Diacetyl control

Diacetyl and 2,3-pentanedione, also known as vicinal diketones (VDKs), are flavor components generated at the beginning of fermentation. If they exceed the specific threshold, VDKs will give beer an undesired off-flavor. Diacetyl, known for its butterscotch or buttery flavor, is the main contributor to these off-flavors.

The reduction in VDKs, carried out by yeast during storage, goes hand-in-hand with other maturation processes and is considered an essential criterion for evaluating the degree of maturation of beer.

Novozymes Maturex® prevents the formation of diacetyl and 2,3-pentanedione by converting precursors directly into the flavor-free end-products of acetoin and 2,3-pentanediol, reducing maturation time by 2–14 days.

Benefits

- Beer free of Diacetyl off-flavors
- Warm maturation (diacetyl rest) shortened or even unnecessary
- Optimized utilization of vessels
- Increased beer volume; reduced fermentation time leads to an increase in throughput
- Beer maintains high quality index
- Right the first time; no need for re-works
- Reduced energy consumption

Performance

Maturex® is a unique enzyme specially designed for the brewing industry. It makes it possible to re-think the fermentation profiles of pilsner-type beers, or any beer types in which diacetyl is not desired. Maturex® can be used to ensure maximum throughput year-round or during special periods with tight capacity, such as peak seasons.

As diacetyl formation is directly linked to adjunct ratio and yeast type, as well as yeast conditions during fermentation, such as stress due to low FAN, Maturex® can prevent occasional peaks in diacetyl. Maturex® is also used in the production of special beers made using special yeast strains, cool fermentation or stopped fermentation.

Diacetyl formation during fermentation

Diacetyl is one of the two vicinal diketones (VDKs), diacetyl (2,3-butanedione) and 2,3-pentanedione. During fermentation, their pre-cursors—α-acetolactate and α-acetohydroxy-butyrate—are excreted from the yeast cell and converted to diacetyl and 2,3-pentanedione, respectively, via extracellular spontaneous oxidative decarboxylation. Late in the fermentation process and during maturation, diacetyl and 2,3-pentanedione are then taken up by the yeast and reduced into the much less flavor-active compounds acetoin (3-hydroxy-2-butanone) and 3-hydroxy-2-pentanone.

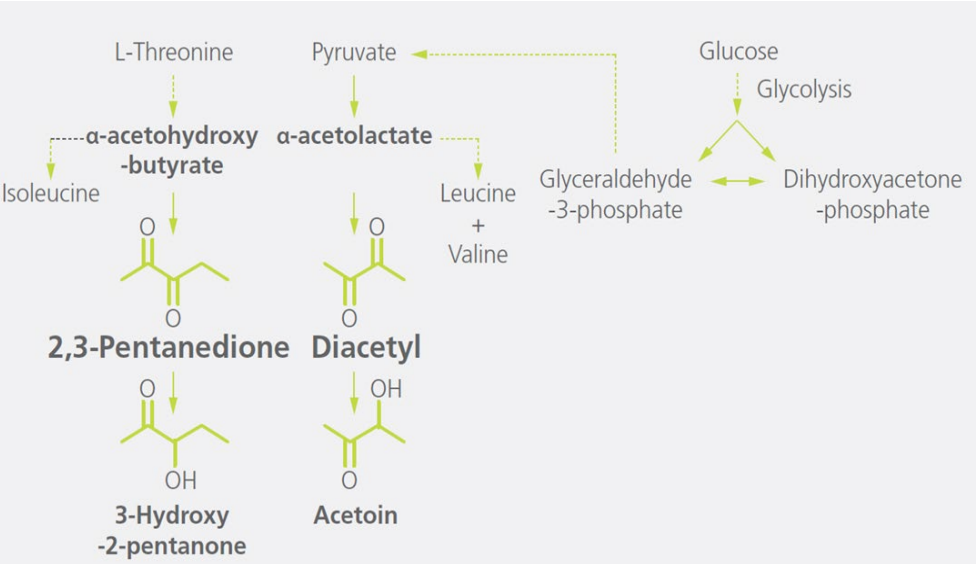

Fig. 1. Formation and reduction of diacetyl and 2,3-pentanedione during yeast fermentation

Maturex® for accelerated diacetyl and 2,3-pentanedione reduction

Maturex® is an acetolactate decarboxylase (ADLC). It reduces the formation of vicinal diketones by converting their precursors directly into acetoin and 3-hydroxy-2-pentanone, respectively. Maturex® competes with the spontaneous decarboxylation of α-acetolactate to diacetyl. But this reaction is slow when compared with the action of Maturex®.

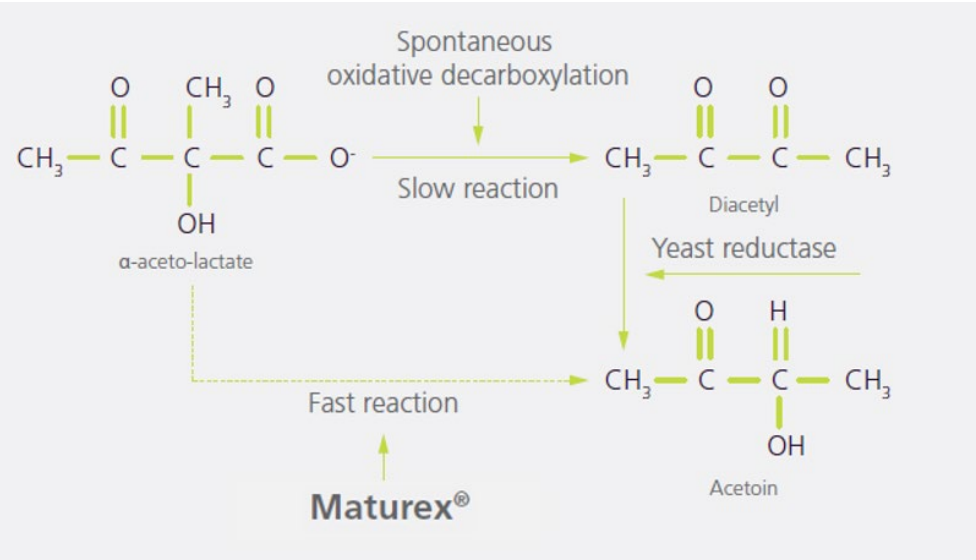

Fig. 2. Action of Novozymes Maturex® during fermentation

Example 1: Large-scale diacetyl rest

Using a standard fermentation temperature profile with a diacetyl rest at 14.5°C, the addition of Maturex® results in achieving acceptable diacetyl values 4 days early—at day 7 instead of day 11, as demonstrated in figures 3 and 4. In this case, the diacetyl rest was shortened from 4 to 2 days, thereby saving energy.

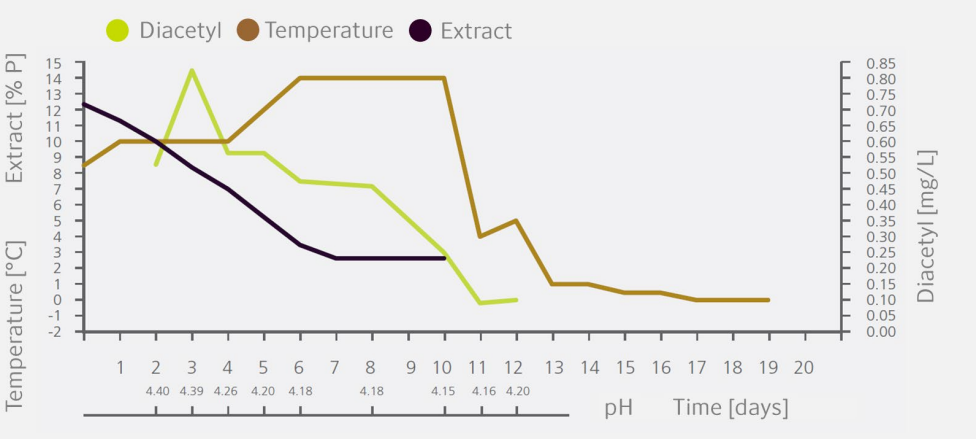

Fig. 3. Reference fermentation

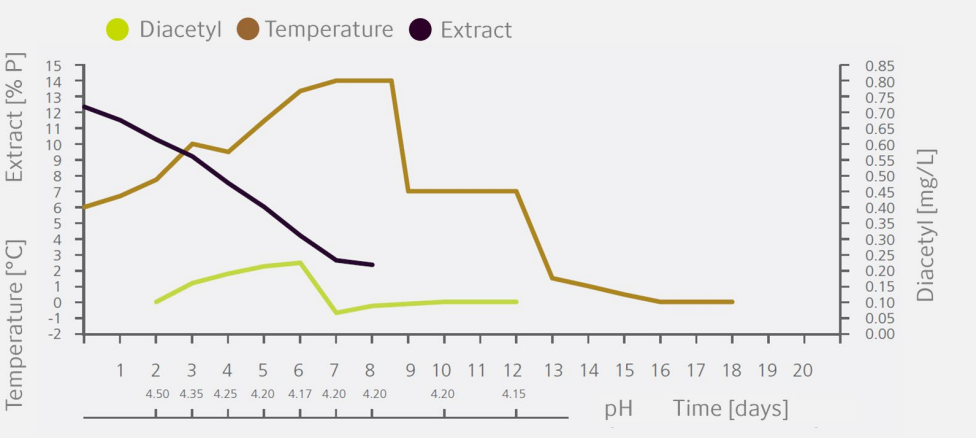

Fig. 4. Fermentation with the addition of Maturex® and reduced diacetyl rest

Example 2: Warm main fermentation—warm maturation—large-scale trial

The initial fermentation temperature is 9°C, and the maximal temperature is 20°C. Using Maturex®, acceptable levels of acceptable diacetyl (0.07 mg/l) is reached when final attenuation is reached. This is after 84 hours (~3 days) of fermentation, compared with the 132 hours (~5 days) observed during the reference test without Maturex®, shown in figure 5 below.

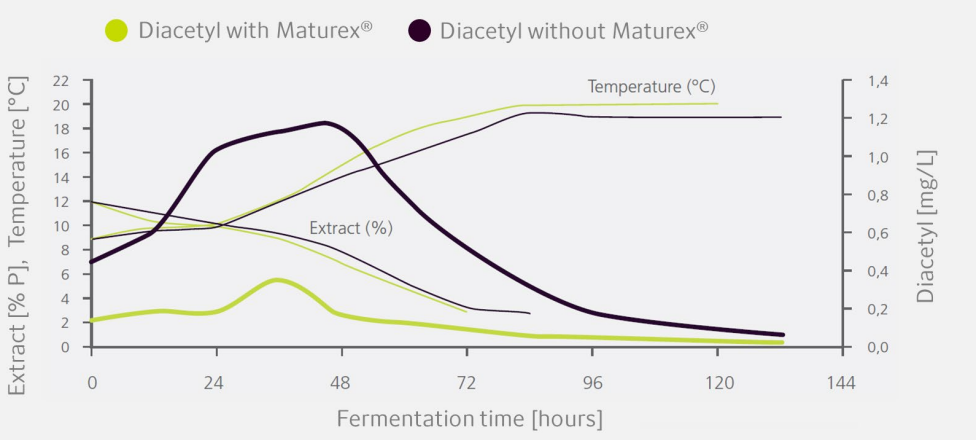

Fig. 5. The effect of Novozymes Maturex® on diacetyl content during fermentation

Example 3: Increased capacity through regular use of Maturex®
After regular implementation of Maturex®, and with no change in the fermentation profile, a 30% increase in output is achieved. This means that maturation time is shortened by 3 days, requiring just 1 day instead of 4 days, as seen in figure 6.

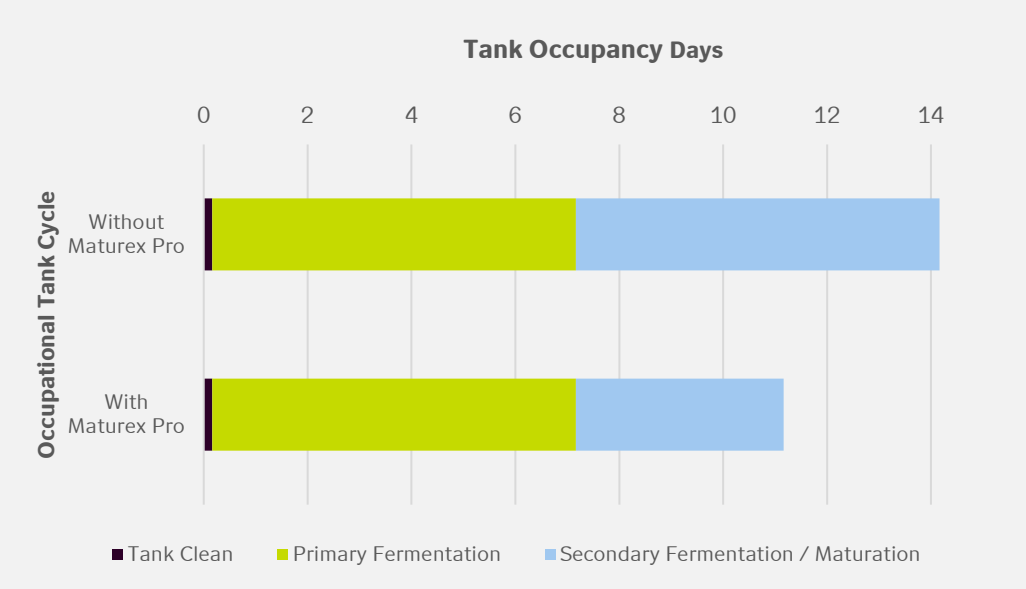

Fig. 6. Tank Occupancy with and without Maturex Pro

Usage

Maturex® is dosed into the cold wort in the fermenting cellar at the beginning of the fermentation process.

- It is important that Maturex® be present in the wort at the same time as yeast in order to maximize diacetyl prevention
- The recommended dosage is 0.5 – 1.5 g/hl cold wort
- In some cases, a higher dosage may be required
- The optimal dosage is reached when diacetyl levels are below the flavor threshold at the end of fermentation

Maturex® interacts with its environment, so the results are not only pH- and temperature-dependent, but also linked to yeast strain, wort composition and original gravity, therefore, each application needs to be individually optimized.

More information can be found in the “Brewing Handbook” available at Novozymes Market.

Monitoring the effect of Maturex®

Standard measurements for VDK and diacetyl, e.g. ANALYT ICA EBC 9.24.1 and 9.24.2, can be used to evaluate the effects of Maturex®. Throughout trials, it is recommended to record VDK or diacetyl development during fermentation by taking samples once or twice a day. Both methods can be used to measure the actual amount of VDK or diacetyl, as well as the "total VDK and diacetyl potential." To measure the "total VDK and diacetyl potential," the wort or beer must be heat-treated prior to analysis. Heat treatment at 60°C for 90 minutes converts the precursor α-acetolactate and α-acetohydroxy-butyrate to diacetyl and 2,3-pentanedione, respectively. Please note that Maturex® works on the precursor released into the fermenting wort. This precursor can be excreted by yeast, as well as by some microorganisms lacking ALDC, such *as Lactococcus lactis* and *Pediococcus damnosus*. Some microorganisms do contain ALDC, however, and as a result, diacetyl is formed inside the cells. In these cases, Maturex® cannot reduce or eliminate the formation of diacetyl.

Optimum pH and temperature

Optimal working conditions for Maturex® are 10–45°C at a pH of 4.0–7.0.

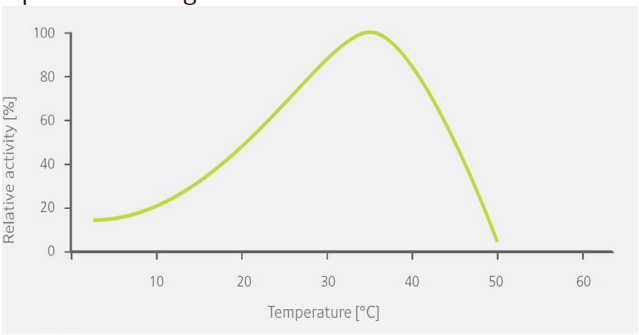

Fig. 8. Effect of temperature on activity of Novozymes Maturex®

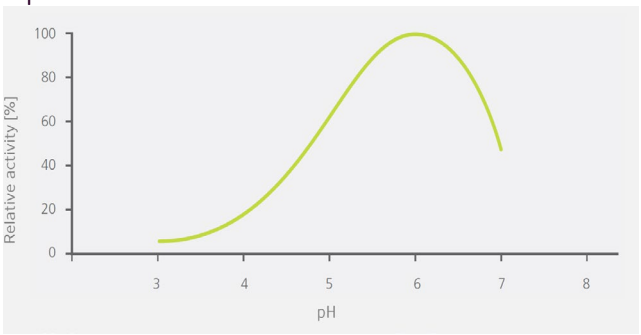

Fig. 9. Effect of pH on activity of Novozymes Maturex®

Product data

Maturex® Pro	
Declared enzyme	Acetolactate decarboxylase (ALDC)
Catalyzes the following reaction:	(2s)-2-hydroxy-2-methyl-3-oxobutanoate <=> (3r)-3-hydroxybutan-2-one + CO_2
Declared activity	2500 ADUL/g
E.C/I.U.B. no.:	4.1.1.5
Physical form	Liquid
Production method	The enzyme product is manufactured via fermentation of a microorganism not present in the final product. The production organism is improved using modern biotechnology
Density	1.15 g/ml

More information about the above-mentioned products is available at Novozymes Market.

Stability

Please see the Product Data Sheet at at Novozymes Market.

Safety, handling and storage

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

Get ahead

Staying ahead of the dynamic food and beverage market requires the best technology and expertise to become even more flexible, efficient and profitable. With our solutions and expertise, Novozymes can support you on that journey. Let’s transform the quality and sustainability of your business together.

About Novozymes
Novozymes is the world leader in biological solutions. Together with customers, partners and the global community, we improve industrial performance while preserving the planet’s resources and helping build better lives. As the world’s largest provider of enzyme and microbial technologies, our bioinnovation enables higher agricultural yields, low-temperature washing, energy-efficient production, renewable fuel and many other benefits that we rely on today and in the future. We call it Rethink Tomorrow.

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