

FORMULATING ESSENTIAL OILS WITH CAVAMAX® & CAVASOL® CYCLODEXTRINS FOR NEW ANTIMICROBIAL SOLUTIONS

Prevention of microbial spoilage is essential in all aqueous-based products. Water-borne paint formulations contain sufficient nutrients to maintain bacterial growth if the pH and temperature are right. In-can contamination originates from the raw materials, the process water used, and the production equipment. To prevent problems, it is necessary to incorporate microbicides. These must be stable, cost-effective, compatible with the other components in the formulation, and must not impair the rheological properties of the formulation, or affect the color of the dried film. Nowadays, they also have to be registered for use, safe to use and environmentally benign.



Petri dishes with bacterial growth

Problems Associated with the Use of Biocides

Today's biocides are chemicals that are intrinsically toxic to organisms, frequently irritant to humans and harmful to the environment. Accordingly, the registration of new active biocides is an extremely rigorous, time consuming and expensive process.



Basics of Essential Oils

Essential oils such as lavender, citronella, rosemary and tea-tree oil are well-known natural products extracted from plants, trees and grasses. They consist of many different compounds and have a variety of uses, e.g. as natural medicines, antimicrobial compounds and animal repellents. Some of them are known to have been used for thousands of years.

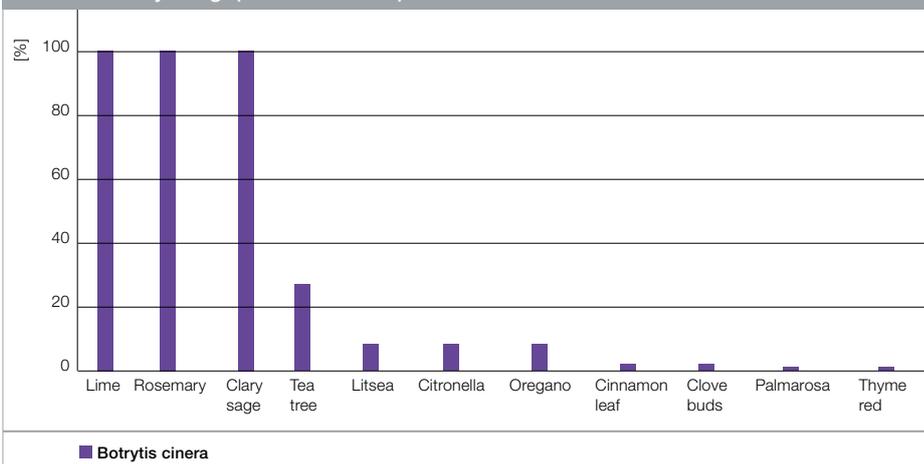
Consumer Trend toward Natural Solutions

Consumer concern about the use of 'harsh' chemicals in products is creating a need for milder, greener, more natural products that can offer an equivalent level of performance. Additionally, a lack of new active materials is creating an opportunity for more natural solutions, such as essential oils.

Encapsulation with Cyclodextrins

CAVAMAX® and CAVASOL® cyclodextrins are a well-known group of natural carbohydrates, which in water are able to encapsulate other organic molecules in a reversible equilibrium-controlled process. This 'molecular encapsulation' effectively modifies the properties of the organic guest molecules, e.g. reduces their volatility, extends their release over time, and improves their stability and solubility in water.

Concentration of Essential Oil Required in Spore Suspension to Prevent Spore Germination by Fungi (40 h Incubation)



Encapsulation of Essential Oils

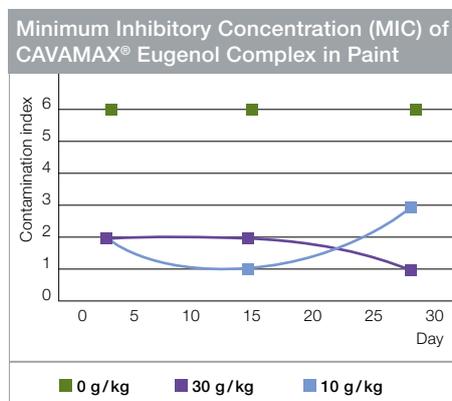
WACKER has many years' experience of producing inclusion complexes. The process is readily scalable, reproducible and low cost.

Molecular encapsulation of essential oils has now been formulated into different aqueous coating products, and industry-standard methods have been used to identify detrimental changes in the performance of the coating.

The addition of the encapsulated essential oils to the aqueous coating formulations at 1.8 to 4.5 g essential oil per kg of paint (0.18 – 0.45%) did not impair the stability of the formulation or change its color or appearance. It did not affect the performance of the coating and it protected the liquid formulation against microbial spoilage.

The minimum inhibitory concentration (MIC) of some encapsulated essential oils was determined in test formulations and found to be in a similar range to their chemical counterparts.

Combinations of essential oil complexes provided synergistic effects.



Reduction in Allergic Effects, Irritation

Certain classes of chemical biocides have been linked to irritation and skin sensitization. Consequently regulatory authorities and consumer groups are pushing for reductions in use or even removal of the offending products. Essential oils are mixtures of chemical families, and some of these compounds are known irritants. Currently, three essential oils have been tested and identified as less irritant and harmful and are listed in Annex I of the Biocidal Products Registry (BPR):

- Lavender oil
- Peppermint oil
- Citronellal

Cyclodextrin inclusion complexes of these three essential oils have been prepared and are available for use as 'in-can preservatives' for aqueous coatings.



1.0 Control, 1.1 CAVAMAX® W7 Cinnamaldehyde (2%), 1.2 CAVAMAX® W7 Cinnamaldehyde (5%), 1.3 CAVASOL® W7 M Vanillin (2%), 1.4 CAVASOL® W7 M Vanillin (5%)



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References / sources:
 Biocidal Products Regulation 528/2012/EC (BPR)
 Annex I: Active Substances of the BPR, Category 4, Traditionally used substances of natural origin.
 Annex V: PT6 Preservatives for products during storage (in-can preservatives)
 MSc Thesis
 Directory of microbicides for the protection of materials.
 Ed. W. Paulus



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