28th Workshop on the Developments in the Italian Ph.D research on Food Science, Technology and Biotechnology

Catania, 18-20 September 2024

Development of a Toolbox for the Characterization and Predictive Analysis of Wax Systems as a Tool for Predicting Physical Food Properties

Annalisa Vissio (annalisa.vissio@unito.it)
Dept. of Agricultural, Forest and Food Sciences (DISAFA), University of Turin, Grugliasco, Italy
Tutor: Prof. Vladimiro Cardenia (DISAFA-UNITO); Co-Tutors: Raffaele Calaminici (Soremartec srl), Carolina Cantele (DISAFA-Unito)

This PhD thesis research project aims to develop a toolbox, based on the chemical characterization of different natural waxes, in order to understand how their composition affects the texturizing activity. The project will lead to create a platform able to predict the physical properties and to properly select wax materials to be included in finished products.

Sviluppo di un toolbox per la caratterizzazione e l'analisi predittiva di sistemi cerosi come strumento per la previsione delle proprietà fisiche degli alimenti

Il progetto di dottorato mira a sviluppare un toolbox basato sulla caratterizzazione chimica delle principali componenti di diverse cere naturali per comprendere come la diversa composizione possa influenzare la capacità delle cere di strutturare oli e realizzare sistemi oleogel. Il progetto contribuirà a sviluppare una piattaforma in grado di predire le proprietà fisiche e selezionare le cere più appropriate per la formulazione di diversi prodotti alimentari.

State of the Art

Solid fats are widely used in different food products due to their plasticity and high melting point, which provide processing advantages such as extended shelf life and ease of handling[1]. However, those fats are typically rich in *trans* and saturated fatty acids, which have been linked to increased risk of cardiovascular diseases, inflammation, and oxidative stress[2]. Therefore, among the different strategies developed, oleogels are proposed as an innovative and healthier alternative to replace conventional solid fats[3]. Oleogelation is an interesting technique because it improves the nutritional quality of foods, making them high in unsaturated fatty acids, low in saturated fatty acids, and *trans* fatty acids. Oleogels are typically prepared by dissolving low concentrations of gelators in vegetable oil[3]. The main structuring agents reported in the literature are fatty acids (e.g., 12-hydroxystearic acid), phytosterols (e.g., β-sitosterol), monoacylglycerols, and waxes (e.g., carnauba, candelilla, beeswax, shellac, rice bran and sunflower). Until now, waxes had to be used at levels of <5% to effectively structure the oil, making them impractical for most food applications because they would impart a waxy mouthfeel[4]. Recent studies have demonstrated the superior oil-binding ability of certain waxes that can gel oil at levels as low as 1%, facilitating consumer acceptance. However, little information is reported on the correlation between the specific composition of waxes and their behavior in oleogel systems and final products. Moreover, it is not clear which waxes component is mainly involved and responsible on the organogelation behavior[5]. Thus, a full characterization is required, which could be reached by traditional analytical methods where thin layer chromatography (TLC) followed by gas or liquid chromatography coupled to mass spectrometry is used or as suggested by a few recent works, preparative liquid chromatography could be a valid alternative to TLC, improving the reproducibility of the process.

1° Year

1. Literature Research about analytical techniques for waxes characterization and studies concerning waxes oleogels behavior in model systems and finished products

2. Experimental Set Up, especially by replacing traditional TLC separation of wax components by preparative liquid chromatography

3. Selection of most critical and important waxes, in particular by comparing the most traditional ones like candellilla and carnauba waxes to the new ones such as rice bran waxes and sunflower waxes

2° Year and 3° Year

Activity	Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
A1)	Characterization of commercial natural waxes																								
A2)	Evaluation of waxes behavior in oleogel model systems																								
A3)	Evaluation of wax oleogel in real food products																								
A4)	Development of toolbox to predict food properties																								
A5)	Thesis and papers preparation																								

A1) After validation and application of the separation methods for the main components of natural waxes (e.g., candelilla, carnauba, bees, rice bran and sunflower waxes), each fraction will be fully characterized from a chemical point of view.

A2) The natural waxes will be evaluated in oleogel model systems. In particular, the organogelation performance will be assessed by binding oil capacity, thermal analysis (differential scanning calorimetry, DSC) and morphological properties (polarized light microscopy). The triglyceride regioisomers and fatty acid composition of selected oils (soybean, high oleic sunflower oil, high linoleic sunflower oil) will also be considered.

A3) The selected wax oleogels will be evaluated in real food systems, specifically chocolate spread and muffins. The performance will be determined by rheological measurements, textural analysis, sensory analysis and stability of the system as related to shelf-life conditions.

A4) Development of a toolbox, based on the correlation and machine learning approaches to predict the physical properties and stability of selected food products.

A5) Writing and editing of the thesis, scientific papers and oral and/or poster communications.

References

1. Thakur D, Singh A, Suhang R, Dhiman A, Chauhan DS (2023), Oleogelation based on plant waxes: characterization and food applications. *Journal Food Science Technology* 60(12), 2927-2944
2. Cerqueira MAPR, Castro LMP (2023), Why does the food industry need fat mimetics? In MAPR Cerqueira, LMP Castro (Eds.). *Fat Mimetics for Food Applications*, 1st ed. John Wiley & Sons Ltd.
3. Manzoor S, Masoodi FA, Naqash F, Rashid R (2022), Oleogels: Promising alternatives to solid fats for food applications. *Food Hydrocolloids for Health*, 2:100058
4. Zetzl AK, Marangoni AG (2014), Structured Emulsions and Edible Oleogels as Solutions to Trans Fat. In Dharma R. Kodali (Eds.).*Trans Fats Replacement Solutions*,1st ed, AOCS Press, pp. 215-243
5. Co ED, Marangoni AG (2018), Oleogels: An Introduction. In A. G. Marangoni, N. Garti (Eds.). *Edible Oleogels Structure and Health Implications*, 2nd ed, AOCS Press, pp. 1-29