Degumming of vegetable oils

In vegetable oil refining it is necessary to remove impurities that affect the taste, smell, visual appearance, and storage stability of the oil. One important class of impurities is phosphatides, also called "gums". Enzymatic degumming is an efficient way of removing these gum impurities.

Benefits

Enzymatic degumming is used for oils from rapeseed/canola, soyabean, ricebran, corn, sunflower seeds, and palm oil.

Higher yields

- Virtually no loss of oil to gums
- Close to zero formation of soaps and no hydrolysis of the oil

Simple process

- Works with crude oil as well as water-degummed oil
- Robust and simple process

Cost-efficient

- Low water consumption
- No wastewater
- No soapstock formation
- Low consumption of bleaching earth
- Reduced oil losses in gums
The increased yield of oil obtained by enzymatic compared to chemical degumming is shown in Figure 1.

![Figure 1. Oil losses during different degumming methods.](image1)

**Product**

The product used for degumming is Lecitase® Ultra. It is a protein-engineered carboxylic ester hydrolase (EC 3.1.1.3) extracted from *Thermomyces lanuginosus/Fusarium oxysporum* and produced by submerged fermentation of a genetically modified *Aspergillus oryzae* microorganism.

Lecitase Ultra is food-grade and kosher/halal-approved. The temperature-and heat-stability performance of Lecitase Ultra is shown in Figure 2.

![Figure 2. Activity versus temperature for Lecitase® Ultra.](image2)
The pH profile of Lecitase Ultra is shown in Figure 3.

![Fig. 3. pH profile of Lecitase® Ultra.](image)

While the material presented above is intended to provide useful information about the features of our enzyme products, in many cases we cannot fully represent the conditions specific to an actual production plant. Please contact your Novozymes representative for further guidance relevant to your own operational needs. Further information on the above-mentioned product is available from the Novozymes Customer Center.

**Performance**

Table 1 represents a compilation of tests carried out on various oils using Lecitase Ultra. As the results show, phosphorus content is reduced to a satisfactory level.

<table>
<thead>
<tr>
<th>Oil type</th>
<th>Average phosphorus content after degumming and before bleaching</th>
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<tbody>
<tr>
<td>Canola</td>
<td>9 ppm</td>
</tr>
<tr>
<td>Rapeseed</td>
<td>3 ppm</td>
</tr>
<tr>
<td>Soya</td>
<td>8 ppm</td>
</tr>
<tr>
<td>Sunflower</td>
<td>3 ppm</td>
</tr>
</tbody>
</table>

*Table 1.*

Figure 4 shows an example of the reduction of phosphorus content as a function of time and enzyme dosage.

![Fig. 4. Performance of Lecitase® Ultra in degumming of soyabean oil.](image)
Citric acid is used in a pretreatment step to facilitate hydration of the phospholipids and to buffer the aqueous phase. Citric acid is added as a solution of approximately 45% w/w. The temperature during the pretreatment/hydration step must be 65–70 ºC with a holding time of 30 minutes. Normally the dosage is 0.65 kg citric acid per metric ton of oil. The oil/water mixture is cooled to 50–55 ºC before the addition of NaOH and Lecitase Ultra. The amount of NaOH should correspond to 1.5 times the amount of citric acid measured on a molar basis. (0.65 kg citric acid corresponds to 0.2 kg NaOH (1.5 molar equivalents).)

NaOH is added as a solution of approximately 4% w/w. The purpose of adding NaOH is to obtain a pH of approximately 4.5 in the water/sludge phase.

The Lecitase Ultra dosage is 300–600 LU/kg oil, corresponding to 30–60 g (or 25–60 ml) enzyme per metric ton of oil. (Lecitase Ultra has an activity of 10,000 LU/g and a density of approximately 1.2 g/ml.) A higher dosage can be used to reduce the reaction time. These additions can be finetuned through laboratory trials.
The maximum temperature tolerance of the enzyme is 55 ºC. The temperature should therefore be maintained at 45–55 ºC for the duration of the enzymatic reaction. If required, the enzyme can be diluted with water to suit the dosage pump. However, the dilute solution should be kept for a maximum of 12 hours at a temperature below 30 ºC to keep the enzyme activity stable.

The total water content of the oil should be in the range 1–2% w/w, which can be achieved by adding the appropriate amount of water, e.g. after enzyme addition.

To obtain an efficient enzyme reaction it is crucial that an emulsion is formed. This can be achieved by applying an in-line high-shear mixer prior to the reaction tank phase. Due care should be taken that the temperature does not rise above 55 ºC during high-shear mixing. The standard reaction time is 1–2 hours. Mechanical stirring is maintained throughout the reaction, although the oil/water mixture may be subjected to one or more high-shear mixing treatments to keep the mixture properly emulsified. When the reaction is complete (after 1–2 hours), the oil/water mixture is heated to 70 ºC and then separated using centrifugation to give a sludge-free oil phase and an oil-free sludge phase.

A detailed description of how to carry out enzymatic degumming in laboratory or industrial trials can be found in the Enzymatic Degumming Manual. Further information, including the manual, is available from the Novozymes Customer Center.

Safety, handling, and storage

Safety, handling, and storage guidelines are provided with all products.