of methanolic and chloroformic leaf extracts, specifically their ability to neutralize free radicals implicated in oxidative stress, thereby laying foundational groundwork for considering these extracts as natural agents in cancer prevention and complementary therapy.

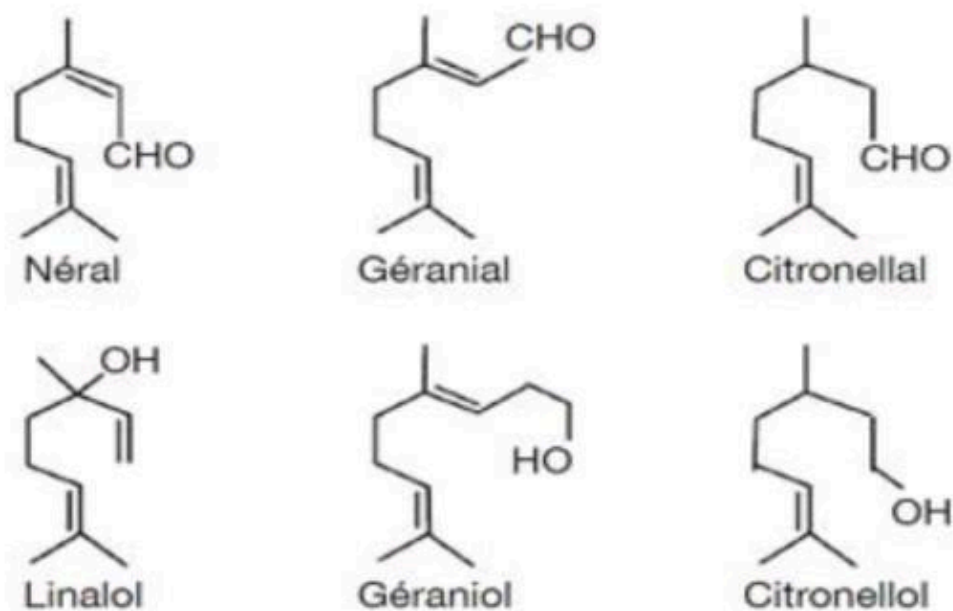


Figure 2. Chemical compositions

Materials and Methods

Plant Material Collection and Preparation

Fresh leaves of *Cymbopogon citratus* were collected from the Kinshasa region in the Democratic Republic of Congo. The collected plant material was thoroughly washed with distilled water to remove dust and impurities, then air-dried at room temperature for several days until a constant weight was achieved. Subsequently, the dried leaves were ground into a fine powder using a mechanical grinder to facilitate extraction.

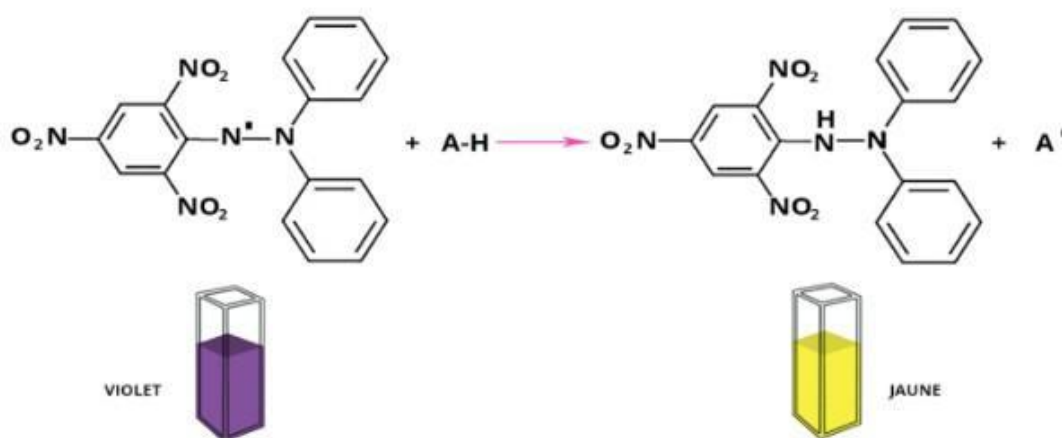


Figure 3. Principle of the DPPH test

Extraction Procedure

The powdered leaves were subjected to successive solvent extraction using methanol and chloroform to obtain polar and non-polar extracts, respectively. Each extraction employed the sonication-assisted method: a measured quantity of the powdered leaves was mixed with the solvent and exposed to ultrasonic waves for enhanced solvent penetration and compound release. The process was repeated multiple times to maximize yield. The combined extracts were filtered and concentrated under reduced pressure using a rotary evaporator to remove solvents, yielding crude extracts.

Assessment of Antioxidant Activity

The antioxidant potential of the leaf extracts was evaluated using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay. Different concentrations of each extract were prepared and mixed with a DPPH solution. After incubation in the dark for 30 minutes at room temperature, the decrease in absorbance was measured spectrophotometrically at 517 nm, indicating the extent of radical scavenging. The percentage of inhibition was calculated relative to a control, and the half-maximal inhibitory concentration (IC₅₀) values for each extract were determined. Additionally, the antioxidant activity index (AAI) was computed to facilitate comparison.

Metabolomic Profiling

The chemical composition of the extracts was characterized by a combination of proton (^1H) and carbon (^{13}C) nuclear magnetic resonance (NMR) spectroscopy to identify the principal metabolites. Complementary chemical profiling was conducted using thin-layer chromatography (TLC), wherein extracts were spotted on silica gel plates and developed in suitable solvent systems. Spots were visualized under ultraviolet light and after spraying with specific reagents to detect compound classes, aiding in the dereplication and annotation of bioactive compounds, particularly terpenoids and phenolics.

Results

The methanolic extraction of *Cymbopogon citratus* leaves resulted in a higher yield (percentage of extract obtained relative to the dry weight of leaves) compared to the chloroformic extraction, indicating that the methanol solvent was more effective in solubilizing the bioactive compounds present in the plant material.

Antioxidant activity assessment using the DPPH radical scavenging assay revealed that the methanolic extract exhibited a significantly greater antioxidant capacity than the chloroformic extract. Specifically, the antioxidant activity index (AAI) of the methanolic extract was calculated as 5.2, contrasting with the lower AAI value of 1.65 observed for the chloroformic extract. Both extracts demonstrated substantial free radical scavenging effects, although their activities were lower than that of the vitamin C reference standard, which showed an AAI of 8.2 under identical assay conditions.

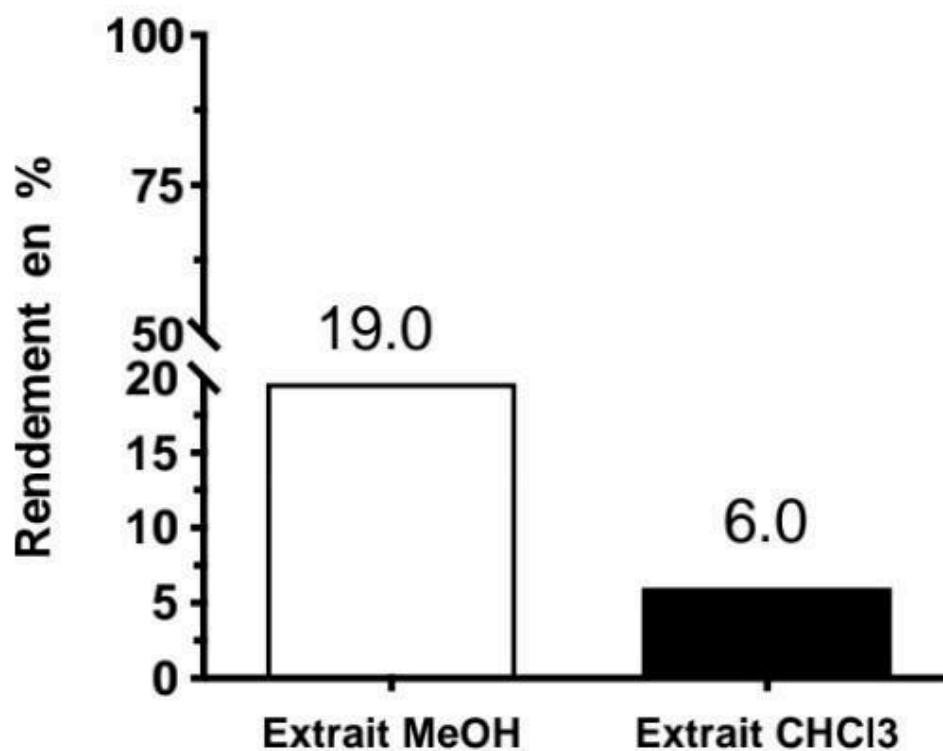


Figure 4. Extraction yield

Further chemical characterization through nuclear magnetic resonance (NMR) spectroscopy and thin-layer chromatography (TLC) confirmed the presence of a broad spectrum of phytochemicals in the extracts. The analyses highlighted a predominance of terpenoids, a class of secondary metabolites known for their potent antioxidant and anticancer properties. These findings align with the traditionally reported medicinal properties of *Cymbopogon citratus* and provide scientific evidence supporting its potential role in oxidative stress mitigation and cancer chemoprevention.

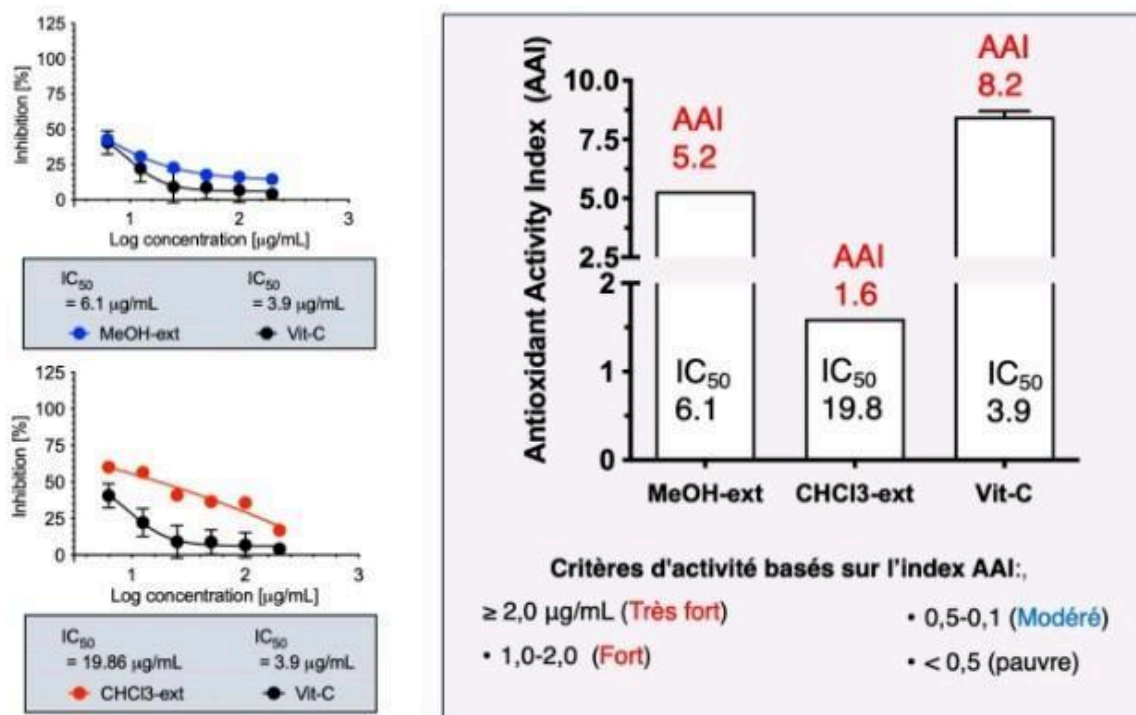


Figure 5. Antioxidant activity

Discussion

The present study indicates that both methanolic and chloroformic extracts of *Cymbopogon citratus* leaves exhibit significant antioxidant activities, with the methanolic extract showing notably higher efficacy as evidenced by an antioxidant activity index (AAI) of 5.2 versus 1.65 for the chloroformic extract. This discrepancy likely reflects the greater solubility and concentration of polar bioactive compounds, such as phenolics and glycosylated metabolites, in the methanolic fraction.

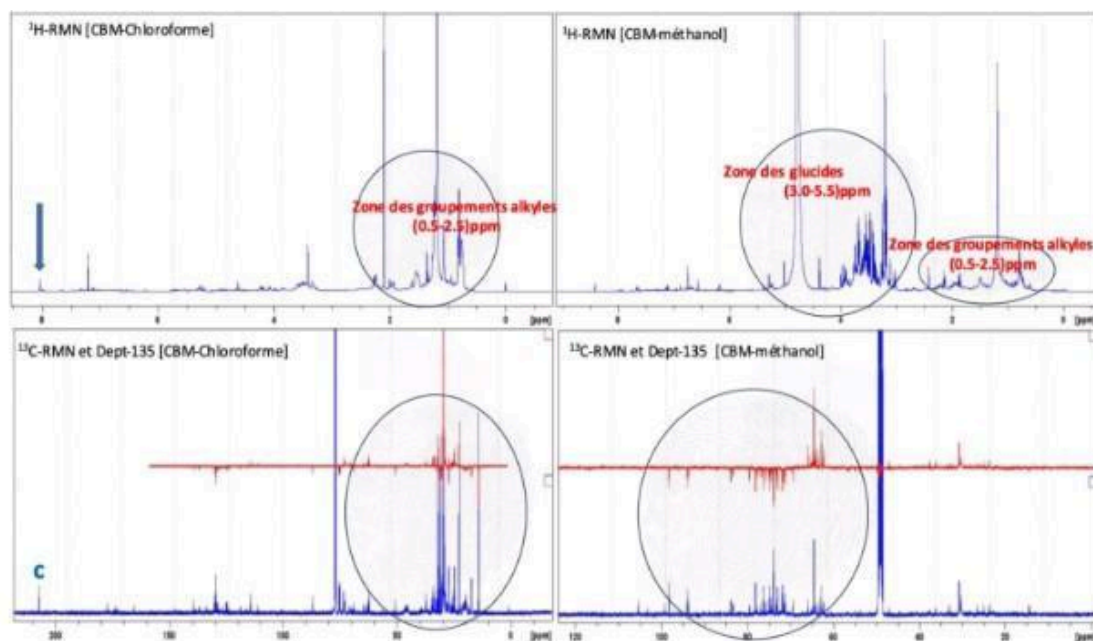


Figure 6. NMR profiles

Antioxidants play a crucial role in neutralizing reactive oxygen species (ROS) and other free radicals, which are implicated in oxidative stress—a major contributor to cellular damage that can initiate and promote carcinogenesis. By mitigating ROS-induced damage to DNA, proteins, and lipids, effective antioxidants can reduce mutation rates and genomic instability, thereby serving as preventive agents against the onset and progression of cancer.

The chemical characterization performed via nuclear magnetic resonance (NMR) spectroscopy and chromatographic techniques highlighted a predominance of terpenoids in both extracts. Terpenoids represent an extensive class of naturally occurring secondary metabolites with well-documented antioxidant, anti-inflammatory, and anticancer properties. These compounds may exert their chemopreventive effects through multiple mechanisms, including scavenging free radicals, modulating detoxifying enzymes, and inducing apoptosis in malignant cells.

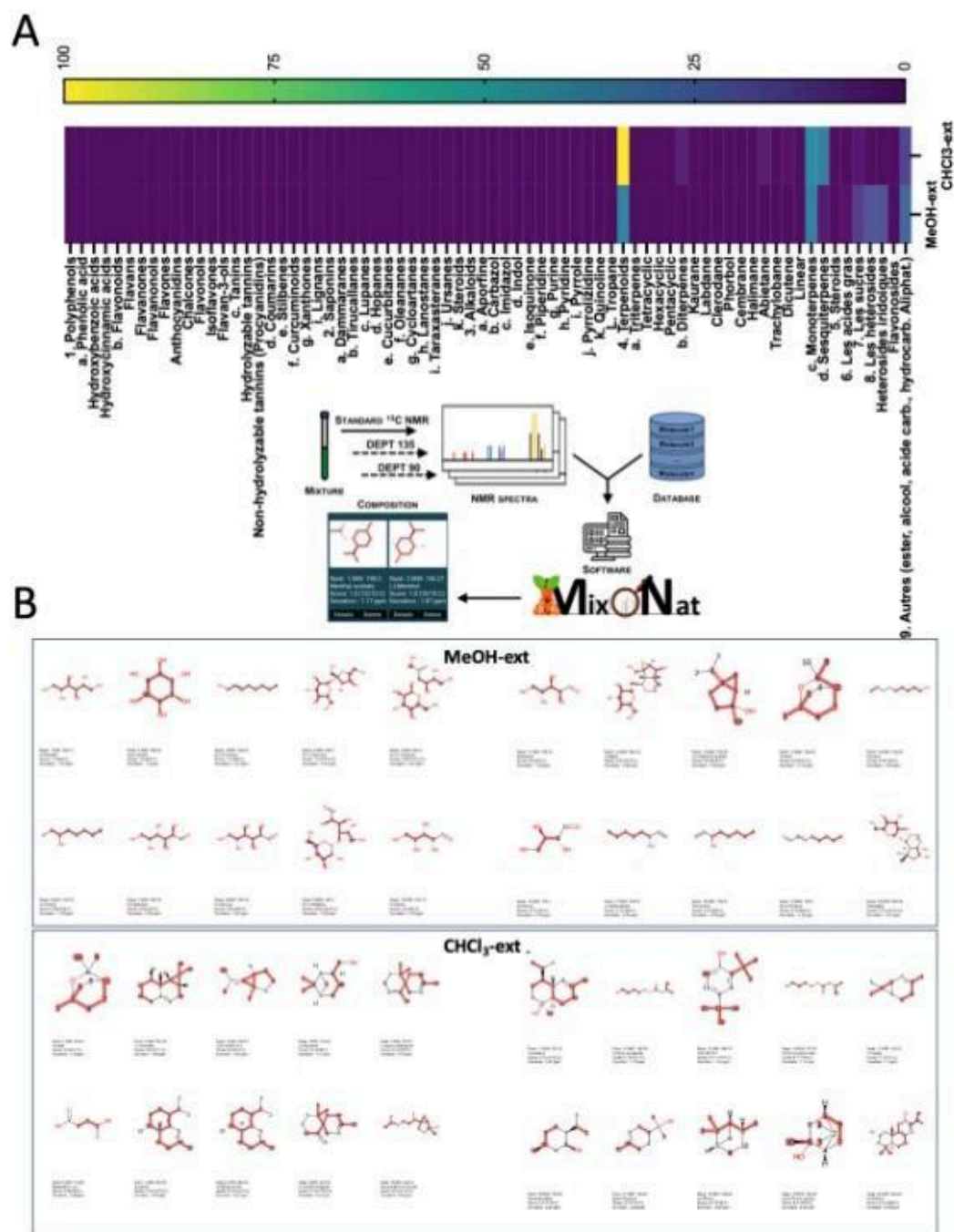


Figure 7. Metabolomic heatmap

The observed strong antioxidant potential corroborates traditional medicinal uses of *Cymbopogon citratus*, where it is employed for its health-promoting properties. Furthermore, the demonstrated activity supports its prospective development as a natural source for dietary supplements or phytotherapeutic formulations aimed at cancer prevention.

Future studies should focus on isolating and identifying the specific bioactive terpenoids and other compounds responsible for the antioxidant activity. Additionally, in vivo investigation and clinical validation are warranted to fully elucidate the therapeutic potential and safety profiles of these extracts in cancer prevention and adjunctive therapy.

Conclusion

This study underscores the significant prophylactic potential of the methanolic extracts of *Cymbopogon citratus* leaves in combating oxidative stress, a pivotal contributor to the pathogenesis of cancer. The demonstrated antioxidant capacity indicates that these extracts hold promise as natural agents to prevent or mitigate oxidative damage at the cellular level. However, to fully validate these preliminary findings, comprehensive in vivo studies and clinical trials are essential. Such investigations will help confirm the therapeutic efficacy, safety profiles, and bioavailability of the active compounds. Moreover, further phytochemical characterization is necessary to precisely identify and quantify the bioactive constituents responsible for the observed antioxidant effects. Ultimately, this research lays a foundation for the future development of *Cymbopogon citratus*-based nutraceuticals or phytomedicines aimed at cancer prevention and complementary therapy.

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