

PHOSPHOLIPID COMPLEXES OF OLIVE FRUITS OR LEAVES EXTRACTS HAVING IMPROVED BIOAVAILABILITY

The present invention relates to novel phospholipids complexes of olive fruits or leaves extracts having improved bioavailability.

TECHNOLOGICAL BACKGROUND

Studies on the active principles of the *Olea europea* have been
5 conducted for decades, and their properties were recently confirmed in experimental and clinical studies.¹

It was reported that *oleuropein*, the main component detectable in the leaves, is the compound responsible for hypotension, coronary dilating and antiarrhythmic action. In one study² the antihypertensive, diuretic,
10 antiatherosclerotic, antioxidant and hypoglycemic effect of triterpenoids isolated from *Olea europea* leaves were confirmed in a salt-sensitive genetically hypertensive rats model. Olive leaf extract also contains other synergistic phytochemicals including *rutin* and *hesperidin*. They are vital in their ability to increase the strength of the capillaries (blood vessels) and to
15 regulate their permeability.

As far as olive oil is concerned, several studies have shown the important role of phenolic compounds contained therein. The main components, tyrosol, verbascoside and hydroxytyrosol, are potent inhibitors of LDL oxidation *in vivo*,³⁻⁴ which is linked to the formation of atherosclerosis
20 plaques that are postulated to contribute to the development of coronary heart disease. Hydroxytyrosol has been reported to reduce, alone, the risk of coronary heart diseases and atherosclerosis⁵⁻⁶, being *in vitro* a potent and dose-dependent inhibitor of copper sulfate-induced oxidation of LDL. These results were also obtained in the animal model.⁷ Verbascoside has been proved
25 to possess potent scavenging actions on superoxide anions and hydroxyl

radicals,⁸⁻⁹ and also to act an antioxidant to inhibit the peroxidation of mouse liver microsome, rat liver mitochondria, the emolysis of erythrocytes induced by radicals; its antioxidant potential has been revealed in many other experimental models.

5 Recent studies have demonstrated that virgin olive oil phenolic components, such as hydroxytyrosol and its secoiridoid derivatives and metabolites - namely compounds with an ortho-diphenolic structure - exert strong antioxidant, as well as other biologically relevant effects.¹⁰⁻¹¹ Although most of these results have been obtained in *in vitro* systems,¹²⁻¹³ evidence of
10 the biological activities of olive oil phenolics *in vivo* is also accumulating.¹⁴⁻¹⁵ Hydroxytyrosol (HT) is apparently the most active of olive phenols, it has been shown to be dose-dependently absorbed in humans, though to different degrees according to its formulation. As an example, its incorporation into a yoghurt decreases its bioavailability when compared to that after
15 administration as a natural component of extra virgin olive oil.¹⁶

Therefore, it is highly desirable to find novel olive fruits or leaves extracts derivatives having improved bioavailability.

Complex compounds of vegetable extracts or of purified components thereof with natural, synthetic or semi-synthetic phospholipids, have been
20 disclosed, e.g., in EP 209 038, EP 275 005, EP 283 713, EP 1 035 859 and EP 1 140 115. The mentioned complexes improve the plasma bioavailability of the extract or purified component, due to their lipophilicity. EP 275 005 states that the formation of the complexes is carried out in an aprotic solvent. EP 1 140 115 generically mentions ethanol among the various solvents that
25 can be used of the preparation of mentioned complexes, but does not provide preparation examples which make use of ethanol as the solvent. Furthermore, the complexes disclosed are phospholipid complexes of proanthocyanidin A2, which are quite different in the chemical structure with respect to the

phospholipids complexes of olive fruits or leaves extracts of the present invention.

DISCLOSURE OF THE INVENTION

The present invention relates to phospholipids complexes of olive fruits
5 or leaves extracts.

It has been found that the phospholipids complexes of the invention provide higher systemic levels of parent agent than unformulated olive fruits or leaves ethanol extracts.

Therefore, the present invention relates to novel phospholipids
10 complexes of olive fruits or leaves extracts having improved bioavailability. In a first embodiment, the invention relates to phospholipids complexes of olive fruits or leaves aqueous extracts; in a second embodiment, the invention relates to phospholipids complexes of olive fruits or leaves ethanol or water-ethanol extracts.

15 According to the invention, phospholipids of either vegetable or synthetic origin can be used; particularly preferred are soy phospholipids, such as phosphatidyl choline, phosphatidyl serine, phosphatidyl ethanolamine.

According to the invention, the complexes are prepared by adding the phospholipid to olive fruits or leaves extracts dissolved in a protic solvent,
20 more particularly adding the phospholipid to the ethanol solution of the extract of olive fruits or leaves, under reflux and with stirring. The resulting suspension is concentrated under reduced pressure to a residue which is then dried. The ratio of phospholipids to olive fruits or leaves extracts is in the range from 10 to 1 w/w, a more preferable mole ratio being 5:1 w/w.

25 The present invention also relates to pharmaceutical compositions containing as the active principle one of the phospholipids complexes of olive fruits or leaves extracts according to the invention, in admixture with a suitable pharmaceutical carrier.

The present invention further relates to the use of the phospholipids complexes of olive fruits or leaves extracts of the invention for the preparation of medicaments having chemopreventive, antioxidant and cardiovascular-diseases preventive actions.

5 The following examples further illustrate the invention.

EXAMPLES

PREPARATION OF OLIVE FRUITS OR LEAVES EXTRACTS

The olive fruit extract used in examples 3 and 4 is prepared as follows. *Fresh Olea europaea L.* fruits (olives) are crushed, kneaded and centrifuged to
10 remove oil and part of the vegetation water. The resulting material (olive pomace) is then extracted with aqueous ethanol (ethanol:water 6:4) at 60°C and the exhausted pomace is discharged. The extracts are filtered, pooled and concentrated to remove ethanol and water-insoluble impurities are removed by centrifugation. The clarified solution is evaporated under reduced pressure to
15 obtain a dry olive fruit purified extract (total phenols content by Folin-Ciocalteu assay: 9.5% w/w).

This extract is further purified on an adsorption resin to obtain a total phenols content of 30% w/w (Folin-Ciocalteu assay) and is then used in examples 1 and 2.

20 The preparation of the extract used in example 5 is similar to that of the extract used in examples 3 and 4, the only difference being that olive pomace is extracted with pure water.

The leaves extract used in examples 6 and 7 is instead prepared by extracting *Olea europaea L. leaves* with aqueous ethanol (ethanol:water 9:1)
25 at 70°C. The extracts are filtered, pooled and concentrated to remove ethanol and water-insoluble impurities are removed by centrifugation and discarded. The clarified solution is dried under reduced pressure to obtain a dry olive leaf purified extract (polyphenols content by HPLC assay: 20.8% w/w), which is

used in example 6. This extract can be further purified on an adsorption resin so as to obtain a total phenol content of 41.6% w/w (HPLC assay), then used for example 7.

EXAMPLE 1 - Preparation of phospholipid complex of an olive fruits
5 purified ethanol extract

Soy phospholipid (150 g) is slowly added to refluxing ethanol (1.6 l) under mechanical stirring. The suspension is refluxed for 1 hour with stirring, then a solution of 50 g of olive fruit purified extract (total phenols by Folin-Ciocalteu assay: 30% w/w; HPLC assay: verbascoside 7.38% w/w) in
10 100 ml of aqueous alcohol (ethanol-water 7.5:2.5) kept at 60°C is added. After completion of the addition, the mixture is refluxed under stirring for 1 hour, then filtered. The resulting solution is concentrated by distillation to 70% w/w dry residue, then dried under *vacuum* at 40°C for 68 hours.

15 158 g of product are obtained having 8.86% w/w total phenol content by Folin-Ciocalteu assay and 2.24% w/w verbascoside content by HPLC assay.

The solubility of the product in organic solvents is noticeably different from the starting extract. In fact, while the starting purified extract is insoluble in methylene chloride, chloroform and acetone and only partially soluble in
20 ethanol, the complexed extract is soluble in methylene chloride and chloroform and insoluble in acetone and ethanol.

^1H , ^{13}C and ^{31}P -NMR spectra confirm complex formation. Most significant data from ^{31}P -NMR analysis are reported in Table 1. Not-complexed phospholipids have a sharp signal in the CDCl_3 ^{31}P -NMR
25 spectrum at δ 0.3 as shown for entry 1 and 3 in Table 1. Complexed phospholipids, on the contrary, have a much broader signal at δ 0.7 (*vide* Δ values) as shown for entry 2 in the same Table. ^1H and ^{13}C nuclei have the same behaviour as ^{31}P in CDCl_3 . Proton and carbon spectra are shown in

Appendix.

Table 1. ^{31}P -NMR (121.380 MHz, CDCl_3 , 30°C) data			
Product	δ (ppm)	Δ (Hz)	
Commercial soy phospholipid	0.3	2.7	
Olive fruit phospholipid complex	0.7	18.3	
Admixture of olive fruit ethanol extract and soy phospholipid	0.3	2.9	

EXAMPLE 2 - Preparation of the phosphatidylcholine complex of olive fruits purified ethanol extract

5 100 g of phosphatidylcholine are dissolved in 1.6 l of ethanol. The mixture is refluxed under mechanical stirring then dropwise added to a solution obtained dissolving 50 g of olive fruit purified extract (total phenols by Folin-Ciocalteu assay: 30% w/w; HPLC assay: verbascoside 7.38% w/w) in 100 ml of aqueous alcohol (ethanol-water 7.5:2.5) kept at 60°C. After
10 completion of the addition, the mixture is refluxed under stirring for 1 hour, then concentrated to 70% w/w dry residue and finally dried under *vacuum* at 40°C for 68 hours.

15 150 g of product are obtained having 10% w/w total phenols content by Folin-Ciocalteu UV assay and 2.46% w/w verbascoside content by HPLC assay. NMR spectra of the product are similar to those obtained in Example 1.

EXAMPLE 3 - Preparation of phospholipids complex of olive fruit ethanol total extract

20 150 g of phospholipid are slowly added to 1.6 l of refluxing ethanol under mechanical stirring. After completion of the addition, the suspension is refluxed for 1 hour, with stirring. A solution of 50 g of olive fruit purified extract (total phenols content by Folin-Ciocalteu assay: 9.5% w/w) in 100 ml

of aqueous alcohol (ethanol-water 7.5:2.5) kept at 60°C is dropwise added. After completion of the addition, the mixture is refluxed under stirring for 1 hour and then filtered. The resulting solution is concentrated to 70% w/w dry residue, then dried under *vacuum* at 40°C for 68 hours.

5 167 g of soy phospholipid complex of olive fruits total extract are obtained having 2.7% w/w total phenols content by Folin-Ciocalteu UV assay. NMR spectra of the product are similar to those obtained in Example 1.

EXAMPLE 4 - Preparation of phosphatidylcholine complex of olive fruits ethanol total extract

10 100 g of phosphatidylcholine are dissolved in 700 ml of ethanol, and the mixture is refluxed under mechanical stirring. A solution of 50 g of olive fruit purified extract (total phenols content by Folin-Ciocalteu assay: 9.5% w/w) in 100 ml of aqueous alcohol (ethanol-water 7.5:2.5) kept at 60°C is dropwise added. After completion of the addition, the mixture is refluxed under stirring
15 for 1 hour, then the solution is concentrated by distillation under atmosphere pressure to 70% w/w dry residue, then dried under *vacuum* at 40°C for 68 hours.

175 g of product are obtained having 4.1% w/w total phenols content by Folin-Ciocalteu UV assay. NMR spectra of the product are similar to those
20 obtained in Example 1.

EXAMPLE 5 - Preparation of phospholipid complex of olive fruit aqueous total extract

100 g of phospholipid are dissolved in ethanol (1250 ml) and refluxed with mechanical stirring. 50 g of olive fruits aqueous total extract (total
25 phenols content by Folin-Ciocalteu assay: 6.8% w/w) are slowly added to the mixture. After completion of the addition, the mixture is refluxed under stirring for 1 hour and then filtered. The resulting solution is concentrated to 70% w/w dry residue, then dried under *vacuum* at 40°C for 68 hours.

139 g of product are obtained having 2.3% w/w total phenols content by Folin-Ciocalteau UV assay. NMR spectra of the product are similar to those obtained in Example 1.

5 EXAMPLE 6 - Preparation of phosphatidylcholine complex of olive leaves ethanol total extract

100 g of olive leave total hydro-alcoholic extract (polyphenols content by HPLC assay: 20.8% w/w) are dissolved in a solution of 128 g of phosphatidylcholine in 2570 ml of ethanol. The resulting solution is refluxed for 1 hour, then concentrated under reduced pressure to a suspension having a
10 70% w/v dry residue. The product is finally dried at 40°C under *vacuum* for 24 hours to yield 218 g of a light brown product (polyphenols by HPLC assay: 9.3% w/w). NMR spectra of the product are similar to those obtained in Example 1.

15 EXAMPLE 7 - Preparation of phosphatidylcholine complex of olive leaves purified ethanol extract

100 g of olive leave purified hydro-alcoholic extract (polyphenols by HPLC assay: 41.6% w/w) are dissolved in a solution of 115 g of phosphatidylcholine in 2570 ml of ethanol. The resulting solution is refluxed for 1 hour, then concentrated under reduced pressure to a suspension having
20 70% w/v dry residue. The product is finally dried at 40°C under *vacuum* for 24 hours to yield 196 g of a light brown product (polyphenols by HPLC assay: 18.8% w/w). NMR spectra of the product are similar to those obtained in Example 1.

EXPERIMENTAL SECTION

25 Tests were carried out to compare the bioavailability of the phospholipid complexes of the invention with that of the uncomplexed olive fruits or leaves ethanol extracts.

Bioavailability of phenols over time and dose ranges were assessed

through evaluation of the urinary excretion over a 24 hour time, both as total HT and as its most representative metabolite, i.e. homovanillyl alcohol (HVAIc), after administration of a highly standardized olive fruit extract both in the uncomplexed and complexed forms with phospholipids to volunteers.

5 In addition, the effects of treatments on the excretion of urinary isoprostanes, an accepted marker of systemic lipid peroxidation formed by the non enzymatic oxidation of the highly unsaturated fatty acid, arachidonic acid, were evaluated.

Six healthy male volunteers that we assigned to two groups of three
10 each one. The first group was administered with the complexes of the invention, from now on referred to as OLEASELECT™ Phytosome®. The second group was administered with a highly standardized olive fruit extract in the uncomplexed form, from now on referred to as OLEASELECT™.

All subjects were submitted for three days to a an olive oil-free diet
15 (washout period), then respectively given either OLEASELECT™ Phytosome®, or OLEASELECT™, one capsule the first time, two capsules the second time, and four capsules the third time, with one week between each administration. Urine of 24-hours were collected the day before and the day after the treatments. Urinary volume was measured and aliquots were stored at
20 -80°C.

The urinary concentrations of HT and its metabolite homovanillyl alcohol (HVAIc) were evaluated before and after treatment. Samples were extracted and incubated with glucuronidase and analyzed by HPLC coupled to mass spectrometry.⁸ The urinary concentrations of F₂-isoprostanes were
25 determined by immunoassay.⁹ Each value was normalized to the concentration of creatinine (Metra Creatinine Assay Kit, Quidel) and is expressed as pg/mg creatinine. The results were analyzed for statistical significance by two-tailed Student's *t* test for paired data.

The group treated with OLEASELECT™ Phytosome® showed a percentage of HT and HVA1c ranging between 5.2 and 7.9. This result demonstrated a strong increase of oral bioavailability. A dose-related reduction of isoprostanes excretion was also observed.

- 5 The group treated with OLEASELECT™ alone showed a percentage of HT and HVA1c ranging between 1 and 2.3, *i.e.* much lower oral bioavailability.

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CLAIMS

1. Phospholipids complexes of olive fruits or leaves extract.
2. Phospholipid complexes according to claim 1, wherein the extract is an
5 aqueous extract.
3. Phospholipid complexes according to claim 1, wherein the extract is an ethanol or water-ethanol extract.
4. The complexes of any one of claims 1 to 3, wherein the phospholipids are soy phospholipids.
- 10 5. The complexes of any one of claims 1-4, wherein the phospholipid to olive fruits or leaves extracts ratio is in the range from 10 to 1 w/w.
6. The complex compounds of claim 5, wherein the phospholipid to olive fruits or leaves extract ratio is from 5 to 1 w/w.
7. A process for the preparation of the complex compounds of claims 1-6,
15 wherein an extract of olive fruits or leaves is reacted with phospholipids in an alcoholic solvent and the complex compound is then isolated by concentration and drying.
8. The process of claim 7, wherein the alcoholic solvent is ethanol.
9. Pharmaceutical compositions containing as the active principle a
20 complex as claimed in claims 1 to 6, in admixture with a suitable pharmaceutical carrier.
10. The use of the complexes of claims 1 to 6 for the preparation of medicaments having chemopreventive, antioxidant and cardiovascular-diseases preventive actions.