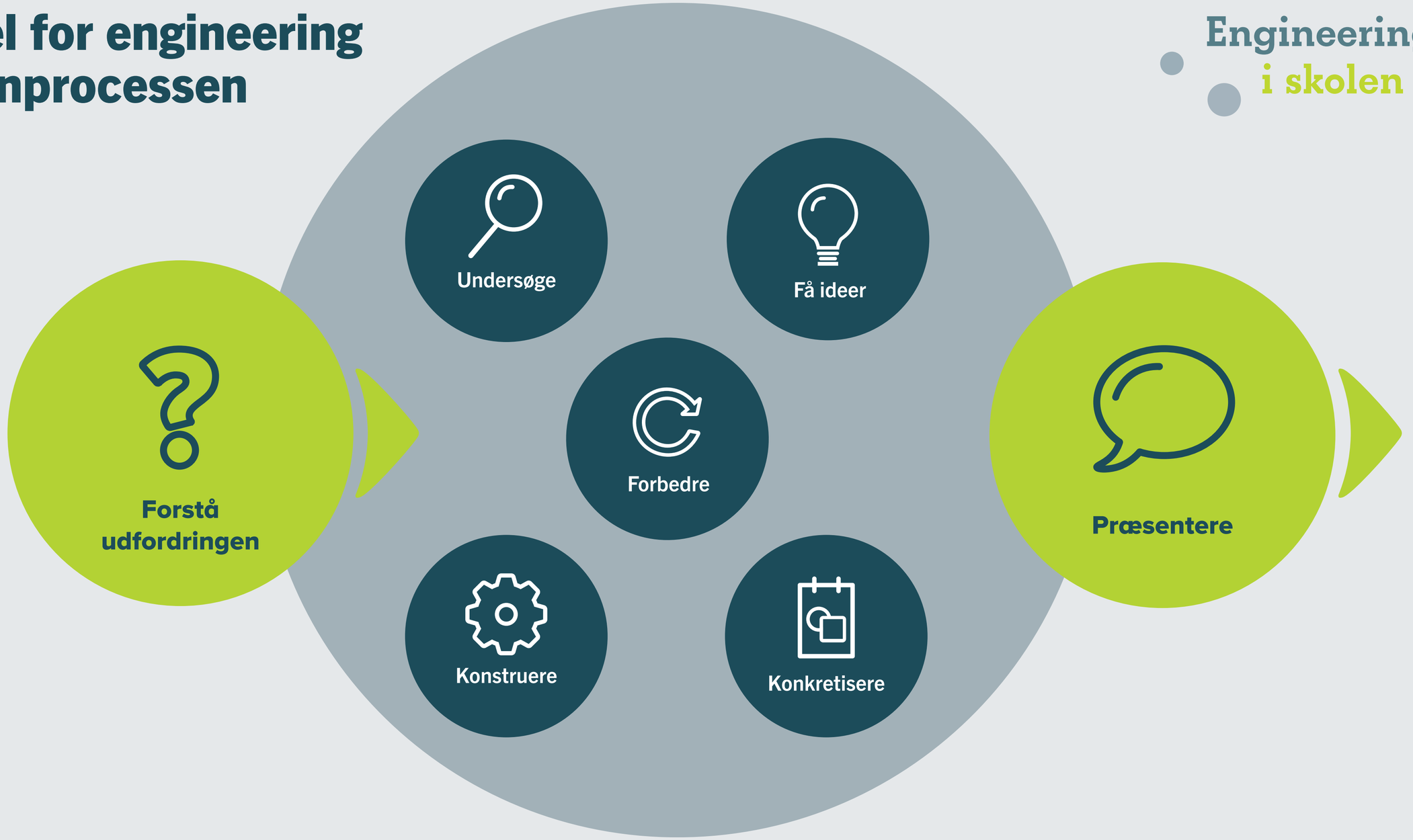
Metoder:

- Io-iodkalium til detektion af stivelse
- Fehling til detektion af nedbrudt stivelse
- Protein: visuelt m fx kød
- Protein: biuret test - https://www.youtube.com/watch?v=z4ohqBeLMho
- Fedt/Triglycerider: mål pH.

Husk: koncentration af substrat, enzym, temperatur

Model for engineering designprocessen

Engineering i skolen



Forstå udfordringen:
Læreren præsenterer udfordringen. Elevgrupper og lærer bliver enige om mål og rammer for det kommende arbejde. Grupperne beskriver udfordringen med egne ord.

Undersøge:
Elevgrupperne kortlægger relevant, viden de får brug for. De skaffer og tilegner sig viden.

Få idéer:
Elevgrupperne forhandler og vælger ideer, de vil gå videre med.

Konkretisere:
Elevgrupperne konkretiserer, skitserer og vælger materialer. De planlægger det videre arbejde og fordeler opgaver.

Konstruere:
Elevgrupperne virkeliggør deres ide til prototype med valgte materialer og redskaber.

Forbedre:
Elevgrupperne tester, evaluerer og forbedrer prototypen.

Præsentere:
Elevgrupperne præsenterer løsning, overvejelser om designprocessen og valg truffet undervej.

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BESTEMMELSE AF VASKEPULVERS ENZYMAKTIVITET

Materialer:
Enzymvaskepulver
20 ml fløde
Phenolrødt
1 % stivelsesopløsning
Jod i jodkalium
Ur
Objektglas på hvidt underlag
3 spatler
8 reagensglas
500 ml Erlenmeyer kolbe
Gryde
10 g fars
Sigte, maskevidde < 0.5 mm

Fremgangsmåde: Der laves en vaskepulveropløsning som anbefalet på pakken. Lav et vandbad på den temperatur, som anbefales på pakken.

A. Amylaseaktivitet, der opstilles følgende reaktionsblandinger:

	Glas 1	**Glas 2**	**Glas 3**
Vaskepulveropløsning, ml	10	10	0
Stivelse, ml	10	0	10
Dest. vand, ml	0	10	10

Vaskepulver tilsættes sidst. Der udtages prøve straks, derefter hvert minut, sålænge det skønnes rimeligt, senere med længere mellemrum.

Prøverne overføres med spatlen til en dråbe iod i iodkalium på et objektglas på hvid baggrund, blå farve viser tilstedeværelse af stivelse. Mål hvor lang tid der går inden stivelsen er nedbrudt.

B. Proteaseaktivitet, der opstilles to reaktionsblandinger:

	Glas 1	**Glas 2**
Vaskepulveropløsning, ml	10	0
Dest.vand, ml	0	0
Fars, g	5	5

Vej efter 2 timer hvor meget kød, der ikke kan passere sigten. Den forsvundne kødmængde er et mål for proteaseaktivitet.

C. Lipaseaktivitet, der opstilles to reaktionsblandinger:

	Glas 1	**Glas 2**
Vaskepulveropløsning, ml	10	10
Dest. vand, ml	0	10
Fløde, ml	10	10
Phenolrødt, dråber	10	10

Der tages tid på, hvor længe det varer, inden de ved fedtspaltningen frigivne syrer, har gjort

opløsningen sur (gul).

Dette er syvende artikel i en serie om vaskemidler anno 2005(-6). Serien startede i Dansk Kemi, 86, nr. 8, 9, 10 og 12 og 87, nr. 1 og 2 og afsluttes i næste nummer her på midtersiderne. Det overordnede formål er at gøre unge kolleger, elever og lærere opmærksomme på, at det er et interessant og udfordrende fagområde. Serien beskriver bl.a. vaskemiddelmarkedet, vaskemidler i dag, kemien i blegesystemer, tensider, øvrige ikke-enzymatiske ingredienser og udviklingen af enzymer til vaskemidler.

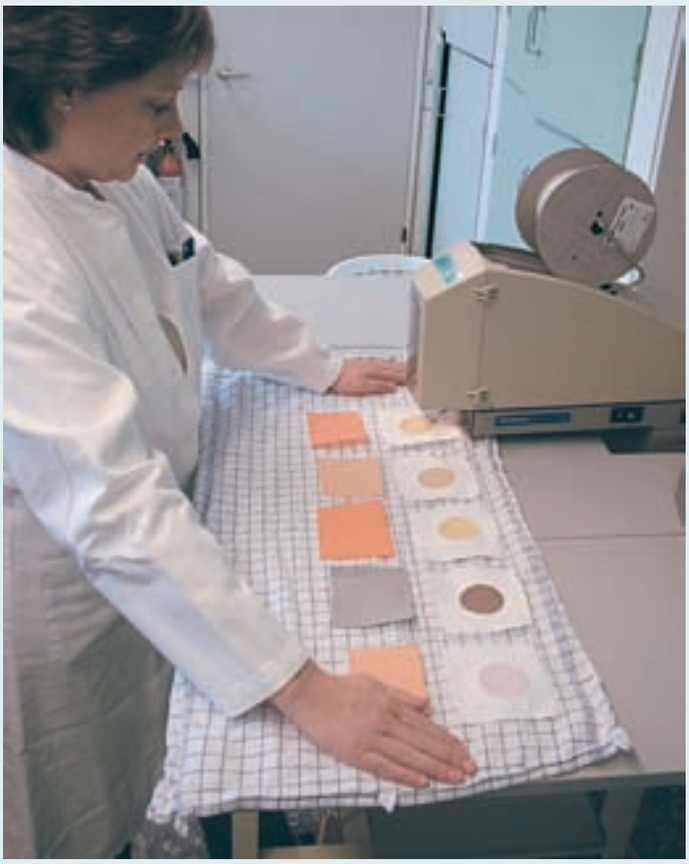
Enzymer til vaskemidler
– fra bugspytkirtler til gensplejsede mikroorganismer

I dag betragtes enzymer verden over som en selvfølgelig ingrediens i vaskemidler og maskinopvaskemidler. Baggrunden er et stykke enestående dansk industrihistorie
I. Tre klassiske enzymgrupper: proteaser, amylaser og lipaser

Af Thomas Callisen, Ture Damhus, Vibeke Skovgaard Nielsen, Peter Skagerlind, Detergent Applications, Novozymes A/S

Det hører med til almen dannelse i vaskemiddelkredse at vide, at »den tyske industrimagnat« Dr. Otto Röhm i 1913 udtog patent på anvendelse af fordøjelsesenzymer fra bugspytkirtler til fjernelse af besværligt smuds under tøjvask m.m. [1]. Röhms idé var sådan set oplagt – vores krop, eller f.eks. grisens, producerer enzymer, der nedbryder de i føden forekommende substanser. Disse enzymer må også kunne bruges til at nedbryde madrester osv. på snavset tøj (patentet nævner specifikt fedt og proteiner). Se boks 1 om enzymer generelt.

I de næste næsten 50 år gjordes forskellige forsøg på at formulere vaske- og iblødsætningsmidler med enzymer fra bugspytkirtler, men med ringe succes, fordi disse enzymer fra naturens side er tilpasset fysiologiske betingelser (navnlig lavt pH), som ligger langt fra betingelserne under vask med stærkt alkaliske vaskemidler. Ikke desto mindre kom firmaet Novo i gang med at producere enzymer, fordi man i forvejen havde fat i kirtlerne til insulinproduktion [2].



Figur 1. Chanette Schultz, Novozymes, i færd med at montere lapper med stivelsesbesmudsninger på et viskestykke før fuldskalavask. Jf. figur 2.

Gennembruddet kom imidlertid, da man begyndte at producere enzymerne ved gæring af mikroorganismer. Af to grunde: man fandt enzymer – først den bakterielle protease, der som Novo-produkt fik handelsnavnet Alcalase – som havde alkalisk pH-optimum (se boks 1), og så muliggjorde gæringerne en helt anderledes fordelagtig procesøkonomi end kirtelekstraktionerne.

Alcalase blev introduceret i forvaske- og iblødsætningsmidlet *Bio-tex* i 1963. Hurtigt bredte budskabet sig om den nye ingrediens, som muliggjorde fjernelse af pletter, der ellers var umulige at få has på. Markedet voksede hurtigt, da Alcalase også viste sig at fungere udmærket i fuldvask. Men lige omkring 1970 tog sagen en skelsættende drejning. Ved et uheld blev nogle engelske arbejdere på en vaskemiddelfabrik udsat for enzymstøv, som de indåndede. Ikke så godt – mikrobielle enzymer er fremmedproteiner og som sådanne potentielle inhalationsallergener (se næste artikel). En forbruger- og pressekampagne, der gik i gang i USA, slog på, at der kunne være en tilsvarende risiko for forbrugere af de enzymholdige vaskemidler. Markedet forsvandt hurtigere, end det var kommet, og 400 medarbejdere af de dengang ca. 2100 ansatte på Novo blev fyret. Senere bekendtgjorde en amerikansk undersøgelseskommission, at der ingen risiko var for forbrugerne ved enzymholdige vaskemidler, og i mellemtiden havde Novo også udviklet ikke-støvende produkter (*prills*, se næste artikel), som muliggjorde sikker håndtering i fabrikkerne. Markedet vendte tilbage, men langsomt. Dette industrihistorisk interessante forløb er beskrevet i [2]. Udviklingen har faktisk været positiv lige siden. Til Alcalase føjede sig flere proteaser, amylaser, cellulaser, lipaser og siden flere enzymtyper, som vi vil beskrive i denne og den efterfølgende artikel.

Det næste afgørende spring fremad var indførelsen af genteknologi til frembringelse af ydedygtige stammer af mikroorganismer, der bliver brugt til en produktion af enzymer, som er stedse mere miljørigtig og økonomisk fordelagtig pga. lavere forbrug af gæringssubstrater, energi, materialer til oprensning osv. Lipaseproduktet Lipolase fra Novo, der blev lanceret i det japanske vaskemiddel *Hi Top* i forbindelse med producenten Lions 100-års jubilæum i 1988, var det første industrielle enzym produceret i en gensplejset værtsorganisme.

Serien her handler om vaskemidler, og vi kan ikke komme meget ind på industrielle enzymer i øvrigt. Novo blev til Novo-Nordisk i 1989 [2], stadig en kombineret lægemiddel- og en- ▶

zymproducent, men så blev Novozymes skilt ud i 2000. Det er værd at bemærke, at med de tre store producenter Chr. Hansen, Danisco (herunder det USA-baserede datterselskab Genencor) og Novozymes er langt hovedparten af verdens produktion af industrielle enzymer faktisk på danske hænder i dag.

Der findes en række oversigtsværker, der enten beskriver industrielle enzymer i almindelighed [3-7] eller vaskemiddelenzymer i særdeleshed [8-10,13,15].

Proteaser

De fleste steder i verden regnes proteaser nu som en fast ingrediens i vaskemidler, da proteaser som nævnt på nogle plettyper øger vaskemidlets effekt i en grad, der ikke opnås af andre vaskemiddelingredienser.

Proteaser er *hydrolaser*, som katalyserer nedbrydningen af *proteiner*. Alle proteaser, som anvendes i vaskemidler i dag, er *serinproteaser* (se videre nedenfor) udviklet fra vildtyper produceret af *Bacillus*-arter. De virker i synergi med tensider, da proteasers delvise nedbrydning af proteinerne i en plet øger effekten af tensiderne, hvorved der ofte opnås en fuldstændig fjernelse af den proteinbaserede plet. Eksempler på pletter, som fjernes med proteaser i vaskemidler, er græs, spinat, mælk, mælkebaserede fødevarer som kakaomælk, æg, kødbaserede fødevarer og blod. Det sidste er særlig interessant, fordi blegemidler i vaskemidler tenderer til at vanskeliggøre fjernelsen af blodpletter. Proteaser kan i princippet modvirke dette, men det er en delikat sag at teste for, da hele scenariet under vasken (opløsningshastighed for vaskepulverets enkelte bestanddele m.v.) er afgørende for, hvem der »vinder«, og disse konkurrerende effekter gør det også til en udfordring at teste proteaser på blod i blegemiddelholdige vaskemidler.

Proteasers effekt under vask påvirkes af flere faktorer såsom vaskemidlets pH, vasketemperaturen og vandets indhold af både hårdhedsioner (se boks 3 i artikel 1) og chlorforbindelser (ved chlorering af ledningsvand). Desuden påvirkes proteaser i en vis udstrækning af de øvrige vaskemiddelkomponenter, herunder blegemidler og sammensætningen af tensidsystemet. Da der vaskes meget forskelligt rundt om i verden (både mht. vaskemiddelsammensætning og vaskebetingelser), og på grund af den store udbredelse af proteaser i vaskemidler, er der udviklet en række forskellige proteaseprodukter i løbet af de seneste 20 år. Ved brug af *protein engineering*, dvs. systematisk udskiftning vha. genteknologi af bestemte aminosyrer mhp. ændring af enzymets egenskaber, er der udviklet

- proteaser med høj effekt i flydende vaskemidler med lavt pH
- proteaser med høj effekt i vask ved lav temperatur
- proteaser, der er mere stabile i blegemiddelholdige pulvervaskemidler
- en protease med høj effekt i områder med meget lav vandhårdhed

En komplikation ved anvendelse af proteaser i flydende vaskemidler er, at proteaser, idet de selv er proteiner, kan nedbryde sig selv, når vaskemidlet står på hylden i supermarkedet eller der-

Boks 1: Crash-kursus i enzymologi

(Hav en god biokemi- eller proteinkemilærebog ved hånden.)

Enzymer er *katalytiske proteiner*. Alle organismer producerer enzymer, som de bruger til at hjælpe sig med forskellige livsprocesser. Den moderne produktion af industrielle enzymer er baseret på mikroorganismer, dvs. bakterier og svampe.

Enzymer har visse generelle karakteristika, som er vigtige for anvendelsen:

De er positivt ladede ved lavt pH og negativt ladede ved højt pH. Et sted derimellem har de et *isolektrisk punkt* [pI, eller pH(I) på IUPAC'sk], hvor de er elektrisk neutrale.

Aktive enzymmolekyler har en 3D-struktur bestemt af hydrogenbindinger og eventuelt tilstedeværende metalioner [f.eks. calcium(2+)] eller *prostetiske grupper* (lavmolekylære forbindelser indlejret i den foldede polypeptidkæde, eventuelt bundet kovalent til den; eksempel: hem, der kendes fra hemoglobin, optræder også i mange enzymer). Begreberne *primær, sekundær, tertiær* og *kvaternær struktur* er vigtige som i proteinkemi generelt. Binding og processering af substratmolekyler sker normalt på et ganske bestemt sted i enzymmolekylet, kaldet *active site* eller på dansk f.eks. det aktive eller katalytiske center.

Molmasser for de enzymer, vi omtaler her i serien, ligger normalt i intervallet fra ca. 25 til 60 kDa. Ved foreskreven dosering af vaskemidler i husholdningen er typiske niveauer af aktivt enzymprotein i vaskevæsken fra nogle få mg/L og nedefter, så der er tale om koncentrationer i nM-området.

Enzymers aktivitet som katalysatorer udviser normalt en pukkelformet kurve som funktion af temperaturen, dvs. der er en optimal temperatur. Ved høj temperatur denatureres de, dvs. polypeptidkæden udfoldes, og aktiviteten forsvinder. Ofte, men ikke altid, er denne proces irreversibel. Med en pædagogisk lidt uheldig fagjargon siger man, at enzymet »dør«.

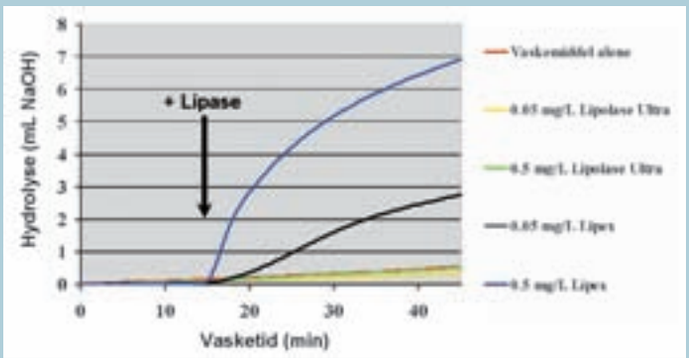
Som regel udviser aktiviteten også et pukkelformet forløb som funktion af pH, dvs. der er en bestemt pH-værdi (eller et pH-interval), hvori aktiviteten er maksimal.

Enzymers aktivitet kan hæmmes af både deres substrater, altså reaktanter i de reaktioner, de katalyserer, af deres produkter og af andre molekyler (hæmmere eller inhibitorer).

Enzymkinetik [20] er disciplinen, hvori enzymernes katalytiske evne studeres kvantitativt. Da nedbrydning af praksisrelevante substrater som proteiner og stivelse er særdeles komplicerede processer, anvendes ofte simplere, kunstige substrater i sådanne undersøgelser, indrettet så reaktionen kan følges ved absorptions- eller fluorescensmålinger. Eksempelvis ved proteasestudier 4-nitroanilider af små peptider, hvor proteasen fraspalter 4-nitroanilin. Sådanne bekvemme substrater anvendes også i *aktivitetsassays*, dvs. analytiske metoder til standardisering af enzympræparaters aktivitet.

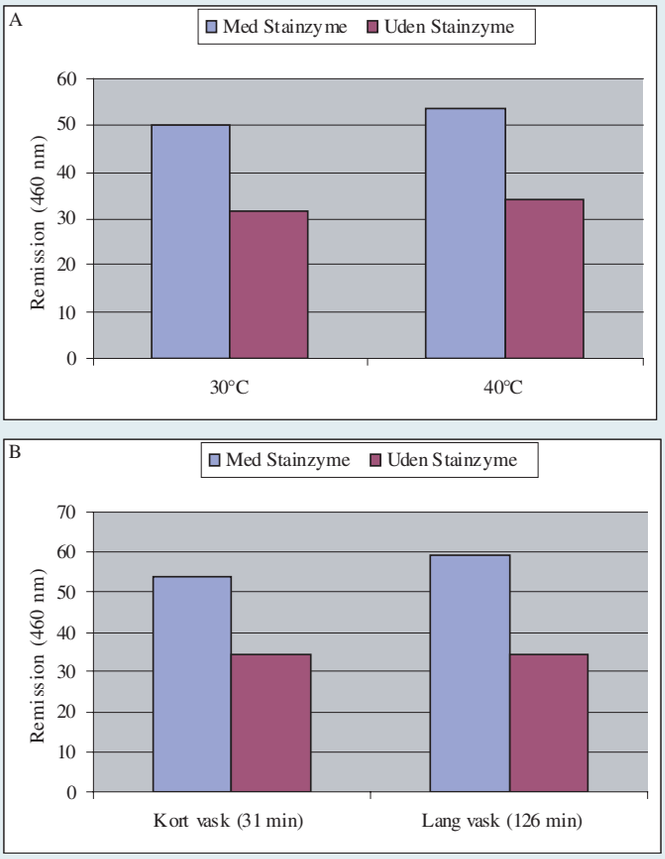
Reaktionshastigheden af hydrolyseprocesser, ved hvilke der dannes titrérbare syregrupper, kan måles i *real time* ved *pH-stat-titrering* (jf. figur 5), en teknik hvormed pH fastholdes og man måler tilsat mængde kompenserende base (OH^-) som funktion af tiden. Sådanne titreringer anvendes i aktivitetsassays af navnlig lipaser. I [8] eksemplificeres anvendelse af metoden til studier af proteasekatalyseret hemoglobinnedbrydning i vaskemiddelopløsninger.

Enzymer inddeles i 6 klasser (*oxidoreductaser, transferaser, hydrolaser, lyaser, isomeraser* og *ligaser*) med talrige underklasser identificeret ved EC-numre [21,22]. Enzymnomenklatur adskiller sig fra systematisk kemisk nomenklatur ved at basere sig primært på den katalyserede reaktion. Det er både godt og skidt. Ofte er underklasserne i EC-systemet overlappende, og hyppigt må der omklassificeres, når flere data er genereret for et givet enzym. I vore dage er identifikation vha. aminosyresekvenser og gener, røntgenkrystalstrukturer, NMR-baserede strukturer og computersimulerede strukturer derfor mindst ligeså vigtige for klassifikationen af enzymer. Disse informationer findes i store databaser, og den nye disciplin *bioinformatik* er vigtig for udnyttelsen af disse informationer.



Figur 5. Eksempel på pH-stat-titrering: substratet er fløde påført stoflapper, som titreres i en brugsopløsning af et flydende USA-vaskemiddel (pH justeret til 9) i nærvær af to lipaser i praksisrelevante doseringer. I begge doseringer skiller den nye lipase Lipex sig klart ud fra Lipolase Ultra, en tidligere vaskemiddellipase. Dette titreringsresultat korrelerer med, at Lipex udviser tydelig vaskeeffekt ved første vask. Jf. kommentar ved [15].

hjemme. Dette kaldes autoproteolyse. Desuden kan proteaser nedbryde de øvrige enzymtyper i vaskemidlet. For at forhindre dette tilsættes de flydende vaskemidler ofte reversible proteaseinhibitorer som borsyre eller derivater af boronsyre [11].



Figur 2. Vaskeeffekt af Stainzyme målt som ændring af gennemsnitlig remission *(ordet dannet af refleksion + emission) ved 460 nm af seks tekniske, ældede stivelsesbesmudninger. Dataene er genereret i fuldskalavaskeforsøg med de tekniske lapper monteret på viskestykker som vist i figur 1.*

Amylaser

Amylaser [af amylum (latin), stivelse] er stivelsesnedbrydende hydrolaser. Amylaser har været anvendt i vaskemidler siden 1973, og efterspørgslen er stadig stigende. En grund hertil er, at mange fødemiddelprodukter, f.eks. babymad, frugtpuréer, chili- og spaghettisaucer, ketchup og chokoladebudding, indeholder stivelse eller kemisk modificerede stivelsestyper, bl.a. for at opnå den rette konsistens.

Fjernelse af stivelse fra tekstiloverflader er ikke bare vigtig for at komme af med synlige pletter, men også fordi stivelse er tilbøjelig til at danne en usynlig film, som kan samle partikulært smuds (sod, lerpartikler osv.) op både under brug og under vask. Resultatet er, at ellers hvidt vasketøj bliver mere og mere gråt efter gentagne vaske. Dette kan altså modvirkes ved brug af amylaser [8,12]. En tilsvarende *anti-redepositionseffekt* er illustreret ved lipaser nedenfor.

Stivelse består generelt af to polymere komponenter: *amylose*, som er uforgrenet poly(glucose) med udelukkende α-1,4-bindinger mellem glucoseenhederne, og *amylopectin*, som ud over α-1,4-bindingerne også indeholder α-1,6-forgreningspunkter. De såkaldte α-amylaser spalter interne 1,4-bindinger i begge stivelseskomponenter og er derfor ideelt egnede til at øge opløseligheden af stivelsen og dermed lette fjernelsen under vask.

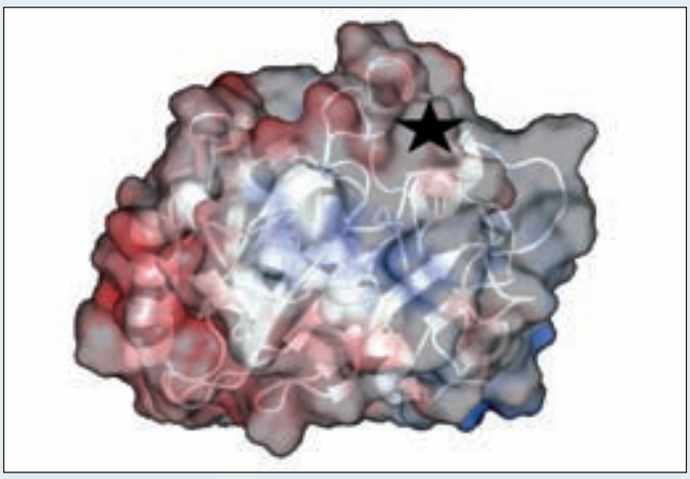
Vaskemiddelamylaser er i dag hovedsageligt bakterielle α-amylaser, som stammer fra *Bacillus*-arter. De har høj indbyrdes homologi (overensstemmelse i aminosyresekvensen) og typisk en tertiær struktur bestående af tre domæner kaldet A, B og C [13]. Det aktive center ligger ofte i en kløft mellem A og B og består af aminosyrer som asparaginsyre og glutaminsyre med sure sidekæder. Ligesom mange proteaser indeholder de fleste α-amylaser calciumioner, som er essentielle for at opretholde den tertiære struktur og dermed den katalytiske aktivitet, når enzymet stresses, eksempelvis ved påvirkning fra blegesystemer i vaskemidler. Læseren vil kunne forstå, at der her er lagt op til en delikat balancegang i forbindelse med vaskemidlernes buildersystemer (se artikel 4 i serien), som naturligvis vil være tilbøjelige til også at frarøve sådanne enzymer deres calciumioner. Amylasernes blegemiddelfølsomhed kan (ligesom proteasernes) spores til en methionin placeret nær det aktive center og er specifikt blevet adresseret ved udskiftning af denne ved protein engineering [13].

I 2004 introduceredes en ny amylase, Stainzyme, som udviser en betydeligt stærkere vaskeeffekt i de fleste markedssegmenter end tidligere kommercielle amylaser. Dette enzym har bredere pH- og temperaturprofiler end forgængerne, hvilket bl.a. betyder, at det leverer stort set samme effekt ved 30°C som ved 40°C, se figur 2A. Ydermere kan vasketiden reduceres, uden at man mister effekt (figur 2B).

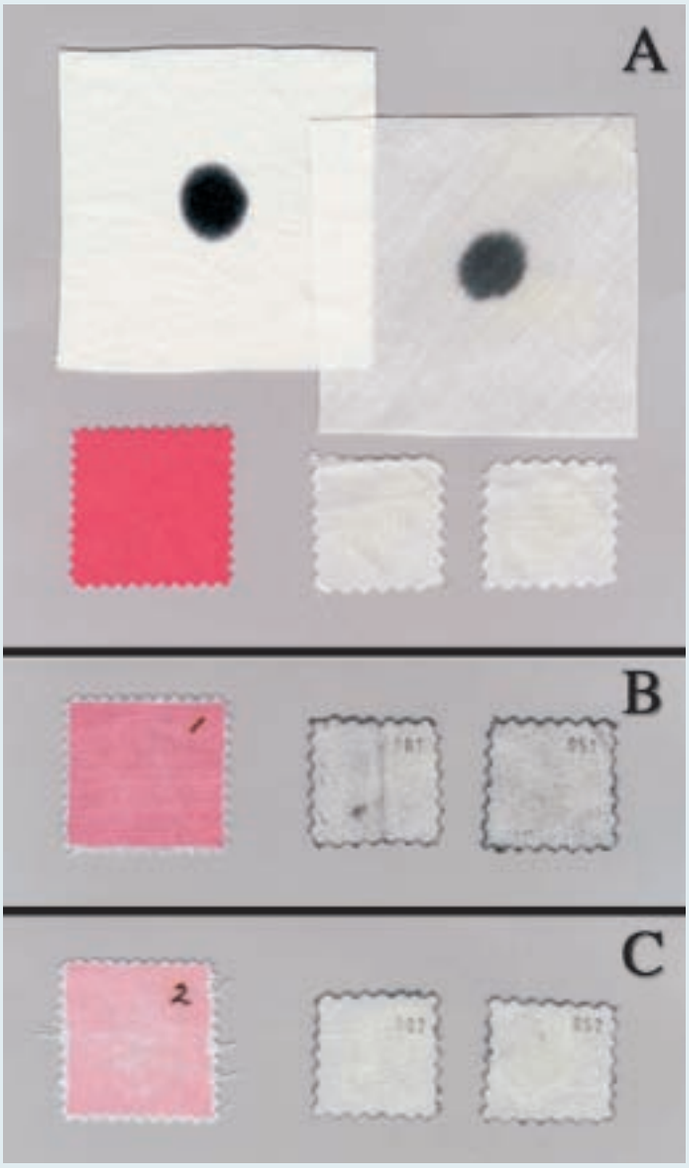
Lipaser

De lipaser, som p.t. anvendes i vaskemidler, er *glyceridlipaser*, der katalyserer den hydrolytiske spaltning af tungtopløselige tri-*O*-acylglyceroler (triglycerider) som animalsk fedt og vegetabilske olier til de mere vand/tensid-opløselige slutprodukter: glycerol og frie fedtsyrer [14,15]. Flere af de nyere vaskemiddellipaser har afsæt i Lipolase, omtalt i indledningen, som er en vildtype fra svampen *Thermomyces lanuginosus*, og er beslægtede med en anden familie af hydrolaser, nemlig serinproteaserne. Disse to typer hydrolaser har begge samme type aktivcenter bestående af en *triade* af aminosyrer (serin, asparaginsyre og histidin), der er centrale for den katalytiske funktion. Adgangen til aktivcentret hos lipaserne går gennem en hydrofob kløft, der i vandigt miljø er beskyttet af et »låg«-segment, som ændrer konformation, når lipasens omgivelser bliver mindre hydrofile. Se figur 3: strukturen af den senest markedsførte vaskemiddellipase, Lipex.

Mange enzymer, som anvendes i vaskeprocesser, har det til ▶



Figur 3. Molekylstrukturen for den 31 kDa store glyceridlipase kaldet Lipex, dannet ud fra røntgenkrystallografiske data for den nært beslægtede Lipolase ved at udskifte de aminosyrer, som adskiller de to enzymer, og siden at minimere strukturens fri energi vha. computermodellering. Spiralerne angiver helixsegmenter, *mens båndene med pile repræsenterer* β-sheets. *De tynde streger i strukturen henviser til segmenter, der ikke har en længerekkende sekundær ordning (også benævnt* random coil*). Flere detaljer om lipasens struktur og fundamentale egenskaber kan findes i [16]. Strukturen er indlejret i en sky som i sin farvekode angiver lipasens overfladepotential ved pH 7 i en afstand af 1.4 Å fra overfladen, hvor skalaen går fra negativ ladning (rød) over neutral (grå) til positiv ladning (blå). Stjernen angiver den hydrofobe kløft, der fører ind til det aktive center. Åbningen er variabel som følge af det bevægelige låg over kløften. Figuren er venligst lavet af Esben P. Friis, Novozymes.*



Figur 4. Smudsfjernelses- og anti-redepositionseffekter ved brug af en lipase i et modelvaskeforsøg.
(A) viser et udvalg af de testlapper, som indgår i forsøget, før vasken: lapper homogent besmudsede med læbestift baseret på vegetabilske fedtstoffer, smudsballast-lapper påført svinefedt med 100 nm store carbon black*-partikler samt rene lapper til sporing af redeposition.*
I (B) ses en læbestiftlap og to af de oprindeligt hvide sporingslapper efter vask med et europæisk vaskepulver.
(C) viser tilsvarende lapper fra en tilsvarende vask, blot er der nu tilsat 0.2 mg Lipex/L til vaskemiddelopløsningen.
Lipasens effekt ses både som øget smudsfjernelse og reduceret redeposition.

fælles, at de bl.a. virker på overflader, hvilket skal forstås i bredeste betydning: på rene og besmudsede flader på tøjemnerne i vasken og på overflader af emulgerede eller suspenderede partikler, jf. artikel 5 om tensider. For at opnå den optimale funktion af enzymerne skal bl.a. deres affinitet til, og diffusion på, disse overflader afstemmes, således at enzymerne opholder sig der, hvor de gør mest gavn (jf. [16,17]). Denne optimering af egenskaber for enzymerne er særdeles udfordrende; man benytter sig ofte af en kombination af *protein engineering, high-throughput screening, anvendelsesforsøg* i realistisk skala samt *mekanistiske studier*, jf. [18] om bioteknologisk produktion af enzymer. I relation til lipaser går optimeringen dels på at maksimere fjernelsen af fedt- og olieholdige pletter, dels på at reducere lipasernes restaktivitet på acylglyceroler, der kan omdannes til flygtige og ildelugtende fedtsyrer (typisk fra mælkeprodukter).

Lipaser kan, som andre enzymer, ud over at fjerne synligt smuds, have anti-redepositionsvirkning. Figur 4 (som er en udvidelse af figur 4 i artikel 5), illustrerer, hvilke forskelle lipasen kan give anledning til i vaskeforsøg, hvor niveauet af fedt, fedtopløselige farvestoffer og partikulært materiale er højt. I figur 4(B) ses, at *carbon black*-partikler overføres til de hvide sporingslapper; endvidere bemærkes en gråfarvning af læbestiftlappen. Tensidsystemet er i dette forsøg stresset af den høje mængde smuds, hvorved suspensionen af *carbon black*/svinefedt ikke er effektiv. Hydrofobe smudspartikler vil i almindelighed under sådanne betingelser være tilbøjelige til at deponere på hydrofobe overflader som polyesterstof eller skjortekraver med rester af hudfedt eller, som i dette eksperiment, delvis renvaskede »aftryk« af læbestift. Når lipasen medtages i vaskeforsøget, reduceres redepositionen i tilgift til, at læbestiftlappen vaskes renere, se figur 4(C). (Disse lipaseeffekter er yderligere blevet dokumenteret med mikroskopi og pH-stat-forsøg [19]).

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Enzyme information

Termamyl®

Description:

Termamyl® is a liquid enzyme containing outstanding heat-stable alpha amylase, expressed and produced by a genetically modified laboratory strain of *Bacillus licheniformis*. It is an enzyme that hydrolyses 1,4 alpha glucosidic linkages in amylose and amylopectin. Starch is rapidly broken down to soluble dextrins and oligosaccharide,

Specification:

Termamyl® is a clear brown liquid

Activity:

One Kilo alpha-amlase Unit is the amount of enzyme which breaks down 5.26g starch per hour. Novozymes standard method for determination of alpha-amylase is based on the following standard conditions:

Substrate soluble starch
Reaction time 7-20 minutes
Temperature 37°C
pH 5.6

The presence of Ca ions and pHs of 5.5 - 6.5 can have a stabilizing effect on the enzyme even at temperatures close to or a little above 100°C.

Applications:

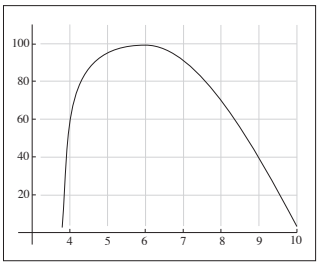
Teramyl® is used in the following industries:

Starch industry - the enzyme is used for continuous liquefaction of starch in steam jet cookers or similar equipment operating at temperatures up to 110°C and thereby taking advantage of the extreme heat stability of this enzyme.

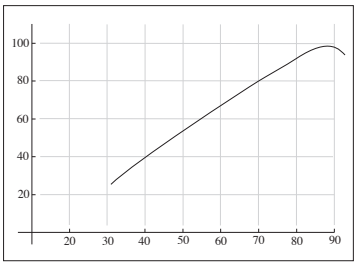
Alcohol industry - the enzyme is used for thinning of starch in distilling mashes. The heat stable of the enzyme is important advantage in the thinning of mashes .

Brewing industry - Termamyl® is used for adjunct liquidification (unmalted grains such as corn, rice, rye, oats, barley, and wheat used in brewing beer which supplement the main mash ingredient - malted barley). Due to the heat stability of the enzyme, the cooking programme can be simplified, it also means more of the adjunct can be used.

Sugar industry - Termamyl® is used to break down starch present in cane sugar. The starch content in the raw sugar is reduced which improves refinery filtering.



The influence of pH on the activity of Terrmamyl®



The influence of temperature on the activity of Termamyl®

Safety:

The product is non-flammable. In the case of spillage or accidental contact with skin or eyes, rinse by flushing with water. Any spillage of the enzyme should be wiped up immediately with a paper towel and disposed of in a waste bin. Do not allow spillages of the enzyme or diluted enzyme to dry to a powder.

Enzyme Information sheet is based on information provide by Nonozymes

Enzyme information

AMG

Description:

AMG - Amyloglucosidase is a liquid enzyme obtained from a selected strain of the fungus *Aspergillus niger*. The enzyme hydrolyses (breaks down) both the 1,4 and the 1,6 alpha linkages in starch. During hydrolysis, glucose units are removed in a step wise manner from the end of the substrate molecule. The rate of hydrolysis depends on the type of linkages and the chain length. The 1,4 alpha linkages are more readily broken than the 1,6 alpha linkages

Specification:

The liquid enzyme is a clear brown preparation.

Activity:

One Novozymes Amyloglucosidase unit is defined as the amount of enzyme which hydrolysis 1 micromole maltose per minute under the following standard condition:

Substrate	maltose
Temperature	25°C
pH	4.3 acetate buffer
Reaction time	30 minutes

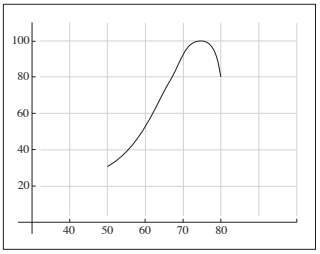
The activity can be destroyed by heating the liquid to 80°C for about 5 minutes or 75°C for about 40 minutes

Applications:

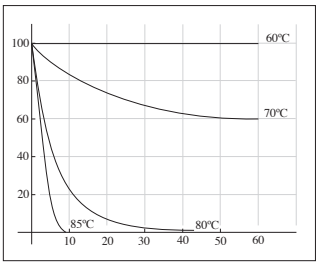
The enzyme is widely used in the following industries

AMG helps industrial bakers to overcome the challenge of crust seperation and moisture loss in pre and part-baked goods. The enzyme enhances crust colour by generating glucose to enable the maillard reaction responsible for crust formation. Major benefits are reduced baking time, achieves desired crust colour and crispness and has limited impact on dough properties, even at high dosages.

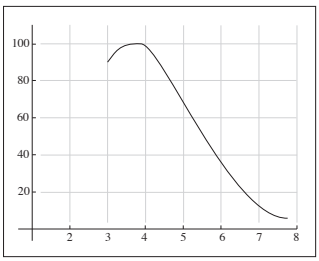
AMG is also used in the production of alcohol and spirits. It is used to degade starch and dextrins efficiently and quickly into fermentable sugars.



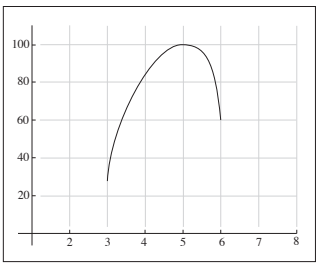
The effect of temperature on activity of AMG



The effect of temperature on stability of AMG



The effect of pH on activity



The effect of pH on stability

Safety:

The product is non-flammable. In the case of spillage or accidental contact with skin or eyes, rinse by flushing with water. Any spillage of the enzyme should be wiped up immediately with a paper towel and disposed of in a waste bin. Do not allow spillages of the enzyme or diluted enzyme to dry to a powder.

Enzyme Information sheet is based on information provide by Nonozymes

Enzyme information

Celluclast®

Description:

Celluclast® is a liquid enzyme preparation made from a selected strain of fungus called *Trichoderma resei*. The enzyme breaks down cellulose to glucose, cellobiose and larger polymers of glucose. The relative amounts of the products formed depends on the reaction conditions. Celluclast® has a pronounced viscosoity-reducing (thinning) effect on soluble cellulosic substrates.

Specification:

Celluclast® is a brown liquid.

Activity:

Novozymes define activity as NCU (Novo Cellulose Unit) which is the amount of enzyme which under standard conditions, degrades CMC to reducing carbohydrates with a reducing power corresponding to 1μmol glucose per minute.

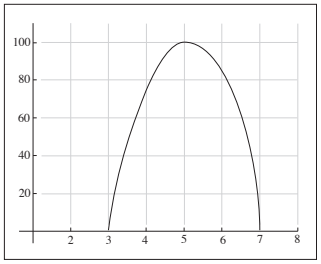
Standard conditions used to determine the activity of the enzyme.

Substrate CMC	Temperature 40°C
pH 4.8	Reaction time 20 minutes

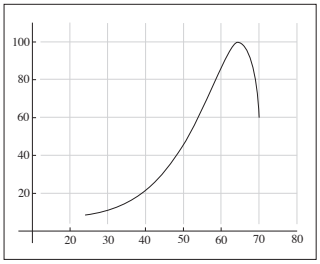
Applications:

The enzyme can be used when the aim is to breakdown cellulosic material for production of fermentable sugars or the reduction of viscosity. The main products of cellulose hydrolysis with the enzyme are cellobiose and glucose. Cellobiose is not a fermentable sugar. To ensure maximum production of fermentable sugars Celluclast® is often used in combination with another enzyme. The ratio of the Celluclast® with another enzyme will depends on the reaction conditions, such as pH, temperature and substrate concentration.

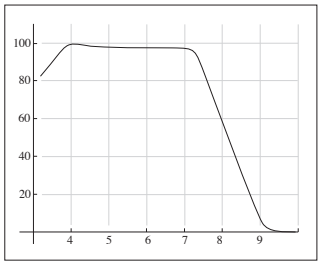
Since substrates can vary greatly trails will need to be done to find out the optimum dose rate of the celluclast and complimentary enzyme. Where the reduction of viscosity is needed to increase the yield of plant products Celluclast® is recommended. Because of the enzymes action on beta-glucans and other non-starch polysaccharides it is often used to reduce viscosity in industries that process a range of grains such as wheat, barley and sorghum.



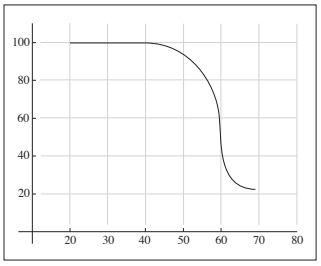
Influence of pH on the activity of Celluclast®



Influence of temperature on the activity of Celluclast®



Influence of pH on the stability of Celluclast®



Influence of temperature on the stability of Celluclast®

Safety:

The product is non-flammable. In the case of spillage or accidental contact with skin or eyes, rinse by flushing with water. Any spillage of the enzyme should be wiped up immediately with a paper towel and disposed of in a waste bin. Do not allow spillages of the enzyme or diluted enzyme to dry to a powder.

Enzyme Information sheet is based on information provide by Nonozymes

Enzyme information

Pectinex® Ultra

Description:

Pectinex® Ultra is a liquid enzyme preparation produced by a selected fungal strain of *Aspergillus aculeatus*. The enzyme preparation contains a collection of pectolytic and hemicellulolytic enzymes. The preparation has the ability to disintegrates plant cell walls.

Specification:

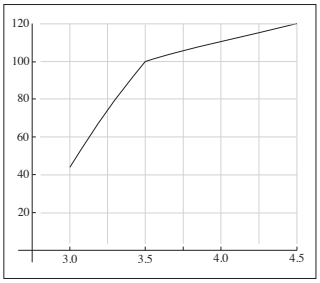
The Pectinex® Ultra preparation is a brownish liquid with a pH of approximately 4.5. The preparation is sterile filtered and bottled under aseptic conditions to ensure that the enzyme preparation that is supplied to commercial customers is virtually free of any microorganisms. Pectinex® Ultra complies with world wide specifications for food-grade enzymes.

Activity:

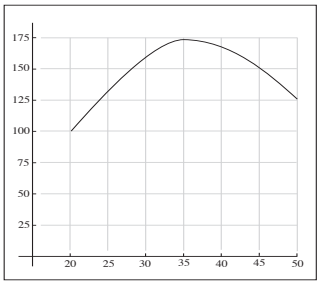
Pectinex® has a standard activity of 26,000 PG/ml (pH 3.5) The standard activity is determined by the measurement of the viscosity reduction of a solution of pectic acid at pH 3.5 and a temperature of 20°C

Applications:

The preparation is especially designed for the treatment of fruit and vegetable mashes and the maceration of plant material. The use of the enzyme preparation on fruit and vegetables mashes leads to increased capacities in the separation of solids and liquids and higher yields of juice.



Influence of pH on pectinase activity



Influence of temperature on pectinase activity

Safety:

The product is non-flammable. In the case of spillage or accidental contact with skin or eyes, rinse by flushing with water. Any spillage of the enzyme should be wiped up immediately with a paper towel and disposed of in a waste bin. Do not allow spillages of the enzyme or diluted enzyme to dry to a powder.

Enzyme Information sheet is based on information provide by Nonozymes

Enzyme information

Viscozyme®

Description:

Viscozyme® is a multienzyme product containing a wide range of carbohydrases, including: arabanase, celluclase B- glucanase, hemicellulase and xylanase. The enzyme mixture is produced from a selected strain of the *Aspergillus group*.

Specification:

The preparation is a clear brown liquid with an activity of 100FBG/g. The optimum conditions for the activity of this enzyme complex is pH 3.3 - 3.5 and a temperature of 40°C - 50°C.

Storage:

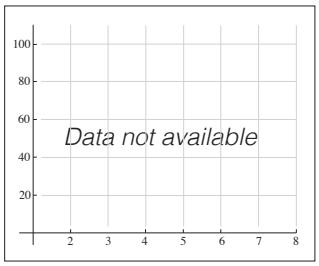
When Viscozyme® is stored at 25°C the activity of the product is maintained for at least three months. When stored at 5°C, the product will maintain its activity for at least one year.

Applications:

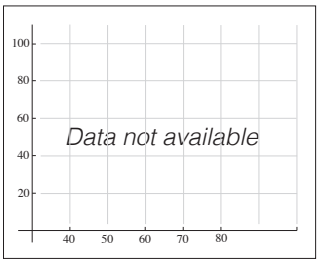
Viscozyme® is a special enzyme used in the breakdown of cell walls for the extraction of useful components from plant tissues and in the processing of cereals and vegetable materials.

The ability of the enzyme preparation to function at low temperatures means there is a reduction in the energy required to obtain products and also a reduction in the degradation of the desired products.

The multi-enzyme nature of Viscozyme® is important in the processing of plant material in the alcohol, brewing, starch and related industries. The ability of the preparation to degrade non starch polysaccarides can be used to improve starch availability in fermentations and to generally reduce viscosity and hence improve yields.



Influence of pH on the activity of Viscozyme®



Influence of temperature on the activity of Viscozyme®

Safety:

The product is non-flammable. In the case of spillage or accidental contact with skin or eyes, rinse by flushing with water. Any spillage of the enzyme should be wiped up immediately with a paper towel and disposed of in a waste bin. Do not allow spillages of the enzyme or diluted enzyme to dry to a powder.

Enzyme Information sheet is based on information provide by Nonozymes

Enzyme information

Dextranase

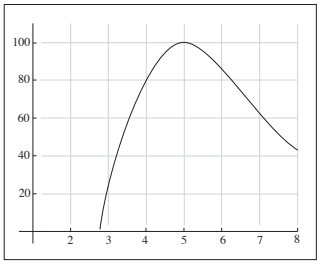
Description: Dextranase is a fungal dextranase produced from a submerged fermentation of a selected strain of *Chaetomium erratium*. The enzyme hydrolyses the 1-6 alpha glucosidic linkages in dextran. The break down products are mainly isomaltose and isomaltotriose.

Specification: Dextranase is an amber coloured liquid.

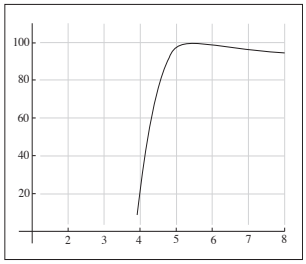
Activity: Enzyme activity is measured in KDU. One Kilo Novo Dextranase Unit (1KDU) is the amount of enzyme which breaks down dextran to give 1g maltose per hour using the following standard conditions:

Substrate	Dextran 500
Reaction time	20mins
Temperature	40°C
pH	5.4

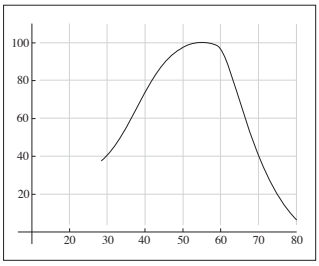
Applications: The enzyme is used in the sugar industry to beak down dextran in raw sugar juices or syrups. Dextran forming bacteria can be a problem during harvesting of sugar cane and beet. The dextran producing bacteria interferes with clarification and sucrose crystallization, reducing factory capacity and yield. The use of the enzyme improves yields The sugar industry often prefer operating conditions of pH 5 - 6 and a temperature between 50 - 60°C



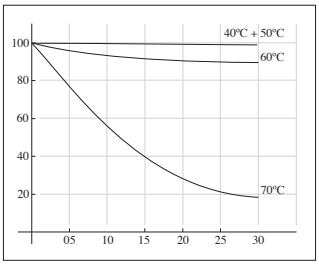
Influence of pH on the activity of Dextranase



Influence of pH on the stability of Dextranase



Influence of temperature on the activity of Dextranase



Influence of temperature on the stability of Dextranase

Safety: The product is non-flammable. In the case of spillage or accidental contact with skin or eyes, rinse by flushing with water. Any spillage of the enzyme should be wiped up immediately with a paper towel and disposed of in a waste bin. Do not allow spillages of the enzyme or diluted enzyme to dry to a powder.

Enzyme Information sheet is based on information provide by Nonozymes

Enzyme information

Neutrase®

Description:

Neutrase® is an endoprotease which can be used in many applications where proteins have to be broken down to polypeptides or peptides. The enzyme is a bacterial protease produced from a selected strain of *Bacillus amyloliquefaciens*. Neutrase® contains only the neutral protease from *Bacillus amyloliquefaciens* where as other commercial preparations contain alkaline protease

Specification:

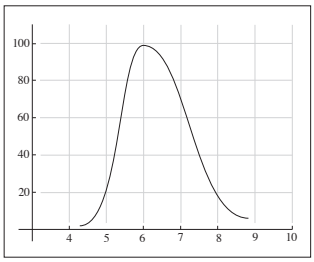
Neutrase® is a clear brown liquid. The product complies with numerous recommended specifications for use in the food industry.

Activity:

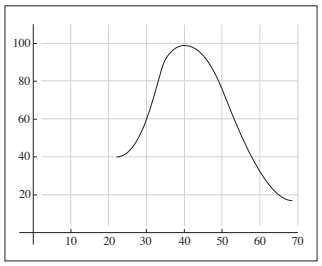
Neutrase® activity as standardized in Anson units (AU). The analytical method is based on denatured haemoglobin in a 0.02M Ca^{2+} buffer. When stored at 5°C the product will maintain the declared activity for at least 1 year if stored at 25°C it will maintain the declared activity for at least 3 months. The enzyme can be inactivated by heat treatment e.g. 2 minutes at 85°C.

Applications:

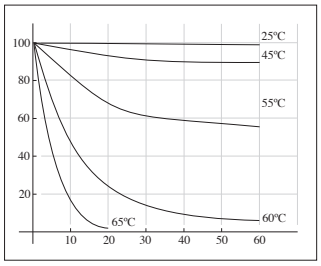
Neutrase® is used to breakdown a wide range of proteins of vegetable and animal origin.



The influence of pH on the activity of Neutrase® at 45°C



The influence of temperature on the activity of Neutrase® at pH 6.



The stability at pH 6.0 of Neutrase® at various temperatures

Safety:

The product is non-flammable. In the case of spillage or accidental contact with skin or eyes, rinse by flushing with water. Any spillage of the enzyme should be wiped up immediately with a paper towel and disposed of in a waste bin. Do not allow spillages of the enzyme or diluted enzyme to dry to a powder.

Enzyme Information sheet is based on information provide by Nonozymes

Enzyme information

Termamyl®

Description:

Termamyl® is a liquid enzyme containing outstanding heat-stable alpha amylase, expressed and produced by a genetically modified laboratory strain of *Bacillus licheniformis*. It is an enzyme that hydrolyses 1,4 alpha glucosidic linkages in amylose and amylopectin. Starch is rapidly broken down to soluble dextrins and oligosaccharide,

Specification:

Termamyl® is a clear brown liquid

Activity:

One Kilo alpha-amlase Unit is the amount of enzyme which breaks down 5.26g starch per hour. Novozymes standard method for determination of alpha-amylase is based on the following standard conditions:

Substrate soluble starch
Reaction time 7-20 minutes
Temperature 37°C
pH 5.6

The presence of Ca ions and pHs of 5.5 - 6.5 can have a stabilizing effect on the enzyme even at temperatures close to or a little above 100°C.

Applications:

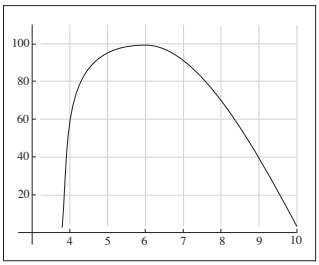
Teramyl® is used in the following industries:

Starch industry - the enzyme is used for continuous liquefaction of starch in steam jet cookers or similar equipment operating at temperatures up to 110°C and thereby taking advantage of the extreme heat stability of this enzyme.

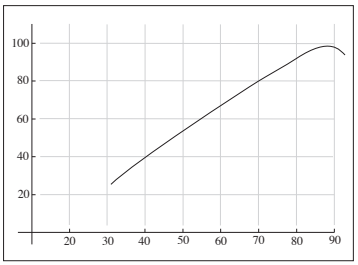
Alcohol industry - the enzyme is used for thinning of starch in distilling mashes. The heat stable of the enzyme is important advantage in the thinning of mashes .

Brewing industry - Termamyl® is used for adjunct liquidification (unmalted grains such as corn, rice, rye, oats, barley, and wheat used in brewing beer which supplement the main mash ingredient - malted barley). Due to the heat stability of the enzyme, the cooking programme can be simplified, it also means more of the adjunct can be used.

Sugar industry - Termamyl® is used to break down starch present in cane sugar. The starch content in the raw sugar is reduced which improves refinery filtering.



The influence of pH on the activity of Terrmamyl®



The influence of temperature on the activity of Termamyl®

Safety:

The product is non-flammable. In the case of spillage or accidental contact with skin or eyes, rinse by flushing with water. Any spillage of the enzyme should be wiped up immediately with a paper towel and disposed of in a waste bin. Do not allow spillages of the enzyme or diluted enzyme to dry to a powder.

Enzyme Information sheet is based on information provide by Nonozymes

Enzyme information

AMG

Description:

AMG - Amyloglucosidase is a liquid enzyme obtained from a selected strain of the fungus *Aspergillus niger*. The enzyme hydrolyses (breaks down) both the 1,4 and the 1,6 alpha linkages in starch. During hydrolysis, glucose units are removed in a step wise manner from the end of the substrate molecule. The rate of hydrolysis depends on the type of linkages and the chain length. The 1,4 alpha linkages are more readily broken than the 1,6 alpha linkages

Specification:

The liquid enzyme is a clear brown preparation.

Activity:

One Novozymes Amyloglucosidase unit is defined as the amount of enzyme which hydrolysis 1 micromole maltose per minute under the following standard condition:

Substrate	maltose
Temperature	25°C
pH	4.3 acetate buffer
Reaction time	30 minutes

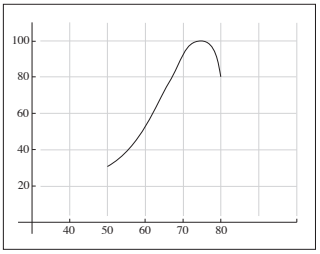
The activity can be destroyed by heating the liquid to 80°C for about 5 minutes or 75°C for about 40 minutes

Applications:

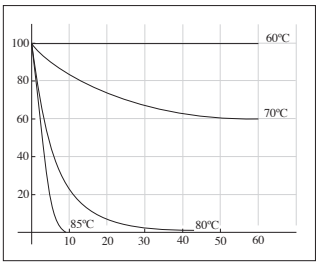
The enzyme is widely used in the following industries

AMG helps industrial bakers to overcome the challenge of crust seperation and moisture loss in pre and part-baked goods. The enzyme enhances crust colour by generating glucose to enable the maillard reaction responsible for crust formation. Major benefits are reduced baking time, achieves desired crust colour and crispness and has limited impact on dough properties, even at high dosages.

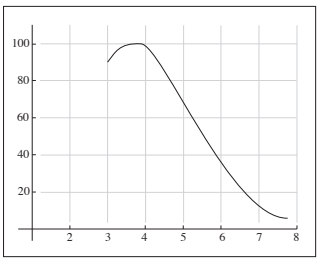
AMG is also used in the production of alcohol and spirits. It is used to degade starch and dextrins efficiently and quickly into fermentable sugars.



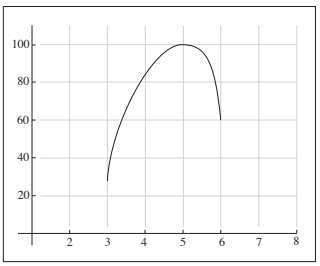
The effect of temperature on activity of AMG



The effect of temperature on stability of AMG



The effect of pH on activity



The effect of pH on stability

Safety:

The product is non-flammable. In the case of spillage or accidental contact with skin or eyes, rinse by flushing with water. Any spillage of the enzyme should be wiped up immediately with a paper towel and disposed of in a waste bin. Do not allow spillages of the enzyme or diluted enzyme to dry to a powder.

Enzyme Information sheet is based on information provide by Nonozymes

Enzyme information

Celluclast®

Description:

Celluclast® is a liquid enzyme preparation made from a selected strain of fungus called *Trichoderma resei*. The enzyme breaks down cellulose to glucose, cellobiose and larger polymers of glucose. The relative amounts of the products formed depends on the reaction conditions. Celluclast® has a pronounced viscosoity-reducing (thinning) effect on soluble cellulosic substrates.

Specification:

Celluclast® is a brown liquid.

Activity:

Novozymes define activity as NCU (Novo Cellulose Unit) which is the amount of enzyme which under standard conditions, degrades CMC to reducing carbohydrates with a reducing power corresponding to 1μmol glucose per minute.

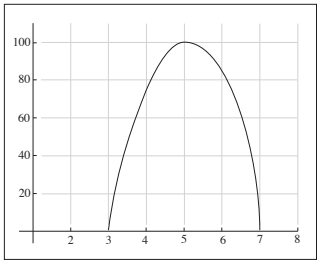
Standard conditions used to determine the activity of the enzyme.

Substrate CMC	Temperature 40°C
pH 4.8	Reaction time 20 minutes

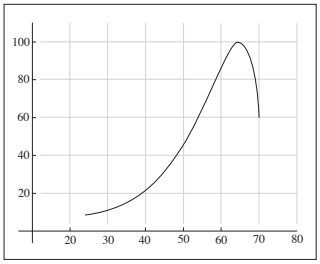
Applications:

The enzyme can be used when the aim is to breakdown cellulosic material for production of fermentable sugars or the reduction of viscosity. The main products of cellulose hydrolysis with the enzyme are cellobiose and glucose. Cellobiose is not a fermentable sugar. To ensure maximum production of fermentable sugars Celluclast® is often used in combination with another enzyme. The ratio of the Celluclast® with another enzyme will depends on the reaction conditions, such as pH, temperature and substrate concentration.

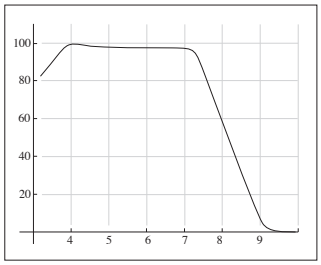
Since substrates can vary greatly trails will need to be done to find out the optimum dose rate of the celluclast and complimentary enzyme. Where the reduction of viscosity is needed to increase the yield of plant products Celluclast® is recommended. Because of the enzymes action on beta-glucans and other non-starch polysaccharides it is often used to reduce viscosity in industries that process a range of grains such as wheat, barley and sorghum.



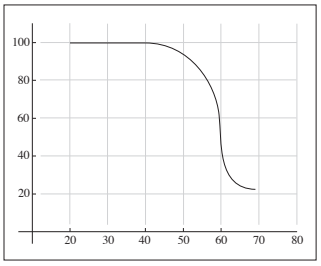
Influence of pH on the activity of Celluclast®



Influence of temperature on the activity of Celluclast®



Influence of pH on the stability of Celluclast®



Influence of temperature on the stability of Celluclast®

Safety:

The product is non-flammable. In the case of spillage or accidental contact with skin or eyes, rinse by flushing with water. Any spillage of the enzyme should be wiped up immediately with a paper towel and disposed of in a waste bin. Do not allow spillages of the enzyme or diluted enzyme to dry to a powder.

Enzyme Information sheet is based on information provide by Nonozymes

Enzyme information

Pectinex® Ultra

Description:

Pectinex® Ultra is a liquid enzyme preparation produced by a selected fungal strain of *Aspergillus aculeatus*. The enzyme preparation contains a collection of pectolytic and hemicellulolytic enzymes. The preparation has the ability to disintegrates plant cell walls.

Specification:

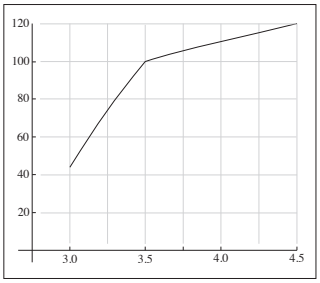
The Pectinex® Ultra preparation is a brownish liquid with a pH of approximately 4.5. The preparation is sterile filtered and bottled under aseptic conditions to ensure that the enzyme preparation that is supplied to commercial customers is virtually free of any microorganisms. Pectinex® Ultra complies with world wide specifications for food-grade enzymes.

Activity:

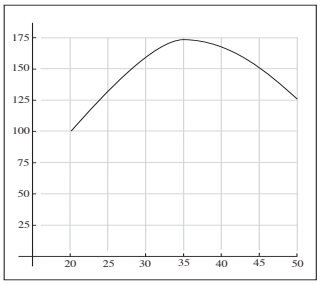
Pectinex® has a standard activity of 26,000 PG/ml (pH 3.5) The standard activity is determined by the measurement of the viscosity reduction of a solution of pectic acid at pH 3.5 and a temperature of 20°C

Applications:

The preparation is especially designed for the treatment of fruit and vegetable mashes and the maceration of plant material. The use of the enzyme preparation on fruit and vegetables mashes leads to increased capacities in the separation of solids and liquids and higher yields of juice.



Influence of pH on pectinase activity



Influence of temperature on pectinase activity

Safety:

The product is non-flammable. In the case of spillage or accidental contact with skin or eyes, rinse by flushing with water. Any spillage of the enzyme should be wiped up immediately with a paper towel and disposed of in a waste bin. Do not allow spillages of the enzyme or diluted enzyme to dry to a powder.

Enzyme Information sheet is based on information provide by Nonozymes

Enzyme information

Viscozyme®

Description:

Viscozyme® is a multienzyme product containing a wide range of carbohydrases, including: arabanase, celluclase B- glucanase, hemicellulase and xylanase. The enzyme mixture is produced from a selected strain of the *Aspergillus group*.

Specification:

The preparation is a clear brown liquid with an activity of 100FBG/g. The optimum conditions for the activity of this enzyme complex is pH 3.3 - 3.5 and a temperature of 40°C - 50°C.

Storage:

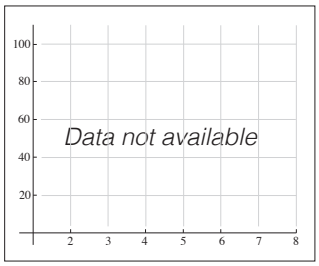
When Viscozyme® is stored at 25°C the activity of the product is maintained for at least three months. When stored at 5°C, the product will maintain its activity for at least one year.

Applications:

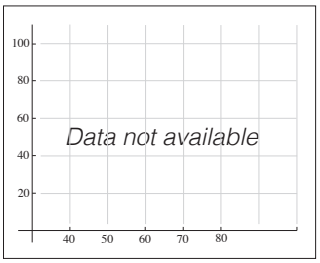
Viscozyme® is a special enzyme used in the breakdown of cell walls for the extraction of useful components from plant tissues and in the processing of cereals and vegetable materials.

The ability of the enzyme preparation to function at low temperatures means there is a reduction in the energy required to obtain products and also a reduction in the degradation of the desired products.

The multi-enzyme nature of Viscozyme® is important in the processing of plant material in the alcohol, brewing, starch and related industries. The ability of the preparation to degrade non starch polysaccarides can be used to improve starch availability in fermentations and to generally reduce viscosity and hence improve yields.



Influence of pH on the activity of Viscozyme®



Influence of temperature on the activity of Viscozyme®

Safety:

The product is non-flammable. In the case of spillage or accidental contact with skin or eyes, rinse by flushing with water. Any spillage of the enzyme should be wiped up immediately with a paper towel and disposed of in a waste bin. Do not allow spillages of the enzyme or diluted enzyme to dry to a powder.

Enzyme Information sheet is based on information provide by Nonozymes

Enzyme information

Dextranase

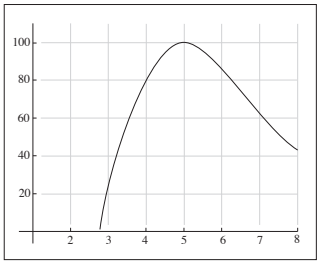
Description: Dextranase is a fungal dextranase produced from a submerged fermentation of a selected strain of *Chaetomium erratium*. The enzyme hydrolyses the 1-6 alpha glucosidic linkages in dextran. The break down products are mainly isomaltose and isomaltotriose.

Specification: Dextranase is an amber coloured liquid.

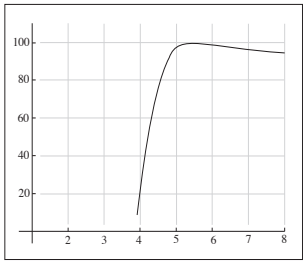
Activity: Enzyme activity is measured in KDU. One Kilo Novo Dextranase Unit (1KDU) is the amount of enzyme which breaks down dextran to give 1g maltose per hour using the following standard conditions:

Substrate	Dextran 500
Reaction time	20mins
Temperature	40°C
pH	5.4

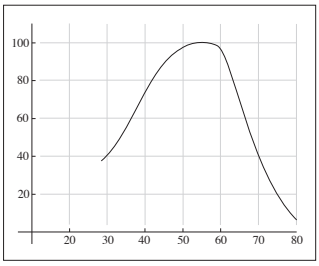
Applications: The enzyme is used in the sugar industry to beak down dextran in raw sugar juices or syrups. Dextran forming bacteria can be a problem during harvesting of sugar cane and beet. The dextran producing bacteria interferes with clarification and sucrose crystallization, reducing factory capacity and yield. The use of the enzyme improves yields The sugar industry often prefer operating conditions of pH 5 - 6 and a temperature between 50 - 60°C



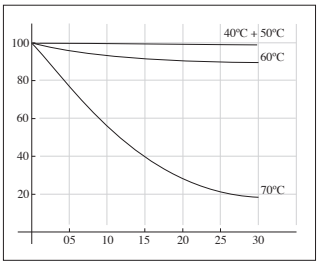
Influence of pH on the activity of Dextranase



Influence of pH on the stability of Dextranase



Influence of temperature on the activity of Dextranase



Influence of temperature on the stability of Dextranase

Safety: The product is non-flammable. In the case of spillage or accidental contact with skin or eyes, rinse by flushing with water. Any spillage of the enzyme should be wiped up immediately with a paper towel and disposed of in a waste bin. Do not allow spillages of the enzyme or diluted enzyme to dry to a powder.

Enzyme Information sheet is based on information provide by Nonozymes

Enzyme information

Neutrase®

Description:

Neutrase® is an endoprotease which can be used in many applications where proteins have to be broken down to polypeptides or peptides. The enzyme is a bacterial protease produced from a selected strain of *Bacillus amyloliquefaciens*. Neutrase® contains only the neutral protease from *Bacillus amyloliquefaciens* where as other commercial preparations contain alkaline protease

Specification:

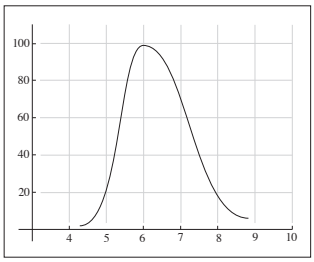
Neutrase® is a clear brown liquid. The product complies with numerous recommended specifications for use in the food industry.

Activity:

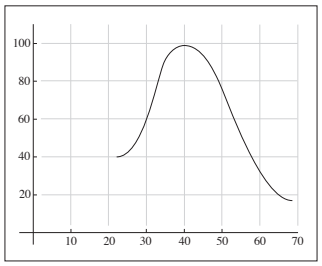
Neutrase® activity as standardized in Anson units (AU). The analytical method is based on denatured haemoglobin in a 0.02M Ca^{2+} buffer. When stored at 5°C the product will maintain the declared activity for at least 1 year if stored at 25°C it will maintain the declared activity for at least 3 months. The enzyme can be inactivated by heat treatment e.g. 2 minutes at 85°C.

Applications:

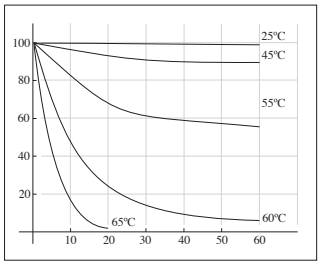
Neutrase® is used to breakdown a wide range of proteins of vegetable and animal origin.



The influence of pH on the activity of Neutrase® at 45°C



The influence of temperature on the activity of Neutrase® at pH 6.



The stability at pH 6.0 of Neutrase® at various temperatures

Safety:

The product is non-flammable. In the case of spillage or accidental contact with skin or eyes, rinse by flushing with water. Any spillage of the enzyme should be wiped up immediately with a paper towel and disposed of in a waste bin. Do not allow spillages of the enzyme or diluted enzyme to dry to a powder.

Enzyme Information sheet is based on information provide by Nonozymes

Novozymes A/S · Krogshoejvej 36 · 2880
novozymes®
Fungamyl®
800 L
May cause allergy or asthma symptoms or breathing difficulties if inhaled. Causes serious eye irritation. Harmful to aquatic life with long lasting effects. Avoid breathing dust/fume/gas/mist/vapours/spray. In case of inadequate ventilation wear respiratory protection. IF INHALED: If breathing is difficult, remove victim to fresh air and keep at rest in a position comfortable for breathing. If experiencing respiratory symptoms: Call a POISON CENTER/doctor. Wear protective gloves/protective clothing/eye protection/face protection. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
Batch: A
Exp. dat
Sample of no commercial value - for trials only.
novozymes®
Termamyl Ultra
300 L
May cause allergy or asthma symptoms or breathing difficulties if inhaled. Causes serious eye irritation. Harmful to aquatic life with long lasting effects. Avoid breathing dust/fume/gas/mist/vapours/spray. In case of inadequate ventilation wear respiratory protection. IF INHALED: If breathing is difficult, remove victim to fresh air and keep at rest in a position comfortable for breathing. If experiencing respiratory symptoms: Call a POISON CENTER/doctor. Wear protective gloves/protective clothing/eye protection/face protection. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
Danger
In case of spillage: Rinse with water - avoid prolonged contact with skin.
Confidential and proprietary.

Novozymes A/S · Krogshoejvej 36 · 28

novozymes®

Lipex®

100 L

May cause allergy or asthma symptoms or breathing difficulties if inhaled. Causes serious eye irritation. Harmful to aquatic life with long lasting effects. Avoid breathing dust/fume/gas/mist/vapours/spray. In case of inadequate ventilation wear respiratory protection. IF INHALED: If breathing is difficult, remove victim to fresh air and keep at rest in a position comfortable for breathing. If experiencing respiratory symptoms: Call a POISON CENTER/doctor. Wear protective gloves/protective clothing/eye protection/face protection. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Batch:

Sample of no commercial value - for trials only.

In case of spillage: Rinse with water - avoid prolonged contact with skin. Confidential and proprietary.

novozymes®

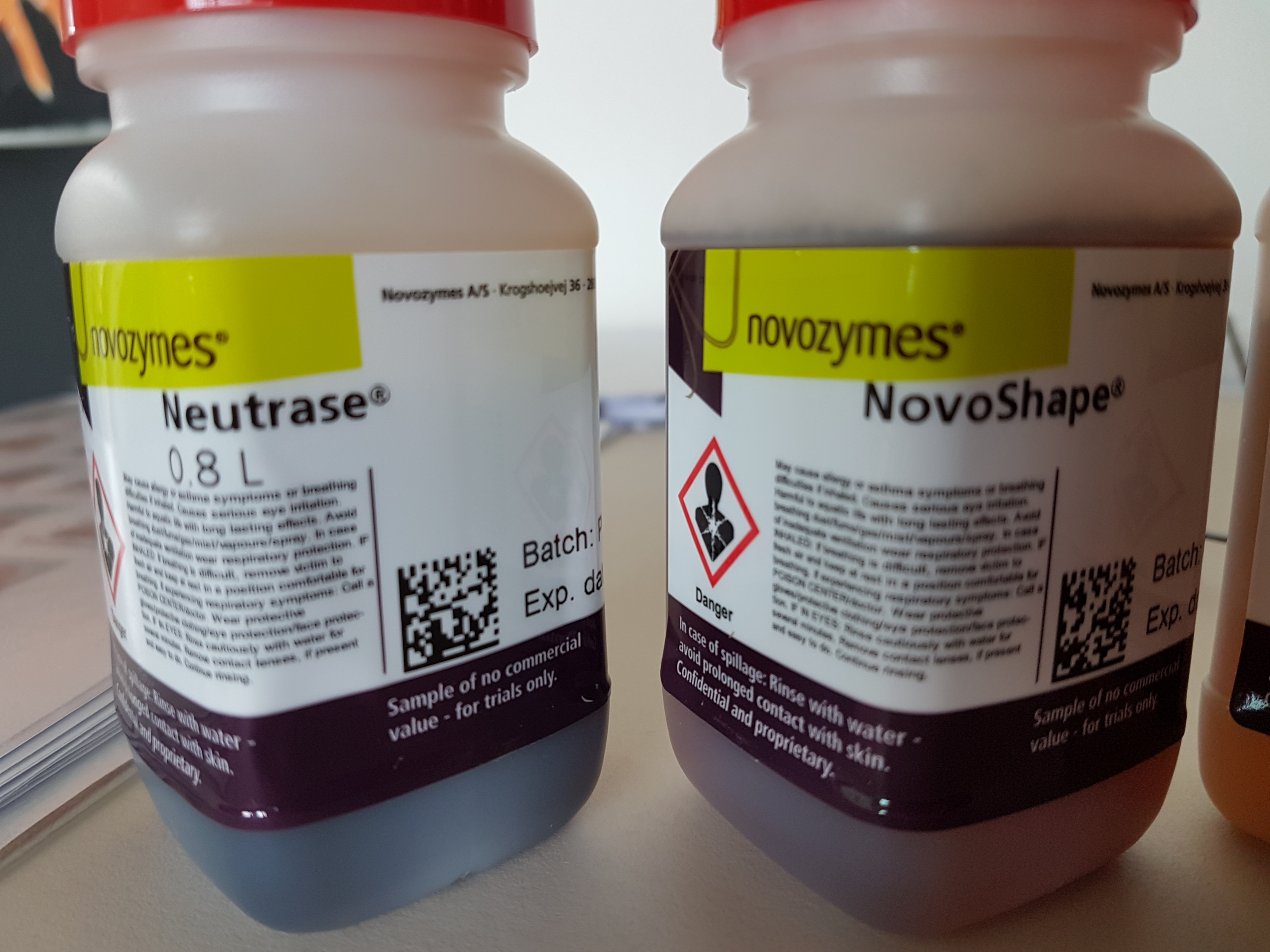
Stainzyme®

12 L

May cause allergy or asthma symptoms or breathing difficulties if inhaled. Causes serious eye irritation. Harmful to aquatic life with long lasting effects. Avoid breathing dust/fume/gas/mist/vapours/spray. In case of inadequate ventilation wear respiratory protection. IF INHALED: If breathing is difficult, remove victim to fresh air and keep at rest in a position comfortable for breathing. If experiencing respiratory symptoms: Call a POISON CENTER/doctor. Wear protective gloves/protective clothing/eye protection/face protection. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Danger

In case of spillage: Rinse with water - avoid prolonged contact with skin. Confidential and proprietary.


novozymes®
Neutrase®
0,8 L
Batch:
Exp. da
Sample of no commercial value - for trials only.
novozymes®
NovoShape®
Danger
In case of spillage: Rinse with water - avoid prolonged contact with skin.
Confidential and proprietary.
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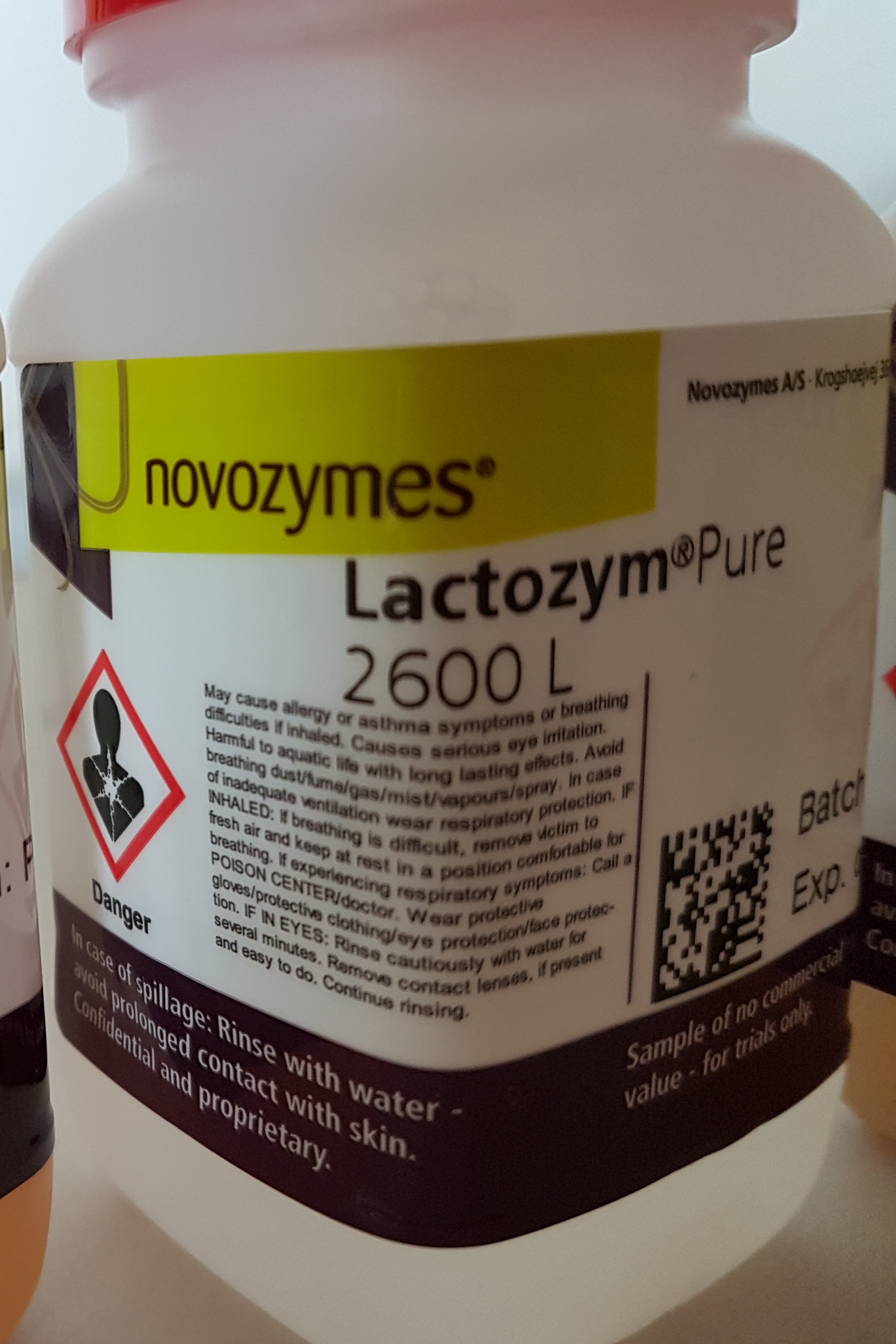
Exp. d
Sample of no commercial value - for trials only.

Novozymes A/S · Krogshoejvej 36
novozymes®
Savinase®
16 L
Batch:
Sample of no commercial value - for trials only.


Novozymes A/S · Krogshoejvej
novozymes®
Lactozym®Pure
2600 L
May cause allergy or asthma symptoms or breathing difficulties if inhaled. Causes serious eye irritation. Harmful to aquatic life with long lasting effects. Avoid breathing dust/fume/gas/mist/vapours/spray. In case of inadequate ventilation wear respiratory protection. IF INHALED: If breathing is difficult, remove victim to fresh air and keep at rest in a position comfortable for breathing. If experiencing respiratory symptoms: Call a POISON CENTER/doctor. Wear protective gloves/protective clothing/eye protection/face protection. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
Danger
Batch
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