SHORT COMMUNICATION

Modulation of the antibiotic activity by the essential oils of *Origanum vulgare* and *Coriandrum sativum*

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Summary

Medicinal plants had been used by traditional populations as a way to treat diseases for centuries. Currently, despite the search of the pharmaceutical industry for different kinds of drugs, the bacterial mechanisms of resistance against antimicrobial drugs are a real problem to the health. *Origanum vulgare* and *Coriandrum sativum* are medicinal plants with essential oils of a known antibacterial activity. The essential oils were assayed for their antibacterial and modulatory antibiotic activities by gaseous contact method. Both essential oils demonstrated modulatory activity mainly when associated with gentamicin and vancomycin. These natural products demonstrated an interesting potential to be studied in association with antibiotics to elaborate new drug formulations, or to be used as functional foods.

Keywords

Origanum vulgare; Coriandrum sativum; gaseous contact; vancomycin; gentamicin; ciprofloxacin

In the history of human civilization, plants always represented the energetic and structural basis of food chain. In the same way, the search of natural resources to prevent and cure health problems through the use of herbs as teas, dyes and other ways, must had been the starting point to justify the use of plant products on all aspects of our lifes [1]. Eating habits and trends in food production and consumption have health, environmental and social impacts, mainly due to substances as food additives and toxins present in fresh and processed food products that can demonstrate adverse and synergistic effects [2]. Different biotechnological processes can be used to create and improve new food and beverage, most of them recently classified as functional foods and/or nutraceuticals [3].

Functional foods have demonstrated physiological benefits beyond basic nutritional [4], and the term nutraceuticals indicate a food (or part of a food) that provides medical or health benefits, including the prevention and/or treatment of a disease. Many of these 'natural' compounds were found to possess therapeutic properties. Potential and future studies should include well-designed clinical trials assessing combinations of these components of functional foods and nutraceutials (polyphenols, flavonoids, lipids) to realize possible synergies regarding human health [2], or in association with antibiotics against drug-resistant infective agents.

In the last decades, an increase in microbial resistance to antibiotics, germicides and disinfectants has become a serious public health problem, mainly to immunocompromised patients. The researchers around the world are seeking for natural products with efficiency in the treatment of bacterial and fungal infections, demonstrating a low toxicity and better antimicrobial effect than usual drugs [5].

Coriandrum sativum (Apiaceae), popularly called coriander, is a vegetable species commonly used as a medicinal plant in several regions of Brazil. Some communities use coriander in headache treatment, as a healing, antipyretic, anthelmintic, analgetic, or for rheumatism and joint pain treatment [6]. Tea and juice from several parts of this plant, as stems and leaves, are the most common

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forms of usage [6]. According to Trajano et al. [7], the essential oil of coriander inhibited the growth of several bacteria.

Origanum vulgare (Lamiaceae), popularly called oregano, is a herbaceous plant of the south Europe [8]. Its use as a remedy is cited by communities for treatment of sore throat and as analgetic and expectorant [8]. There are many reports about the antibacterial and antifungal activity of the essential oil of oregano [9], but all using the direct contact method.

The objective of this study was to verify the potential of the volatile compounds of *Coriandrum sativum* and *Origanum vulgare* essential oils to modulate the antibacterial activity of vancomycin, gentamicin and ciprofloxacin using the gaseous contact method.

MATERIALS AND METHODS

The bacterial strains were obtained from the Laboratory of Microbiology, Federal University of Paraíba – UFPB, João Pessoa – PB, Brazil, through Dr. Edeltrudes de Oliveira Lima. The essential oil from leaves of *Coriandrum sativum* and *Origanum vulgare* used in the assays were obtained from Sigma-Aldrich (St. Louis, Missouri, USA). The analysis of the essential oil constituents was performed by Dr. José Galberto Martins Costa (Universidade Regional do Cariri – URCA, Crato, Brazil) by gas chromatography – mass spectrometry using GC17-A instrument (Shimadzu, Tokyo, Japan). The microorganisms used in the modulatory of antibiotic activity assays were the standard strains of *Staphylococcus aureus* ATCC25923 and *Escherichia coli* ATCC1873. The microorganisms were spread on Heart Infusion agar (Difco, Leeuwarden, The Netherlands). Disks containing vancomycin (30 μg), gentamicin (10 μg) and ciprofloxacin (5 μg; Laborclin, Campinas, Brazil). The plates were inverted and, inside the lid, 100 μl of 50% essential oil solution in dimethylsulfoxide (DMSO) was deposited. Any direct contact between the essential oils and the bacteria was avoided. As controls, plates containing DMSO in association with antibiotics and plates containing only antibiotics were used. The plates were incubated for 24 h at 35 °C. The effect was measured on the basis of diameter of the inhibiton zone. The tests were performed in triplicate [10].

RESULTS AND DISCUSSION

The chemical analysis of *Coriandrum sativum* essential oil showed the following composition: linalool (39.8%), linalool oxide (27.3%), *p*-cymene (17.6%), camphor (7.4%) and α-pinene (4.9%). The chemical analysis of *Origanum vulgare* essential oil showed the carvacrol as major compound (68.1%), *p*-cymene (15.9%), α-pinene (2.5%), myrcene (2.1%), γ-terpinene (1.9%), *trans*-caryophyllene (1.3%) and limonene (1.3%).

The essential oil of *O. vulgare* showed a better modulatory effect against *E. coli* and *Staph. aureus,* enhancing by 12.2% and 11.7% the antibiotic activity of ciprofloxacin and vancomycin, respectively. Regarding the essential oil of *C. sativum*, the best result observed was that against *E. coli* and *Staph. aureus*, when an enhancement of 11.9% and 2% of the antibiotic activity of gentamicin was observed (Tab. 1).

The antimicrobial activity of an essential oil is directly associated with the capacity to affect the bacterial respiratory chain and energy production of microorganisms [11]. There are several possible mechanisms how the essential oil may affect bac-

Tab. 1. Modulation of the antibiotic activity associated with essential oils from *Coriandrum sativum* and *Origanum vulgare* at gaseous contact.

Treatments	*Staph. aureus* ATCC 25923			*E. coli* ATCC 1873		
	Vancomycin	Ciprofloxacin	Gentamicin	Vancomycin	Ciprofloxacin	Gentamicin
	[mm]					
No treatment	17 ± 0	23.5 ± 0.5	20 ± 0.5	18 ± 0	24.5 ± 0.5	21 ± 0
DMSO	17 ± 0	23.5 ± 0.5	20 ± 0.5	18 ± 0	24.5 ± 0.5	21 ± 0
EOCS 50%	17 ± 0 (0%)	22.5 ± 0.5 (– 4.3%)	20.5 ± 0.5 (+ 2%)	19.0 ± 0 (+ 5.5%)	26 ± 0 (+ 6.2%)	23.5 ± 0.5 (+ 11.9%)
EOOV 50%	19 ± 0 (+ 11.7%)	22.5 ± 0.5 (– 4.3%)	21 ± 0 (+ 5%)	19.5 ± 0.5 (+ 8.3%)	27.5 ± 0.5 (+ 12.2%)	20.5 ± 0.5 (– 2.4%)

Values are expressed as mean ± standard deviation.
EOCS – essential oil of *Coriandrum sativum*, EOOV – essential oil of *Origanum vulgare*. (+) – synergism, (–) – antagonism.

teria, all these mechanisms depending on the hydrophobic behaviour and the interaction with the bacterial cell membrane [12]. The essential oil of several plants has shown a promising antibiotic or modulatory potential against several microorganisms [13]. However, the data usually regard direct contact, but there are only few works reporting on the capacity of the volatile compounds of the essential oils to affect the bacterial growth or modulate the antibiotic activity in a synergistic manner by gaseous contact.

Coutinho et al. [13] showed that *Croton zehntneri* essential oil increased the antibiotic activity of norfloxacin by 39.5% at gaseous contact. A similar effect was observed with *Zanthoxylum articulatum* essential oil that enhanced by 70.9% the antibiotic activity of norfloxacin [14]. However, the effect of essential oils at gaseous contact against fungi is apparently different [15] – for *Thymus vulgaris*, *Foeniculum vulgare, Eugenia caryophyllata* Thumb., *Pinus sylvestris, Salvia officinalis*, *Melissa officinalis* and *Lavandula vera* essential oils, no inhibition was observed with fungal species *Epidermophyton floccosum* and *Aspergilus flavus* var. *columnaris*; essential oils from *F. vulgare, E. caryophyllata* Thumb. and *P. sylvestris* were antifungally active at gaseous contact with *Microsporum gypseum*, *Trichophyton mentagrophytes* (animal and human), *Scopulariopsis brevicaulis, Mucor* spp. and *Rhizopus* spp.

Our results regarding the composition of *O. vulgare* and *C. sativum* essential oils, they are similar to previously published data. Rodrigues et al. [16] studied essential oil of *O. vulgare* and found the same major compound. Santos et al. [9] and Pereira et al. [17] determined a similar composition and showed antibiotic activity by direct contact against strains of *E. coli* and *Staph. aureus*. Our data on the chemical composition of essential oil from *C. sativum* are similar to those observed by Ishikawa et al. [6]. According to Wiest et al. [18], the hydroalcoholic extract of *C. sativum* had no antibiotic activity, but the essential oil inhibited *E. coli* and *Staph. aureus* strains, as well as other microorganisms [7].

In spite of the fact that the antimicrobial activity of the described essential oils is well known, this is the first study that identifies their capacity to modulate the antibiotic activity of commonly used antibacterial drugs by gaseous contact. Our results indicate the potential use of these spices as a biotechnological source of adjuvants of antibiotic activity, demonstrating this possible usage in the future as a functional food or a nutritional supplement with nutraceutical effect.

CONCLUSION

The essential oils of *Origanum vulgare* and *Coriandrum sativum* present a synergistic effect, modulating the antibiotic activity of assayed antibiotics against *E. coli* (Gram-negative bacterium). This discovery may be a basis for development of new formulations and treatments combining the use of essential oils by inhalation and antibiotics, but further experiments are required.

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