

Title Synergistic action between fractions of essential oils from *Cymbopogon citratus*, *Ocimum gratissimum* and *Thymus vulgaris* against *Penicillium expansum*

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Abstract

Penicillium expansum is a mould that causes the rotting of several fruits and vegetables, especially apples onto which it also synthesizes some dangerous mycotoxins. The degree of synergism between fractions of essential from *Cymbopogon citratus*, *Ocimum gratissimum* and *Thymus vulgaris* was evaluated against two mycotoxin producing strains of *P. expansum*. The antifungal activity determined by dilution method and expressed as a Number of Decimal Reduction of the colony forming units per ml (NDR cfu) showed that the essential oils extracted from *O. gratissimum* was significantly ($P < 0.05$) more active against *P. expansum* than those extracted from *C. citratus* and *T. vulgaris*. Fractions enriched with oxygenated terpenes were significantly ($P < 0.05$) more active than their respective essential oils, whereas most of the fractions enriched with terpene hydrocarbons, were significantly ($P < 0.05$) less active. The fungicidal activity of mixtures of fractions from the same essential oils or from two different essential oils showed that there exist synergistic, additive and antagonistic effects between fractions of the three essential oils tested against both fungal strains. The synergistic effects observed could be exploited in order to maximize the antimicrobial activity of essential oils and to minimize the concentrations of essential oil required to produce a given antimicrobial effect without any alteration of the food test.