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5.1. Future Directions in Product Design and Engineering

Cosmetic products are a potential source of value generation for the companies, the customers, and the society when they are created under sustainable principles. Their design is a major challenge because it requires the simultaneous consideration of many interrelated factors, such as ingredients, composition, micro-structure, and production process, among others. This is even more critical at early design stages when information is scarce and the effects of design decisions on the product are unclear. With the aim of creating a decision-based support system for the design of emulsified cosmetic products at early design stages, this study presents a novel ontology-based knowledge base. It was created considering emulsion science principles, heuristics, expert knowledge, and their interrelations. The building blocks of the knowledge base are:

- General subproblems in emulsion formulation, which are related to physicochemical phenomena or properties that are to be promoted or limited in the product. For example, a specific rheological behavior (shear thinning, thixotropic behavior).

- General solution strategies, which are solution paths related to the emulsion's nature or micro-structure not directly related to a specific compound or process technology. For example, the implementation of a steric surfactant system.

- Data bases of different cosmetic ingredient types (emollients, surfactants, preservatives, actives, among others)

- Heuristics and interrelationships between ingredients and the previous listed design elements

In this study, the ontology-based knowledge base is presented in detail. Following, it is implemented in a decision-making support system which enables product designers to understand the product as a whole system, to perform product-wide information query, to graphically represent ingredients information, and to design/screen/explore possible design options. The ontology and the architecture of the decision support software are presented (Figure 1). Among its possible uses are: (a) analysis of solution strategies and its effects, (b) support in decision-making during reformulation or ingredient substitution, (c) design of a new emulsified product, and (d) graphical representation for cosmetic product design. The decision support software is exemplified through a case study: the design of a moisturizing cream.
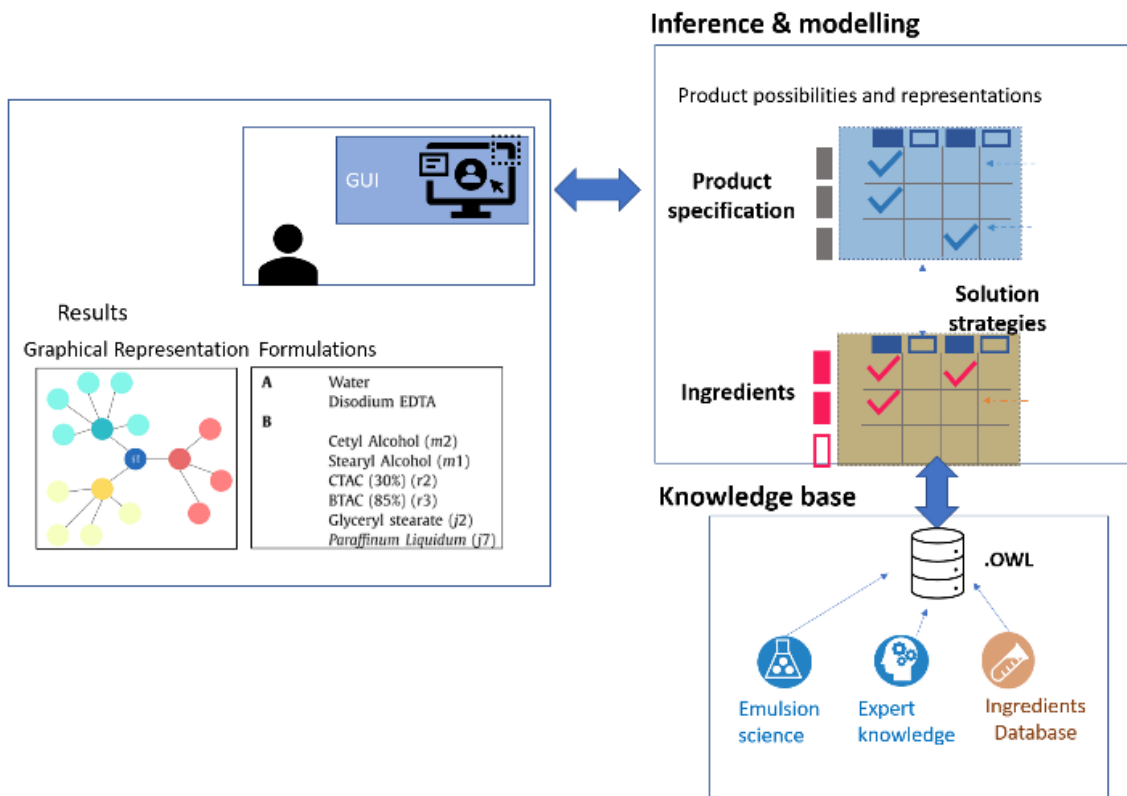

Figure 1 Elements of the decision support system for the design of cosmetic emulsions