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Decoding the Antidiabetic Potential of Essential Oils: Phytochemical Profiling and Enzyme Inhibition of *Zingiber officinale* and *Cymbopogon nardus*

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Diabetes mellitus is a chronic metabolic disorder affecting more than 400 million individuals worldwide. Although synthetic drugs are commonly used to manage this condition, their adverse effects have generated increasing interest in safer natural therapies. Antioxidants are particularly important in mitigating oxidative stress, which contributes to diabetic complications, while the inhibition of carbohydrate-hydrolyzing enzymes such as α-glucosidase and α-amylase is a key strategy for controlling postprandial hyperglycemia. In this study, the essential oils of *Zingiber officinale* Roscoe and *Cymbopogon nardus* (L.) Rendle were examined for its phytochemical composition, antioxidant capacity, and enzyme inhibitory activities. Gas chromatography–mass spectrometry analysis revealed that the dominant constituents of *Z. officinale* oil included dodecanoic acid, 1,2,3-propanetriyl ester (37.81%), dodecanoic acid, 1-(hydroxymethyl)- 1,2-ethanediyl ester (9.52%), 3-(octanoyloxy)propane-1,2-diyl bis(decanoate) (4.73%), gingerol (3.62%), and smaller proportions of phenolic and terpenoid compounds such as linalool, geranyl acetate, zingiberene, and farnesene. The main phytochemicals detected in *C. nardus* oil were dodecanoic acid, 1,2,3-propanetriyl ester (22.95%), hexadecanoic acid, 2-[(1-oxododecyl)oxy]-1,3-propanediyl ester (2.74%), D-limonene (2.49%), eudesm-11-en-1α-ol (2.01%), α-phellandrene (1.93%), citronellol, geraniol, α-terpineol, and citronellal. Biological evaluation showed that *Z. officinale* essential oil exhibited significantly higher bioactivity, with stronger antioxidant capacity (55.4% improvement), greater α-amylase inhibition (39.7% increase), and superior α-glucosidase inhibition (24.5% enhancement) compared with *C. nardus.* These findings suggest that the complex mixture of phytochemicals in *Z. officinale* may act synergistically to counter oxidative stress and inhibit enzymes relevant to type 2 diabetes mellitus, highlighting its potential as a natural therapeutic option for reducing postprandial glucose levels and limiting long- term diabetic complications.

Keywords: GC-MS, Ginger oil, Citronella oil, Oxidative stress, Type 2 Diabetes Mellitus

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