

TRANSFERM[®]

Yield+

Featuring MGT[®] technology by MASCOMA

FERMENTATION HAS NEW LEADERSHIP



TRANSFORM® Yield+ is a game-changing new yeast developed by Mascoma LLC that is now available for fuel ethanol production. Commercialized by Lallemand Biofuels & Distilled Spirits and Mascoma LLC, TRANSFORM Yield+ will allow ethanol production facilities to reach a new level of fermentation efficiency.

NEXT GENERATION YEAST

TRANSFORM Yield+ is derived from an advanced strain of *Saccharomyces cerevisiae* yeast. It is bioengineered to outperform conventional yeast products for fuel ethanol production from liquefied grains. It has unique features allowing fuel ethanol production facilities using TRANSFORM Yield+ to realize substantial benefits.

- + Up to 4% yield gains in ethanol
- + Reduction in glycerol of approximately 30%
- + Reduction in separately purchased glucoamylase (GA) enzyme

PROVEN IN TRIALS

TRANSFORM Yield+ performance has been demonstrated in numerous production trials. The specific results and benefits that an ethanol production facility will experience will depend on the production plant design, operational parameters and process conditions.

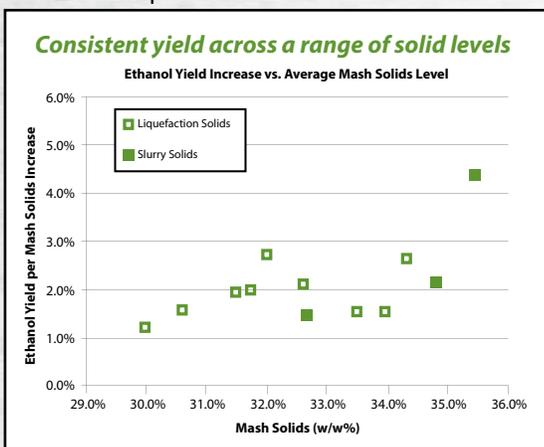


Figure 1: Performance of TRANSFORM Yield+ at various beginning solids levels. Based on plant data ranging from 30-35% total solids, the increase in alcohol ranged from 1-3%. The conclusion is that TRANSFORM Yield+ can increase yield at any solids level.

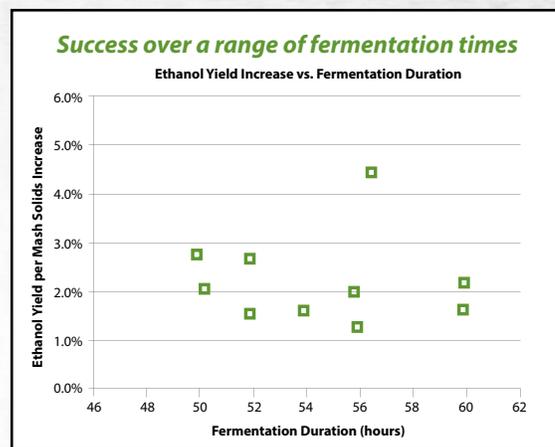


Figure 2: Performance of TRANSFORM Yield+ with various fermentation times. Shows a 1-3% increase range between 50-60 hours of fermentation time.

TRANSFORM Yield+ Fermentation Results

Representative Commercial Performance

Commercial Facility	Ethanol Yield Increase Achieved (per Mash Solids Measurement)	Glycerol Reduction	Glucoamylase Enzyme Reduction Relative to Conventional Yeast
Plant 1: 55 MGPY	4.4%	19%	24%
Plant 2: 49 MGPY	1.2%	24%	24%
Plant 3: 125 MGPY	1.6%	40%	40%
Plant 4: 60 MGPY	2.6%	21%	21%
Plant 5: 115 MGPY	2.0%	35%	25%
Plant 6: 30 MGPY	2.0%	25%	29%
Plant 7: 110 MGPY	3.2%	21%	45%
Plant 8: 40 MGPY	2.7%	21%	31%
Plant 9: 50 MGPY	2.1%	32%	25%
Average	2.4%	27%	29%

Over 7,500 commercial fermentation batches completed and over 800 million gallons of ethanol produced using TransFerm Yield+.

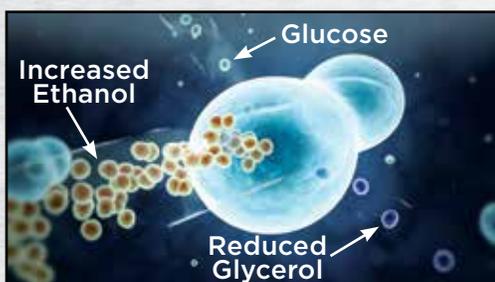
HOW TRANSFERM Yield+ WORKS



The yeast cell makes its own GA to break down feedstock (starch).

GA PRODUCTION

Glucoamylase (GA) is an enzyme that breaks down the starch in ethanol feedstock and converts it into glucose sugar. TRANSFERM Yield+ makes its own GA, so less is required to be added in the fermentation process. This allows producers to save on input costs.

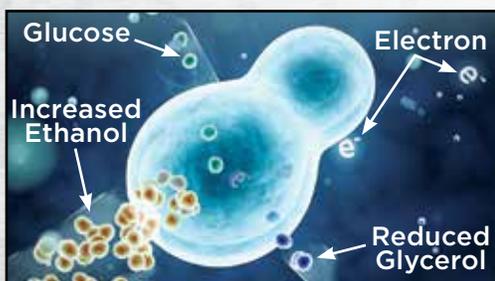


Glycerol production is reduced and ethanol is increased.

GLYCEROL REDUCTION

Conventional yeast produces glycerol as a byproduct during fermentation. This diverts yeast from producing ethanol and reduces overall yield potential. Typically, glycerol produced during fermentation accounts for about 5% of the total soluble sugars.

Using synthetic biology, Mascoma scientists incorporated a metabolic pathway in TRANSFERM Yield+ that reduces glycerol production and increases ethanol production. The result is up to 4% ethanol yield increase per bushel of corn.



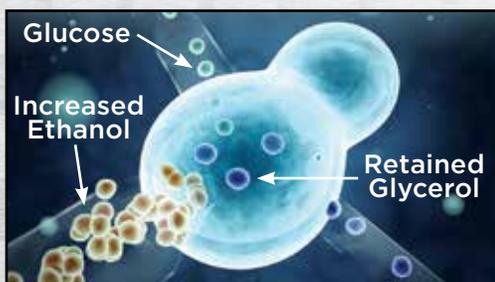
Glycerol is used as an electron acceptor to balance yeast metabolism.

BALANCING YEAST METABOLISM

Yeast makes glycerol for two reasons.

1. To respond to high sugar levels and temperatures required in the ethanol fermentation process
2. To balance their internal yeast metabolism (redox potential) by using glycerol as an electron acceptor

Mascoma scientists introduced a new pathway in TRANSFERM Yield+ that balances yeast metabolism (redox potential) while making less glycerol.



Sufficient glycerol is maintained for the fermentation process.

ROBUST IN THE FERMENTOR

TRANSFERM Yield+ makes sufficient glycerol to use internally during the fermentation process. It has consistently demonstrated that it can handle temperatures and sugar stress on an industrial scale equal to or better than conventional yeast. A reduced amount of glycerol is produced while a greater amount of ethanol is produced. The result is an increase in yield with no compromises in the fermentation process. Ethanol concentration is high and the fermentation time is not affected.

Watch the TRANSFERM Yield+ video by scanning the QR code.



TRANSFERM Yield+ Use

Vessel	Dosage	Fermentation Time
Propagation Tank	0.15 - 0.35 w/w%*	6 - 10 hours
Main Fermentor	0.05 - 0.06 w/w%	48 - 60 hours

*Should be sufficient to provide 200 - 400 x 10⁶ viable cells/mL at end of propagation.

Temperature and pH

Optimal Temperature Range	90°F - 95°F (32°C - 35°C)**
Optimal pH Range	4.0 - 5.5

**Yeast are able to tolerate short temperature excursions up to 100°F (38°C), though this is to be avoided especially in the later stages of fermentation when ethanol concentration is high.

Nitrogen Supplementation

The yeast should be provided sufficient nitrogen to ensure a robust and complete fermentation. In a whole-corn mash it is preferable to have added nitrogen, supplied for instance as 500 - 1500 ppm urea or 200 - 700 ppm of ammonia, or a combination of the two. Use of mash with a lower amino nitrogen content such as fractionated mash may require further added nutrients.

TRANSFERM Yield+ Storage:

TRANSFERM Yield+ is supplied as a stabilized cream yeast (20% solids).

- + Packed in 1,000 kg (2,205 lb) totes
- + Stable for up to 3 months from date of manufacture when stored at refrigeration temperatures (40°F, 4°C)
- + Stable for approximately 1 week when removed from refrigeration and stored at plant temperatures (86°F, 30°C)

TRANSFERM Yield+ Quality Specifications:

Percent Solids	Viable Yeast Cells per mL	Total Bacterial Count per mL
20 - 24%	>5 x 10 ⁹	<10 ⁵

Fermentation has new leadership. TRANSFERM Yield+ sets a new standard for fermentation efficiency in fuel ethanol production. Talk to your Lallemand Biofuels & Distilled Spirits or Mascoma LLC representative today to learn more about TRANSFERM Yield+.

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Pursuant to 21 CFR § 170.30, Lallemand Biofuels & Distilled Spirits (LBDS) has determined through scientific procedures that TransFermYield+ is GRAS (Generally Recognized as Safe) for the production of Distillers' co-products, such as DDGS, for use in animal feeding applications. In addition, TransFermYield+ is listed in the Official Publication of the American Association of Feed Control Officials (AAFCO) as an approved yeast for production of Distillers' co-products. This product is only to be used as a processing aid in the production of fuel ethanol and distillers co-products and is not to be used as a direct addition to food or animal feeds.

Facilities using intergeneric microorganisms are subject to premanufacturing review procedures under the Toxic Substances Control Act (TSCA) 40 CFR § 725. Mascoma's bioengineered *Saccharomyces cerevisiae* strain in TransFermYield+ has met the review requirements via completion of a Microbial Commercial Activity Notice (MCAN). For further information, please contact LBDS or Mascoma, LLC.

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