Development of encapsulated olive oil and olive extracts as innovative health food ingredients

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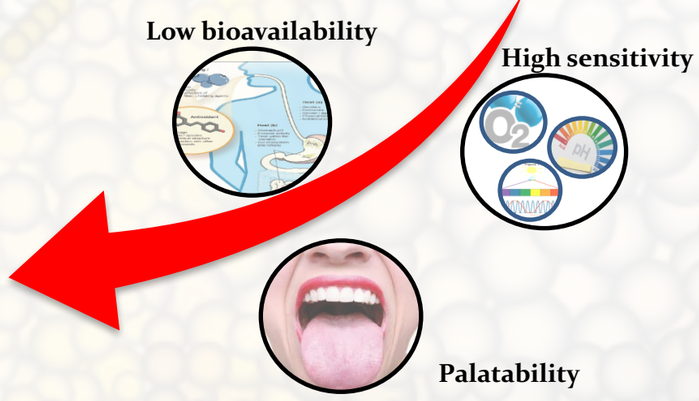
Extensive evidence of **health promoting** properties of olive oil and olive phenolics has been shown in literature during the last decades (Martín-Peláez et al., 2013) and thus, the economical and public health potential is substantial.

- **Cancer prevention**
- **Cardiovascular disease prevention**
- **Age-related processes prevention**
- **Antimicrobial**

Uses of phenolic compounds is rather limited in their natural form due to their **sensitivity** to **environmental factors** during food processing, **bioavailability** (solubility, gut residence time and interaction with other nutrients), and **bitter-astringent taste**.

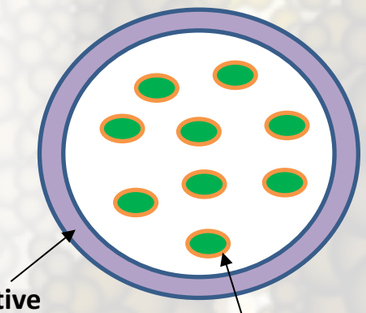
Free radical scavenging



State of the art

Use and application of phenolic compounds in food systems requires optimised **formulation** and/or the development of **delivery systems** to overcome these limitations. **Encapsulation** is defined as a technology for packaging solids, liquids or gases in miniature particles that can protect the core material from environmental conditions. Many techniques and packaging materials have been studied and adapted to the material to be encapsulated and the processing conditions

Encapsulation technologies

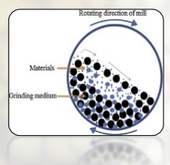


Freeze-drying

Freeze-drying is a simple technique that has been used to encapsulate heat-sensitive materials like phenolic extracts from fruits (Laine et al., 2008) using carbohydrates as encapsulating agent. Olive leaf extract has been encapsulated with ß-cyclodextrins by molecular complexation and freeze-drying (Mourtzinos *et al.*, 2007) thereby storage stability and solubility of phenolics were improved and antioxidant activity remained unaltered.

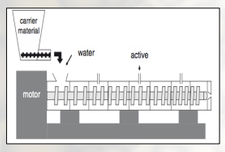
Spray-drying

Spray-drying is the most commonly used encapsulation technique in the food industry (continuous, economical). Wall materials are gums, proteins for their film forming and emulsifying properties, as well as maltodextrins for their physical and thermal properties, although a combination of these is normally applied (Calvo *et al.*, 2010). Olive leaf extract was physically encapsulated by spray-drying by using chitosan as wall material and smooth microparticles were obtained (Kosaraju *et al.*, 2006).



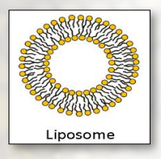
Co-milling

Ball-milling has been used in the pharmaceutical sector for size reduction and to enhance solubility of poorly water-soluble drugs; co-milling (two or more components) has been applied to obtain molecular dispersions of the compound of interest in a matrix of the carrier and to increase the amorphous state (Bandarkar and Vavia, 2011).



Extrusion

In hot melt extrusion, active ingredients are encapsulated in a matrix of carbohydrate melt that is extruded and hardened to produce and amorphous matrix that controls stability and release of encapsulated material. Melt extrusion has been used to encapsulate flavour oil, nutraceuticals and enzymes for food and cosmetic applications (Zuidam and Heinrich, 2010)



Liposomes

Liposomes are vesicles formed by a lipid bilayer (phospholipids) with amphiphilic properties. Their biocompatibility, small size and ability to carry wide variety of compounds (hydro- and lipophilic) have made liposomes an attractive drug delivery system, although their use in foods has also been studied to encapsulate phenolic compounds (Rashidinejad *et al.* 2014))

Aim of the project

To develop **encapsulated olive oil and olive leaf extract** rich in phenolic compounds with health properties. Phenolic extracts will be encapsulated using several drying technologies like freeze-drying, spray-drying and co-milling, and other methods (e.g. extrusion and liposomes). Technological functionality, quality and stability of encapsulates will be evaluated in both model systems and real food systems, along with their effects on food/gut-related microorganisms and tumoral cells.

PhD Thesis Objectives and Milestones

The following activities will be carried out (Table 1):

A1) Development of encapsulated polyphenolic olive extracts and olive oil using different techniques
- A1.1. Freeze-drying and co-milling encapsulation (University of Teramo)
- A1.2. Spray-drying and liposome encapsulation (University of Ljubljana)
- A1.3. Extrusion encapsulation (University of Bolzano)

A2) Evaluation of technological functionality and stability of produced encapsulated extracts, including encapsulation efficiency, polyphenol content, morphology (SEM), thermal stability (DSC), water sorption.

A3) Assessing the effect of encapsulated extracts on microbial growth of food and gut related microorganisms

A4) Determination of stability, health functionality and bioavailability in real food systems: development of model and formulated emulsified and gelled products.

A5) Collaborative activities with University of L'Aquila to understand effect of encapsulated polyphenols on tumour initiation and progression.

A6) Writing and Editing of the PhD thesis, scientific papers and oral and/or poster communications.

Activity	Months: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 22 24 26 28 30 32 34 36
A1) Development of encapsulated phenolic rich extracts	■ ■
1) Freeze-drying and co-milling	■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■
2) Spray-drying and liposomes	■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■
3) Extrusion encapsulation	■ ■ ■ ■ ■ ■
A2) Technological functionality and stability	■ ■
A3) Effect on microbial growth	■ ■ ■
A4) Properties in real food systems	■ ■ ■ ■ ■ ■
A5) Effect on tumour initiation and progression	■ ■ ■ ■ ■ ■
A6) Writing and editing PhD thesis	■ ■

Selected references

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