Strategies for Development of Healthier Foods with Improved Bioaccessibility of Bioactive Compounds: from Model to Real Food Systems

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The present PhD thesis research project is aimed at developing healthy foods using innovative strategies, including the use of lipophenols, to preserve bioactive compounds (such as phenolic compounds, polyunsaturated fatty acids and phytosterols) from degradation and increase their bioaccessibility.

Strategie per lo sviluppo di alimenti salutari con migliorata bioaccessibilità dei composti bioattivi: dal sistema modello al prodotto alimentare

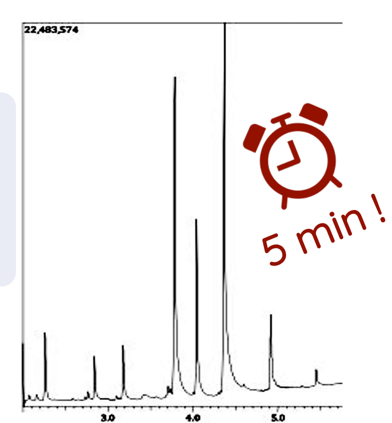
Questo progetto di tesi di dottorato mira a sviluppare alimenti salutari attraverso strategie innovative, come l'impiego di lipofenoli, atte a preservare dalla degradazione composti bioattivi – quali composti fenolici, acidi grassi polinsaturi e fitosteroli – migliorandone la bioaccessibilità.

State of the Art

The health benefits of bioactive compounds such as polyunsaturated fatty acids (PUFAs), phytosterols and polyphenols are now well established and known to all, evidenced also by the recent and increasing consumer interest towards the consumption of healthy foods rich in these compounds. Indeed, polyphenols, PUFAs and phytosterols, thanks to their properties, have been widely demonstrated both *in vitro* and *in vivo* to reduce the risk of many diseases, mostly related to inflammatory and oxidative stresses, such as cardiovascular diseases (CVDs), cancer, neurodegenerative disorders, obesity and diabetes. However, the presence of these bioactive compounds in foods is often low or reduced due to the food processing and/or their degradation during shelf-life and their assimilation by the human body is rather poor. Specifically, PUFAs and phytosterols can be easily degraded by oxidation during the food production and storage and gastrointestinal digestion (GID) (Chai et al., 2018). On the other hand, polyphenols, in addition to being prone to degradation during GID due to chemical and biochemical transformations, are often characterized by poor availability as a result of their strong hydrophilicity, which hampers their passage through the hydrophobic phospholipid bilayer of the intestinal epithelium cell membrane (McClements et al., 2015). One of the strategies adopted to overcome these issues is the exploitation of lipophenols, which are lipidic molecules (mainly PUFAs and phytosterols) conjugated to phenolic compounds (Crauste, Rosell, Durand, & Vercauteren, 2016), naturally present mainly as ferulic, caffeic and coumaric acids derivatives in different plant species such as algae, apple, potato, tomato, pea and cereal, but also successfully synthesized as well, by chemical or enzymatic esterification or etherification, involving fatty alcohols and fatty acids with different chain lengths and degrees of unsaturation, and polyphenols characterized by different structures (Crauste et al., 2016; Domergue & Kosma, 2017). From both natural and synthesized lipophenols, promising results have been reported in terms of antioxidant, anticancer, anti-inflammatory, antimicrobial activities, enzymes inhibition capacity and interaction with endocannabinoid system, as well as stability during GID (Crauste et al., 2016; Domergue & Kosma, 2017). The interest in lipophenols lies as much in preserving foods from oxidation as in delivering bioactive molecules undamaged into the human body in order to be absorbed in sufficient doses to exert their physiological functions, taking advantage of the benefits of both molecules. Indeed, the phenolic compounds would protect the lipidic part against oxidation, and in return they would be protected against degradation during GID due to the withdrawn hydroxylic groups, and their bioavailability would be boosted due to the increased lipophilicity. Although this topic covers a large part of the literature, the behaviour during shelf-life and GID of lipophenol-containing food matrices requires to be in depth investigated, because of the potential big impact they could have on the successful development of healthy foods.

1° year

1. Literature research
2. Experimental set up
3. Extraction and isolation of lipophenols from natural sources
4. Synthesis of lipophenols with different structures
5. Development and optimization of a fast detection method of lipophenols by GC/MS



2° year | 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	Evaluation of Lipophenols in Model Systems:																								
	1) Natural Lipophenols in Emulsion System																								
	2) Evaluation of Different Synthesis Lipophenol Compounds Composition in Emulsion System																								
A2	Evaluation of Lipophenols in Real Food Systems and Set Up of Food Products																								
A3	Bioaccessibility Studies																								
A4	Thesis and Paper Preparation																								

A1) The obtained natural and synthesized lipophenols will be evaluated in model systems and, specifically, in oil-in-water (O/W) emulsion. In particular, the performance of the synthesized lipophenols will be evaluated as related to their different composition.
A2) The selected lipophenols will be evaluated in real food systems, setting up the food products accordingly to the results obtained from the studies in the model systems and to the behaviour of the lipophenols once integrated into the food matrix itself.
A3) Bioaccessibility studies on the effectiveness of the lipophenols will be performed throughout the evaluation in model systems (rapid *in vitro* screening of the stability of the lipophenols as related to the lipases activity), as well as in real food systems (stability of the lipophenols during a whole *in vitro* gastrointestinal digestion process). *In vivo* studies will be also considered once the food products will be ultimately set up.
A4) Writing and editing of the PhD thesis, scientific papers and oral and/or poster communications.

References

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