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OPTIMIZATION AND CHARACTERIZATION OF ESSENTIAL OILS MIXTURE WITH ANTIMICROBIAL AND ANTIOXIDANT PROPERTIES FORMULATED IN SOLID LIPID MICROPARTICLES

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Abstract:

In the present study, mixtures of EO are prepared by combining individual EO according to a Simplex-Lattice Design. The evaluation of in vitro antioxidant and the potential antimicrobial activities of EO mixtures was carried out. Afterward, solid lipid particles loaded with the selected EO mixture were prepared according to a hot homogenization process. A central composite design was used to estimate the contribution and coefficient of parameters and their interactions.

The different formulations present encapsulation efficiency varying between 16.346% and 65.13% with particle size varying between 0.207µm and 201.34µm. The Pareto plot reveals two significant effects which interact in the range of variation of the parameters chosen for the encapsulation rate as well as three significant effects concerning the particle size

Key Words: essential oils, solid lipid microparticles, design of experiment, Response Surface Methodology

I- Introduction :

Recently, research on essential oils (EO) and the viability of using them as active ingredients has aroused great interest due to their antibacterial, antifungal, antiviral, antioxidant, and healing properties, and have been widely used in pharmaceuticals, cosmetics, and food. Solid lipid particles (SLP) are carrier systems based on a high melting point lipid as a solid core. They are derived from an oil-in-water (O/W) emulsion by exchanging the liquid lipid (oil) with a solid lipid. SLP can be used to enhance the drug's bioavailability and protect the chemically labile entrapped bioactive compounds.

II- Material and Methods:

Table 1: simplex-lattice design

Expérience	H1	H2	H3
1	0	0.5	0.5
2	0.25	0.25	0.5
3	0.5	0.5	0
4	0	0.75	0.25
5	0.75	0	0.25
6	025	0.5	0.25
7	0	1	0
8	0.25	0.75	0
9	1	0	0
10	0	0.25	0.75
11	0.5	0	0.5
12	0.75	0.25	0
13	0	0	1
14	0.25	0	0.75
15	0.5	0.25	0.25

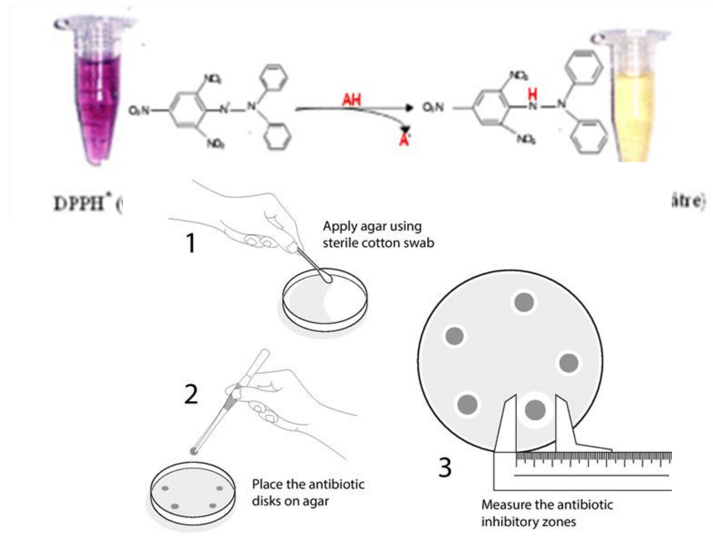

Figure 1: Antioxidant and antimicrobial activities testing

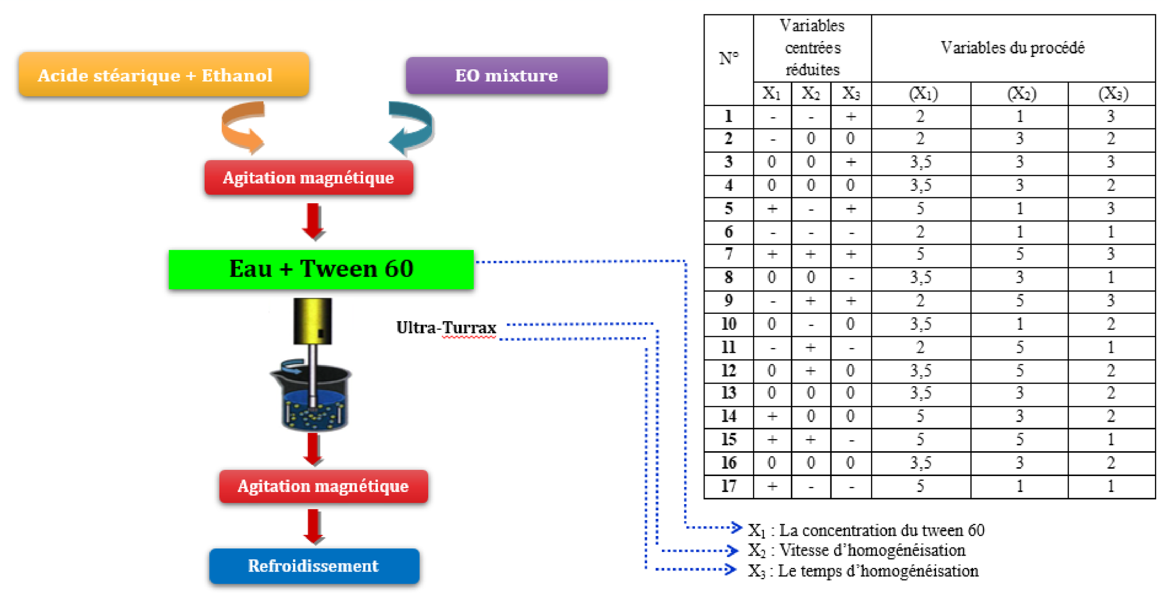

Figure 2: SLM preparation methodology

II. 1. Mixture Design: The Simplex-Lattice Design has symmetrically distributed experimental points and a well-chosen polynomial equation to represent the surface response. The applied mixtures are given in table 1.

II.2 Antioxidant activity by DPPH free radical scavenging: In absence of antioxidants, the (DPPH) radical shows a maximum absorption at 517 nm (purple) but the color gradually turns to yellow in presence of more amounts of antioxidants.

II.3 Antimicrobial activity by disc diffusion methodology: The potential antimicrobial activity of EO mixtures were investigated through inhibition zones evaluation against two Gram-positive bacteria (S. aureus and B. subtilis), two Gram-negative (E. coli and P. aeruginosa), one mould (A. niger), and one yeast (S. cerevisiae) as fungal strains.

III- Results and Discussion:

III.1. Antioxidant and Antimicrobial activity: The more active mixture correspond to the combination situated between 20-40% of Myrtus communis EO, less than 15% of Pistacia lentiscus EO and 55-80% of Salvia officinalis EO. As shown in FIGURE 3, However, the combination of 20-40% of Myrtus communis EO, less than 10% of Pistacia lentiscus EO and 60-80% of Salvia officinalis EO, gives optimal antimicrobial activities for the six tested Gram-, Gram+ and Fungi strains.

III.2. Response Surface of SLM:

Encapsulation efficiency All SLMs obtained by the hot homogenization process showed EE (%) ranging from 16,346% to 65,13 %; the mathematical model simplifies to the following (R^2 = 0.88): **EE% = 27,27 + 14,89 CT60 + 17,15 CT60²**

Particle size D[3.2] (µm) range from 0,207µm to 201,34µm with a polynomial second-degree equation of EO loaded-SLM particle size (R^2 = 0.88): **$D_{[3.2]}$ = 41,61 + 35,08CT60 + 74,14CT60*TH + 88,72TH²**

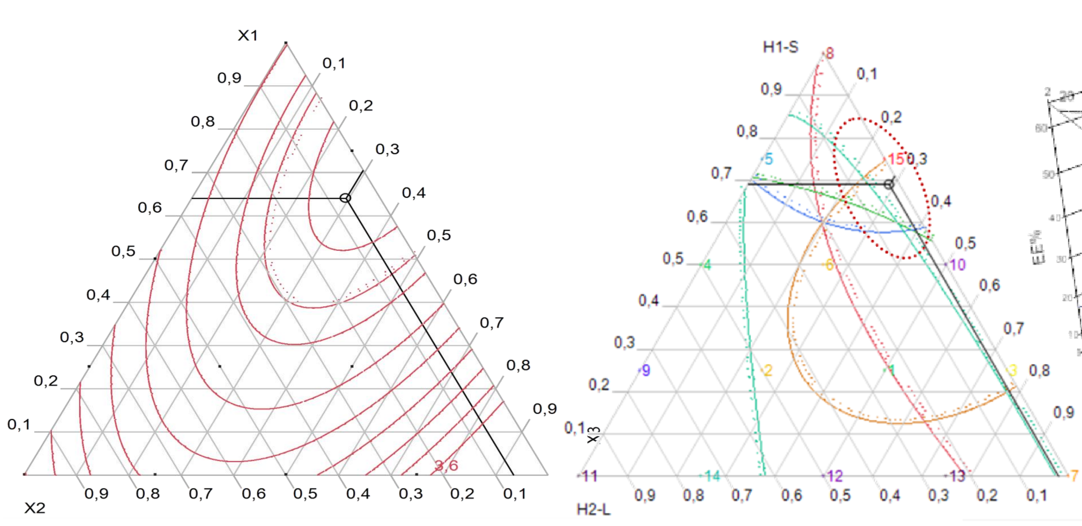

Figure 3: Antioxidant and Antimicrobial activity

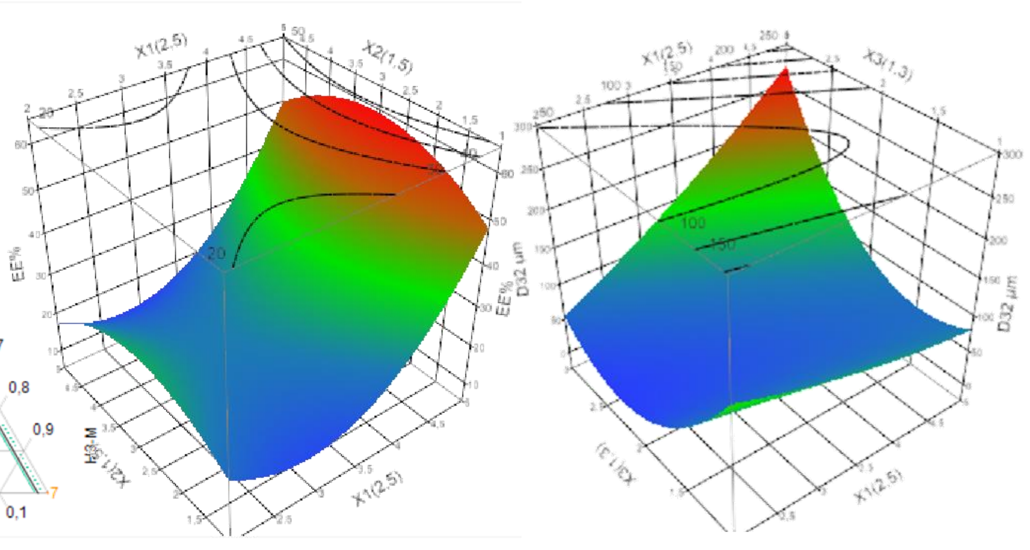

Figure 4: Response Surface of D[3.2] and Encapsulation efficiency

Conclusion: The design of experiments was effectively used to select an essential oil mixture based on its activities for use in the optimization of the SLM formulation.
The selected factors in this study were found to have a significant effect on the quality of the produced particles and mathematical models were established for the encapsulation efficiency and particle size based on the surface response methodology.