Modification of phospholipids

Identification

Key words
Phospholipids (lecithin), emulsifiers, phospholipase, Lipase

Latest version
2012/07/17

Completed by
DIL

How does it work?

Primary objective
Phospholipids are modified to obtain products possessing improved technological, physicochemical and nutritional properties. This includes in particular improvement of emulsifying properties, increase of dispersibility in aqueous systems or obtaining of nutritionally valuable phospholipid fractions

Working principle
The principle is based on modification of the structure of phospholipid molecules or on separation of individual components or component groups from the matrix. The modification can be achieved by physical, chemical and enzymatic (Enzymatic modification of phospholipids) methods.

Physical methods:
1. Fractionation by separation of neutral and polar lipids (de-oiling) [1]
2. Fractionation of de-oiled lecithin by alcohols due to a different solubility of phospholipid fractions [2]
3. Coating of proteins by phospholipids during spray drying in order to obtain powdered products having 30-50 % phospholipid fractions[1]

Chemical methods:
1. Chemical hydrolysis for release of fatty acids to modify the hydrophobicity of phospholipid molecules making them more hydrophilic
2. Hydrogenation of unsaturated fatty acids to obtain more saturated molecules
3. Hydroxylation of unsaturated fatty acids to obtain more hydrophilic molecules
4. Acylation of the NH2-group of the zwitterionic phosphatidylethanolamine (PE) to obtain a negatively charged phospholipid molecule [1,2,3]

Enzymatic methods:
1. Enzymatic hydrolysis for release of fatty acids by phospholipases A1, A2 in order to obtain phospholipids with increased hydrophilicity (lysophospholipids) [4,5]
2. Enzymatic hydrolysis by phospholipase D to generate phospholipid molecules with modified head group [6]
3. Enzymatic hydrolysis by phospholipase C to obtain a diacyl glycerol (DAG)[7]
4. Enzymatic release of fatty acids by Lipase to obtain lysophospholipids [7,8]

Images

Additional effects
Obtaining phospholipids with a high purity

Important process parameters
temperature, pH-value, treatment time, ion concentration, enzyme dosage, solvent

Important product parameters
water content
What can it be used for?

**Products**
- Lecithin blends, egg yolk, dairy products, bakery products, additives, vegetable oil

**Operations**
- Separation, structure forming, conversion, stabilizing

**Solutions for shortcomings**
- Food industry requirements for natural emulsifiers with specific properties.
  - Phospholipids with modified structures may be applied for producing of nutraceuticals

What can it NOT be used for?

**Products**
- Products naturally not containing lecithin because addition of phospholipids must be declared (in EU as E322). So, food additives declared as E-number could decrease consumer acceptance of such products

**Operations**
- Application of chemical modification in foods is limited.
  - Restricted application of phospholipases due to source and product specificity of the enzymes

**Other limitations**
- Chemical and physical modification is rarely selective and difficult to control.
  - Scale-up problems for enzymatic modification

**Risks or hazards**
- It is difficult to totally control chemical modification, so side-processes can take place leading to undesired products, for example undesired distribution of fatty acids in the product can occur.

Implementation

**Maturity**
- The technology is available on industrial scale. Products are used in food, pharmaceuticals, plastics, coatings, cosmetics etc. However, Enzymatic modification of phospholipids by phospholipase D has been applied only in lab-scale.

**Modularity /Implementation**
- Phospholipases have to be permanently optimised by protein engineering in order to meet specific needs of the food industry, resulting in higher production costs

**Consumer aspects**
- Non-GMO lecithin should be used. Additionally, phospholipases originated from genetically modified microorganisms may be critical

**Legal aspects**
- The Codex Alimentarius Committee of the FAO/WHO lists food-grade lecithins with recommended purity criteria for worldwide use. The EU-approved food additive number E322 comprise physically fractionated and enzymatically hydrolyzed lecithins [2]. While hydroxylation is allowed in the US for baking applications none of the products resulting from these processes has food grade status in Europe. These products are limited to applications in cosmetics and pharmaceuticals [3]. For this reason, Enzymatic modification of phospholipids is preferred

**Environmental aspects**
- Compared to physical or chemical methods, enzymatic approach (Enzymatic modification of phospholipids) allows a better control of reactions, greatly reduces the consumption of toxic solvents, saves chemicals, energy and water due to mild reaction conditions, reduces waste and increases product yield [1,2].
Facilities that might be interesting for you

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<td>Auditorium IRTA</td>
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<td>Video observation system for market research and product development tasks - Keki</td>
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Further Information

**Institutes**
- DIL, TU München, Martin Luther Universität Halle Wittenberg, DTU Food, Texas A&M University

**Companies**
- Lecithos Consulting, Lecipro Consulting, Unilever, Novozymes, Biocatalysts, Nestlé Research Centre

**References**