

**Catalog # 06-3150 Savinase® 16L**

Note: Sold in collaboration with Novozymes A/S for research purposes only.

Savinase® 16L catalyses the stereoselective hydrolysis of amino esters and selective esters, as well as strained amides, under alkaline conditions. Suitable for the hydrolysis of proteins, and internal peptide bonds. Used in transesterification and transpeptidation.

Declared activity 16 KNU-S/g. A serine endoprotease that hydrolyzes internal peptide bonds. Color can vary from batch to batch. Color intensity is not an indication of enzyme activity. Packaging must be kept intact, dry and away from sunlight. Please follow the recommendations and use the product before the best before date to avoid the need for a higher dosage.

**Other Endoproteases products offered by Strem:**

06-3112 Alcalase® 2.5 L  
06-3110 Alcalase® 2.4 L FG  
06-3137 Savinase® 12 T  
06-3115 Esperase® 8.0 L  
06-3160 Neutrase® 0.8 L  
96-0224 Novozymes Endoprotease Screening Kit (contains 6 endoprotease enzymes)

**Lipase products offered by Strem:**

06-3123 Novozym® 435  
06-3155 Lipozyme® TL IM  
06-3120 Novozym® 40086  
06-3105 Lipozyme® CALB L  
06-3118 Palatase® 20000 L  
06-3140 Lipozyme® TL 100 L  
06-3125 Resinase® HT  
06-3135 Novozym® 51032  
06-3100 Novocor® AD L  
96-0220 Novozymes Lipase Screening Kit (contains 9 lipase enzymes)

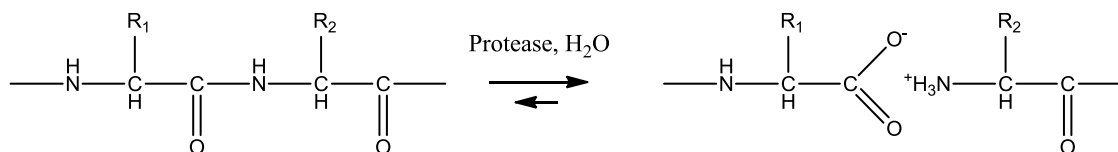
## Novozymes Protease Products

### Storage

Kits should be optimally stored at 0-10°C/32-50°F. If stored above 25°C/77°F the samples should be used within 3 months.

### Introduction

Proteases (EC 3.4.21.62) belong to the class of enzymes known as hydrolases, which catalyze hydrolysis of various bonds in presence of water. Proteases are also referred to as Peptidases or Proteinases. Proteases catalyze proteolysis of peptide bonds in polypeptides, proteins and selective hydrolysis of carboxylic esters and amino esters. There are different classes of Proteases, i.e. serine, threonine, cysteine, aspartate, glutamic acid and metallo – proteases.



**Figure 1.** Proteolysis of a peptide bond.

## Description and optimum usage conditions

| Strem Catalog Number | Product            | EC No.    | Specifity                                  | Format    | Optimal Conditions | Unit Activity | Application                                                                                                                                             |
|----------------------|--------------------|-----------|--------------------------------------------|-----------|--------------------|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| 06-3110              | Alcalase® 2.4 L FG | 3.4.21.62 | Serine endopeptidase (mainly subtilisin A) | Liquid    | 30-65°C, pH 7-9    | 2.4 AU-A/g    | Stereoselective hydrolysis of amino esters and selective esters; suitable for hydrolysis of proteins; used in transesterification and transpeptidation. |
| 06-3112              | Alcalase® 2.5 L    | 3.4.21.62 | Serine endopeptidase (mainly subtilisin A) | Liquid    | 30-65°C, pH 7-10   | 2.5 AU-A/g    | Stereoselective hydrolysis of amino esters and selective esters; suitable for hydrolysis of proteins; used in transesterification and transpeptidation. |
| 06-3137              | Savinase® 12 T     | 3.4.21.62 | Serine endopeptidase (mainly subtilisin A) | Granulate | 30-70°C, pH 8-10   | 12 KNPU-S/g   | Stereoselective hydrolysis of amino esters and selective esters; suitable for hydrolysis of proteins, hydrolysis of strained amides                     |
| 06-3150              | Savinase® 16 L     | 3.4.21.62 | Serine endopeptidase (mainly subtilisin A) | Granulate | 30-70°C, pH 8-10   | 16 KNPU-S/g   | Stereoselective hydrolysis of amino esters and selective esters; suitable for hydrolysis of proteins, hydrolysis of strained amides                     |
| 06-3115              | Esperase® 8.0 L    | 3.4.21.62 | Serine endopeptidase (mainly subtilisin A) | Liquid    | pH 8-12.5          | 8 KNPU-E/g    | Hydrolysis of internal peptide bonds; characterized by excellent performance at elevated temperature and pH.                                            |
| 06-3160              | Neutrase 0.8 L     | 3.4.22    | Metalloprotease                            | Liquid    | 40-50°C, pH 7      | 0.8 AU/g      | Kinetic resolution of amino esters                                                                                                                      |

\* K = Kilo, AU = Anson Unit, NPU = Novo Protease Unit, 1 AU = 1NPU, ASNU = Asparaginase Unit, USP = Trypsin activity unit using USP Crystallized Trypsin Reference Standard

The activity is determined relative to a protease A standard. The result is given in the same units as the standard.

1 ASNU is the amount of enzyme that produces 1 µmol Ammonia per minute under the standard reaction conditions.

## Screening Procedure

Listed below is recommended equipment for conducting the screens, however, pH-stat system gives more consistent results.

| Simple equipment                                                             | Advanced equipment                       |
|------------------------------------------------------------------------------|------------------------------------------|
| Reaction vessel (e.g., 25 mL round bottom or Erlenmeyer flask or test tubes) | Thermostat reaction vessel (e.g., 25 mL) |

|                                       |                                                                           |
|---------------------------------------|---------------------------------------------------------------------------|
| pH-meter or pH-paper (range 5 - 9)    | Autotitrator/pH-stat system (pH-meter, automatic burette/addition funnel) |
| Burette or calibrated addition funnel | Recording device (e.g., x/y-plotter)                                      |
| Propeller mixer or magnetic needle    | Propeller mixer                                                           |

### Buffer Preparation

| 0.1M Potassium Phosphate Buffer at 25°C                                    |                                                   |                                                   | 0.1M Sodium Phosphate Buffer at 25°C                                       |                                                    |                                                    |
|----------------------------------------------------------------------------|---------------------------------------------------|---------------------------------------------------|----------------------------------------------------------------------------|----------------------------------------------------|----------------------------------------------------|
| pH                                                                         | Volume of 1M K <sub>2</sub> HPO <sub>4</sub> (ml) | Volume of 1M KH <sub>2</sub> PO <sub>4</sub> (ml) | pH                                                                         | Volume of 1M Na <sub>2</sub> HPO <sub>4</sub> (ml) | Volume of 1M NaH <sub>2</sub> PO <sub>4</sub> (ml) |
| 5.8                                                                        | 8.5                                               | 91.5                                              | 5.8                                                                        | 7.9                                                | 92.1                                               |
| 6.0                                                                        | 13.2                                              | 86.8                                              | 6.0                                                                        | 12.0                                               | 88.0                                               |
| 6.2                                                                        | 19.2                                              | 80.8                                              | 6.2                                                                        | 17.8                                               | 82.2                                               |
| 6.4                                                                        | 27.8                                              | 72.2                                              | 6.4                                                                        | 25.5                                               | 74.5                                               |
| 6.6                                                                        | 38.1                                              | 61.9                                              | 6.6                                                                        | 35.2                                               | 64.8                                               |
| 6.8                                                                        | 49.7                                              | 50.3                                              | 6.8                                                                        | 46.3                                               | 53.7                                               |
| 7.0                                                                        | 61.5                                              | 38.5                                              | 7.0                                                                        | 57.7                                               | 42.3                                               |
| 7.2                                                                        | 71.7                                              | 28.3                                              | 7.2                                                                        | 68.4                                               | 31.6                                               |
| 7.4                                                                        | 80.2                                              | 19.8                                              | 7.4                                                                        | 77.4                                               | 22.6                                               |
| 7.6                                                                        | 86.6                                              | 13.4                                              | 7.6                                                                        | 84.5                                               | 15.5                                               |
| 7.8                                                                        | 90.8                                              | 9.2                                               | 7.8                                                                        | 89.6                                               | 10.4                                               |
| 8.0                                                                        | 94.0                                              | 6.0                                               | 8.0                                                                        | 93.2                                               | 6.8                                                |
| Dilute combined 1M stock solutions to 1 L with distilled H <sub>2</sub> O. |                                                   |                                                   | Dilute combined 1M stock solutions to 1 L with distilled H <sub>2</sub> O. |                                                    |                                                    |

### Analytical method principles

In-process reaction monitoring:

Depending on substrate and product, different methods can be used for in process reaction monitoring.

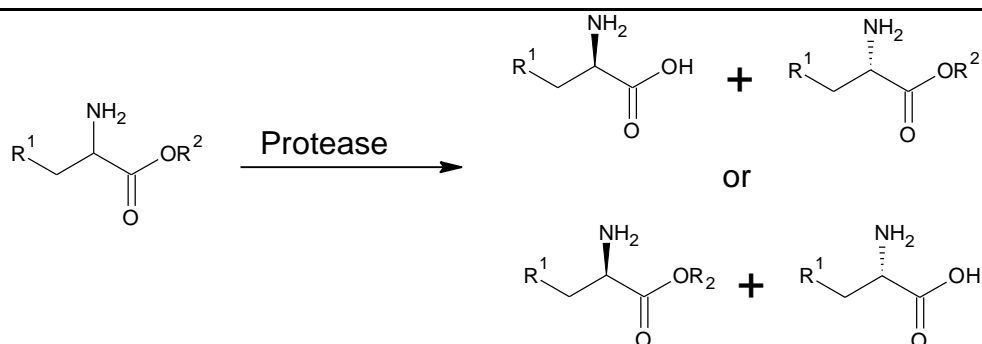
- Thin Layer Chromatography (TLC) is a simple method for monitoring reaction progress and completion.
- To quantitatively estimate product formation and consumption of reactant, HPLC or GC can be used for monitoring.
- Chiral HPLC is recommended to estimate chiral purity or consumption of isomers of racemic mixture.
- Final chiral purity can be obtained by analyzing product isolated by using an appropriate chiral column.

Key parameters for Enantiomeric excess (ee) and Enantioselectivity (E) can be calculated from the areas in chiral HPLC: % ee = ((R-S)/(R+S)) × 100 where R and S stand for the individual optical isomer in the mixture (and R + S = 1), where R = area for R isomer and S = area for S isomer.

$$E = \frac{\ln \left[ \frac{1 - e.e._s}{1 + e.e._s / e.e._p} \right]}{\ln \left[ \frac{1 + e.e._s}{1 + e.e._s / e.e._p} \right]}$$

## Kinetic Resolution

### Example 1. Kinetic Resolution by hydrolysis of Racemic Amino Ester/ Simple Racemic Ester <sup>1,2</sup>

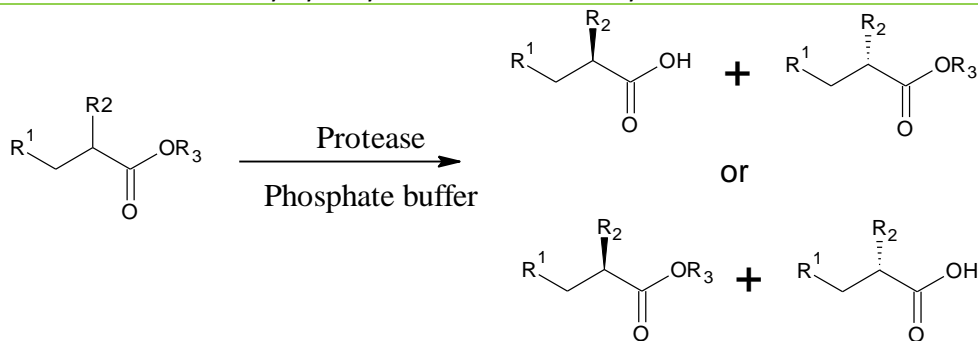


- Racemic amino ester / simple racemic ester (1-2 mmol) is solubilized in potassium phosphate buffer (0.1 M, 10 mL, pH 7.5) and reaction mixture is homogenized by stirring.
  - For liquid substrates, emulsion or suspension will be formed.
  - For solid substrates, solution is prepared by adding 10%v/v organic solvent\*
- Protease Enzyme (50% wt/wt for solid enzyme or 10-20% v/v wrt to buffer for liquid enzyme) is added to reaction mixture.
- Reaction mixture is maintained at pH 7.5 by adjusting with 1N NaOH.
- Typical reaction temperature is 25-30°C and reaction time is 24-48 hours, depending on substrate.
- The reaction product is recovered by extraction or filtration.

\* isopropanol (IPA), tert-butanol, tetrahydrofuran (THF) or acetonitrile.

Kinetic resolution of racemic amino ester can be converted into dynamic kinetic resolution leading to formation of catalytic quantities of aldehydes leading to formation of one of chiral amino acids in good yields.<sup>2</sup>

**Example 2.** Kinetic resolution by hydrolysis of racemic carboxylic ester



- Racemic ester (1-2 mmol) and potassium phosphate buffer (0.1 M, pH 7.0, 5 mL) is homogenized by stirring.
- Protease Enzyme (50% wt/wt with regards to substrate for solid enzyme or 10-20% v/v with regards to solvent mixture for liquid enzyme) is added under stirring.
- Reaction mixture is maintained at pH 7.0-9.0 by adjusting with 1N NaOH.
- Typical reaction temperature is 20-35°C and reaction time is 24-48 hours, depending on substrate.
- Reaction product is recovered by extraction or filtration.

## References

1. S.-T. Chen, W.-H. Huang, K.-T. Wang, *J. Org. Chem.* **1994**, *59*, 7580–7581.
2. D. A. Schichl, S. Enthaler, W. Holla, T. Riermeier, U. Kragl and M. Beller *Eur. J. Org. Chem.* **2008**, 3506–3512

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