Phospholipids for Nutrition

BENEFITS, FUNCTIONALITY AND USES

ALC
AMERICAN LECITHIN COMPANY
About Phospholipids

Phospholipids are natural substances that are essential to life. They are present in every cell in the body, and maintain cellular membrane integrity. They also contribute to the regulation of many biological pathways, including cellular communication and synthesis of the neuro-transmitter acetylcholine.

Due to their importance in many biological functions, phospholipids and phospholipid-derived nutritional supplements have become some of the fastest-growing products in the nutritional supplement market.

American Lecithin’s phospholipid products are of high quality, purity and functionality. They are derived from non-GMO soybeans or are PCR-negative, and are manufactured to meet strict GMP regulations.

American Lecithin offers a wide range of phospholipid products for use in nutritional supplements that are formulated for tablets, hard shell capsules, soft gel capsules and liquid formulations. These include:

Polyenylphosphatidylcholines (PPC):
- PhosChol®
- PHOSPHOLIPON®
- PHOSAL®

Soybean Phosphatidylserines:
- ALCOLEC® PS

Glycerophosphocholines:
- ALCOLEC® GPC

Delivery systems and compounds:
- PhytoSolve® transparent emulsions
- SOLUTHIN® MD carrier for tableting

See product details on page 11
PhosChol® contains pure polyenylphosphatidylcholine from soy. This phospholipid is rich in essential linoleic acid (its polyunsaturated fatty acids containing a high percentage of Dilinoleoylphosphatidylcholine). Studies on the efficacy of PPC against fibrosis and cirrhosis used PHOSPHOLIPON® comprised of 94-96% PC, a mixture rich in polyunsaturated PC (PPC), especially dilinoleoyl-phosphatidylcholine (DLPC). In the body, PPC is a precursor for the synthesis of the neurotransmitter acetylcholine.

In many countries, PPC is a successfully marketed product and is popular for its hepatoprotective benefits. In North America, American Lecithin offers PPC of the highest purity from the world’s largest soy phospholipid manufacturing plant in Germany.

Like other highly unsaturated lipids, PPC is highly susceptible to oxidation and deterioration. We have developed safe and gentle technologies for PPC purification and fractionation. For easy handling, American Lecithin offers solid and liquid forms of PPC.

Health benefits in scientific literature:
- High efficacy in liver regeneration
- Cholesterol-lowering effect

How PPC Benefits Cell Function

PPC plays a vital role in all basic biological cellular processes, such as the flow of information that occurs within cells, formation of cellular energy and intracellular communications.

PPC, rich in essential fatty acids such as linoleic acid, has a marked fluidizing effect on the cellular membrane. By increasing cell membrane fluidity, cellular membrane breakdown is decreased.

The breakdown of cellular membranes and impairment of cellular membrane repair mechanisms is associated with liver diseases, cancer, neurological diseases and cell death.

Studies indicate that PPC increases hepatic collagenase activity and may help prevent fibrosis and cirrhosis by encouraging collagen breakdown.
ALCOLEC® PS
(Phosphatidylserine (PS))

Phosphatidylserine is present in all cellular membranes (mainly in the inner layer), and concentrated in the human brain and nerves.[5] A variety of structural and regulatory functions in biological cell activities has been demonstrated for PS.[8] Among other mechanisms, PS modulates the activity of receptors, enzymes, ion channels and signaling molecules.[8, 9] ALCOLEC® PS is soy-derived and runs no risk of contamination with any kind of prion.[7] ALCOLEC® PS is available in non-GMO grades. Also, American Lecithin offers highly refined PS grades that do not contain proteins.

Health benefits in scientific literature:
- Improved exercise capacity [5, 8]
- Increased neurotransmitter release in the brain [10, 11]
- Reversed age-associated nerve cell dendrite loss [10]
- Increased brain glucose level:
  - Improved memory [10, 11]
  - Shorter reaction time [10-12]
  - Better hand-eye coordination [10-12]
  - Higher stress resistance [5, 8, 12]
  - Mood improvement [10-12]

FDA Qualified health claims for phosphatidylserine (PS):
- Consumption of phosphatidylserine may reduce the risk of dementia in the elderly [23]
- Consumption of phosphatidylserine may reduce the risk of cognitive dysfunction in the elderly [23]

α-GPC
(Alpha-Glycerophosphocholine)

α-GPC is a unique phospholipid-derived molecule necessary for healthy cell function. It is also a nutrient for all body cells [13] and is contained in breast milk.[14] The tiny α-GPC molecule contains no fatty acids and easily passes the blood-brain barrier.[15] This hydrophilic molecule blends clearly into liquid formulations as it forms stable unimolecular solutions in aqueous systems.

Nattermann Phospholipid GmbH launched alpha-GPC in the early 1980s. In Italy, a pharmaceutical version has been launched as Gliatilin®, aka choline alfoscerate. Pharmaceutical α-GPC is often prescribed during the early stages of dementia, and has become popular in many countries.

American Lecithin sponsored a 2010 study that evaluated ALCOLEC® GPC efficacy in protecting cognitive brain function after heart surgery.[20] ALCOLEC® GPC has been explored as a protective nutrient in a patient pool of 20 people who received the surgery under general anesthesia. ALCOLEC® GPC (1200mg) was administered in soft gelatin capsules twice a day for 14 days (one week prior to, and a week after, surgery). Post-operative cognitive function was assessed using the psychometric mini-mental state examination (MMSE) and Benton visual retention test (BVRT). After administration for just two weeks, this initial study concluded that α-GPC has possibilities to prevent and lower risk of postoperative cognitive dysfunction.

ALCOLEC® GPC is manufactured to outstanding quality standards. Due to its deep vertical integration, in-house production starts with crude lecithin. This unique control of a multi-step process provides extremely high purity and no contamination with foreign material, as only the very safest solvents are used. American Lecithin’s special grades reduce the hygroscopicity of the molecule.

Health benefits in scientific literature:
- Plays a vital role in tissue growth and renewal, organ vitality, reproduction, and mind-body integration [16]
- Significantly benefits attention, mental focus, recall and cognition [17]
- Offers benefits to defend memory decline caused by poor brain circulation or Alzheimer’s disease [17]
- Valuable for brain recovery after stroke or circulatory injury [18]
- Can revitalize master hormone functions [19]
PhytoSolve®
(Phospholipid-based Delivery System)

The proprietary PhytoSolve® technology delivers lipophilic-active nutritional ingredients in a naturally clear system with proven enhanced bioavailability properties.[21] PhytoSolve® is patent pending in the U.S.[22] Under this patent, the PhytoSolve® delivery system capitalizes on the natural emulsification properties of phosphatidylcholine (PC).

PhytoSolve® is used in nutritional supplement applications for delivery of lipophilic active ingredients such as fat-soluble vitamins, omega-3 fatty acids (i.e., docosahexaenoic acid), coenzyme Q10, conjugated linoleic acid (CLA) and lutein, into soft gel capsules and liquid formulations.

In microbiological challenge tests, PhytoSolve® proved self-preserving. All ingredients used in the PhytoSolve® technology are natural, GRAS, non-GMO, vegan, and without synthetic surfactants or preservatives.

Benefits:
- Based only on natural, non-GMO raw materials
- Transparent emulsion
- Free of synthetic surfactants
- Self-emulsifying system
- Preservative free
- Enhanced bioavailability (up to ten-fold depending on the active ingredient) [21]
- Pleasant taste

The PhytoSolve® technology has been shown to increase the bioavailability of lipophilic active ingredients as nutritional supplements. The bioavailability of Coenzyme Q10 and Vitamin E[21] increased when consumed in a PhytoSolve® delivery system vs. a hard gelatin capsule containing the pure material used as reference standard.

Twenty-four volunteers (12 men and 12 women) were randomly assigned into two treatment groups. One group received PhytoSolve® with CoQ10 and Vitamin E, the other group received the pure reference products CoQ10 and Vitamin E in capsules. Both groups received the same oral dose of each test nutrient: 100 mg of CoQ10 and 120 mg of tocopherol (Vitamin E) equivalents.

The test subjects received their respective products and their blood levels were monitored over a 14 hour period. The test samples were administered after an overnight fast. Blood levels of CoQ10 and Vitamin E were evaluated at time zero (just prior to administration of test samples) and hourly for 14 hours. Standardized meals and snacks were administered periodically post-dosing.

PhytoSolve® with CoQ10 and Vitamin E, the other group containing PhytoSolve® showed significantly higher CoQ10 blood levels. The data indicates that there is a fourfold increase in bioavailability (area-under-the-curve, AUC) when CoQ10 is delivered in a PhytoSolve® delivery system.

For Vitamin E, the results are even better. The data indicates that there is a 10-fold increase in bioavailability (AUC) when Vitamin E is delivered in a PhytoSolve® delivery system.

The PhytoSolve® delivery systems were well tolerated by the volunteers and offer an alternative to traditional delivery methods for nutritional ingredients with an increase in bioavailability.
SOLUTHIN® MD
(Phosphatidylcholine in Tablets)

Phosphatidylcholine is widely used for improved bioavailability of oral formulations\(^{[24]}\). The SOLUTHIN® MD technology incorporates American Lecithin’s high-quality phosphatidylcholine (PC) ingredients plated onto a maltodextrin carrier for use in delivery systems for nutritional supplement applications.

This technology is used to deliver solid nutritional supplement formulations in the form of granules, pellets, tablets and extrudates. The SOLUTHIN® MD technology delivers unsaturated phosphatidylcholine in a powdered form that is compressible for chewable tablets, easily blendable for tabletting and free-flowing for use in hard gel capsules.

Benefits:
- Enables solid formulations of unsaturated PC
- All natural and GRAS ingredients
- Easily dispersible in water

Products for Nutritional Applications

Polyenylphosphatidylcholines

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>PhosChol®</td>
<td>Nutritional supplement</td>
</tr>
<tr>
<td>PHOSPHOLIPON 90 G/NG®</td>
<td>&gt;90% PC, granulated</td>
</tr>
<tr>
<td>PHOSAL 75 SA®</td>
<td>75% PC, liquid in safflower oil</td>
</tr>
<tr>
<td>PHOSAL 53 MCT®</td>
<td>53% PC, liquid in medium-chain triglycerides</td>
</tr>
<tr>
<td>PHOSAL 50 SA®</td>
<td>50% PC, in safflower oil</td>
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Soybean Phosphatidylserines

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
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<tbody>
<tr>
<td>ALCOLEC® PS 20 F</td>
<td>20% PS, liquid</td>
</tr>
<tr>
<td>ALCOLEC® PS 20 P</td>
<td>20% PS, powder</td>
</tr>
<tr>
<td>ALCOLEC® PS 40 P</td>
<td>40% PS, powder</td>
</tr>
<tr>
<td>ALCOLEC® PS 50 P</td>
<td>50% PS, powder</td>
</tr>
<tr>
<td>ALCOLEC® PS 70 P</td>
<td>70% PS, powder</td>
</tr>
</tbody>
</table>

Glycerophosphocholines

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
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<tbody>
<tr>
<td>ALCOLEC® GPC COMPOUND</td>
<td>50% GPC, fine granules</td>
</tr>
<tr>
<td>ALCOLEC® GPC X</td>
<td>Pure GPC, powder</td>
</tr>
<tr>
<td>PHOSAL® GPC 85</td>
<td>85% GPC, viscous aqueous concentrate</td>
</tr>
</tbody>
</table>

Delivery Systems and Compounds based on Soybean Phospholipids

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>PhytoSolve®</td>
<td>Class of hydrophilic, customized transparent emulsions consisting of polyols, phospholipids and active lipophilic components</td>
</tr>
<tr>
<td>SOLUTHIN® MD</td>
<td>PC on maltodextrin carrier for tabletting</td>
</tr>
</tbody>
</table>

From left: SOLUTHIN® MD is easily compressed into tablets, and is easily dispersed in water; PhytoSolve® with coenzyme Q10, PhytoSolve® with vitamin E, and PHOSPHOLIPON® 90G.
<table>
<thead>
<tr>
<th>Product Type</th>
<th>Ingredients</th>
<th>Typical Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hard Capsules</strong></td>
<td>• ALCOLEC® PS grades</td>
<td>Brain function, cognitive capacity, memory</td>
</tr>
<tr>
<td>(Gelatine &amp; HPMC)</td>
<td>• ALCOLEC® GPC Compound, GPC X</td>
<td>Choline source, nervous system, brain function</td>
</tr>
<tr>
<td></td>
<td>• SOLUTHIN® MD</td>
<td>Powder form of unsaturated PC for solid delivery systems</td>
</tr>
<tr>
<td></td>
<td>• PhytoSolve® (HPMC)</td>
<td>Solubility enhancer, bioavailability enhancer</td>
</tr>
<tr>
<td></td>
<td>• PHOSAL® 75 SA</td>
<td>Solubility enhancer, good compatibility with capsule material</td>
</tr>
<tr>
<td><strong>Soft Gelatin Capsules</strong></td>
<td>• ALCOLEC® GPC 85</td>
<td>Choline source, nervous system, brain function</td>
</tr>
<tr>
<td></td>
<td>• PHOSAL® grades</td>
<td>Solubility enhancer, bioavailability enhancer</td>
</tr>
<tr>
<td><strong>Powder Compounds and Granulates</strong></td>
<td>• ALCOLEC® PS grades</td>
<td>Brain function, cognitive capacity, memory</td>
</tr>
<tr>
<td></td>
<td>• ALCOLEC® GPC X</td>
<td>Choline source, nervous system, brain function</td>
</tr>
<tr>
<td></td>
<td>• SOLUTHIN® MD</td>
<td>Powder form of unsaturated PC, easily dispersible in water</td>
</tr>
<tr>
<td><strong>Energy Bars</strong></td>
<td>• ALCOLEC® PS grades</td>
<td>High levels of phosphatidylserine, widely recognized as a contributor to good health</td>
</tr>
<tr>
<td></td>
<td>• ALCOLEC® GPC X</td>
<td>Choline source, nervous system, brain function</td>
</tr>
<tr>
<td><strong>High Caloric Sports Gels</strong></td>
<td>• PhytoSolve®</td>
<td>Higher caloric value than current sports gels</td>
</tr>
<tr>
<td><strong>Dairy Products</strong></td>
<td>• PhytoSolve®</td>
<td>Enrichment of e.g. yoghurt with nutrients, such as Omega-3 triglycerides, Lutein, CLA; improved bioavailability</td>
</tr>
<tr>
<td><strong>Drinks</strong></td>
<td>• ALCOLEC® GPC 85</td>
<td>Water soluble choline source, brain function, mental performance</td>
</tr>
<tr>
<td></td>
<td>• PhytoSolve®</td>
<td>Solubilization of lipophilic actives (e.g. Omega-3 triglycerides, CoQ10, Vitamin E, Lutein, CLA)</td>
</tr>
<tr>
<td><strong>Tablets</strong></td>
<td>• SOLUTHIN® MD</td>
<td>Powder form of unsaturated PC, for solid drug delivery systems</td>
</tr>
<tr>
<td></td>
<td>• ALCOLEC® PS grades</td>
<td>Brain function, cognitive capacity, memory</td>
</tr>
<tr>
<td></td>
<td>• ALCOLEC® GPC Compound, GPC X</td>
<td>Choline source, nervous system, brain function</td>
</tr>
</tbody>
</table>

These suggestions and information on application technology have been compiled to the best of our knowledge and belief on the basis of data, publications and regulations currently available, including those in the field of patent legislation. We cannot, however, accept any liability. We explicitly draw attention to the fact that every manufacturer is responsible for compliance with all statutory regulations, including those in the field of patent legislation.
Notes:


[20] Yamamoto Y., Watanabe G. et al., Division of Cardiac Surgery, Tokyo Medical University, Tokyo, Japan, 2010:” Protective Cognitive Brain Function After Heart Surgery: Treatment with the Nutritive α-GPC”.


New FDA regulations have changed the industry. By law, all nutritional supplement manufacturers must be GMP compliant, effective June 2010. Many are challenged to implement these complex rules.

American Lecithin, a supplier of GMP ingredients that are certified under the ICH Q7A pharmaceutical guideline, can help its customers on the sourcing side meet the GMP challenge. Working with a GMP-certified supplier of raw materials has distinct advantages for the manufacturer of nutritional supplements:

- Assurance that the raw material purchased is Safe, Pure and Effective.
- “Dock to Stock” convenience. Quality materials from a certified supplier can go directly into manufacturing stock without lengthy incoming quality control hold.
- “Lot-to-lot” raw material traceability.

This allows for:
- Reduced analytical expenses.
- Efficient incoming materials release for lower inventory costs.
- Effortless supplier qualification without comprehensive questionnaires.
- A strong quality profile during GMP audits.

About American Lecithin Company

For more than 80 years, American Lecithin has continually improved the basic properties of its lecithins, creating new products with better performance in a broad range of uses. We are committed to providing the very best in quality, consistency and technical support for our full range of products, from standard grade lecithins to high-tech fractions.

American Lecithin’s ALCOLEC®, PHOSAL®, PHOSPHOLIPON®, SOLUTHIN® and PhytoSolve® products are used in a wide variety of nutritional supplements both as active nutritional ingredients and excipients. Visit www.americanlecithin.us for additional information, or contact us directly.

Visit the Phospholipid Research Center, www.phospholipid-institute.com for basic scientific questions on lecithins and phospholipids.