



BEST PRACTICES IPA SOLUTIONS

India Pale Ale (IPA) is a beer style defined by higher hopping rates. The original IPAs were brewed in the late 18th century with more hops and higher levels of alcohol than a typical pale ale in order to survive the long voyage to India. The modern IPA family includes a diverse range of beer styles that are all defined by their very prominent hoppy character.

The choice of yeast strain is an important consideration in brewing any IPA style. Each yeast strain produces unique flavor compounds that directly impact the aroma of the final beer, from relatively neutral to more fruity esters. The level of attenuation will impact the perception of bitterness and the level of flocculation will impact the clarity of the finished beer.

Recent research is uncovering how different yeast strains can influence flavor and aroma by interacting with specific hop-derived flavor compounds, a process called biotransformation. The Lallemand Brewing R&D lab has identified specific enzyme activities in several LalBrew® Premium strains that are important for biotransformation, including β -glucosidase and β -lyase.

The combination of primary yeast metabolism (attenuation, production of esters, flocculation) and secondary interactions with hop compounds (biotransformation) will determine the flavor and aroma of the finished beer.

Armed with this data, the brewer is well equipped to choose the best yeast for each IPA style. Lallemand Brewing is at the forefront of hop flavor and aroma research and we are ready to help you with any questions about brewing hoppy beer styles.



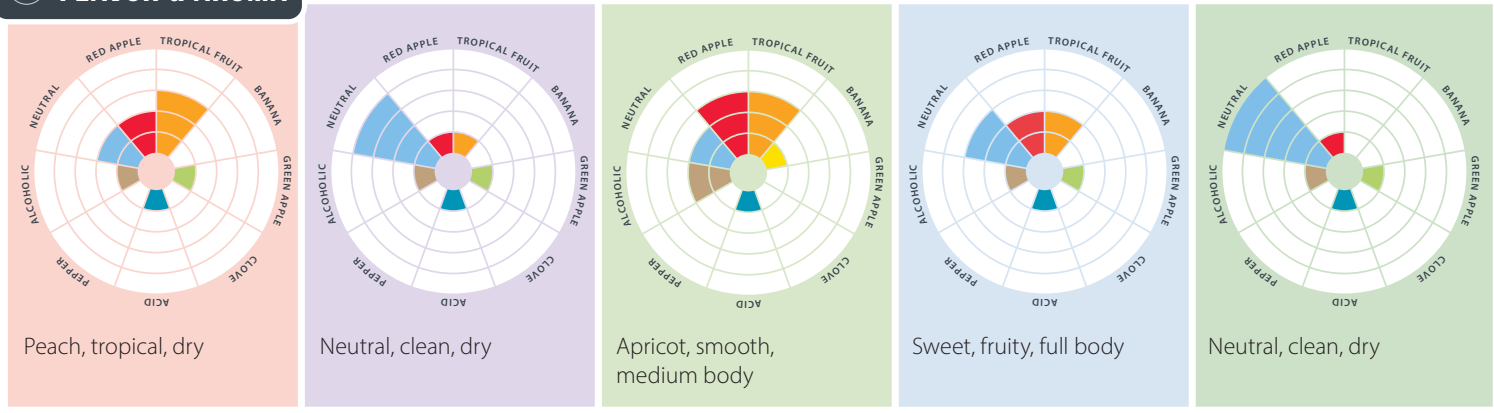
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QUICK FACTS

NEW ENGLAND	BRY-97	VERDANT IPA	WINDSOR	NOTTINGHAM
AMERICAN EAST COAST ALE YEAST	AMERICAN WEST COAST ALE YEAST	IPA-STYLE ALE YEAST	BRITISH-STYLE ALE YEAST	HIGH PERFORMANCE ALE YEAST
ATTENUATION AND STANDARD DEV. IN 12°P STANDARD WORT: 81.2 (2.0)	ATTENUATION AND STANDARD DEV. IN 12°P STANDARD WORT: 83.2 (0.9)	ATTENUATION AND STANDARD DEV. IN 12°P STANDARD WORT: 78.3 (3.2)	ATTENUATION AND STANDARD DEV. IN 12°P STANDARD WORT: 68.6 (1.8)	ATTENUATION AND STANDARD DEV. IN 12°P STANDARD WORT: 83.6 (1.2)
FLOCCULATION: Medium	FLOCCULATION: High	FLOCCULATION: Medium	FLOCCULATION: Low	FLOCCULATION: High
ALCOHOL TOLERANCE: 9% ABV	ALCOHOL TOLERANCE: 13% ABV	ALCOHOL TOLERANCE: 10% ABV	ALCOHOL TOLERANCE: 12% ABV	ALCOHOL TOLERANCE: 14% ABV
BIOTRANSFORMATION: β -glucosidase High, β -lyase Low	BIOTRANSFORMATION: β -glucosidase High, β -lyase Medium	BIOTRANSFORMATION: β -glucosidase Medium, β -lyase High	BIOTRANSFORMATION: β -glucosidase Medium, β -lyase Low	BIOTRANSFORMATION: β -glucosidase Medium, β -lyase Medium

FLAVOR & AROMA





FERMENTATION KINETICS & FLOCCULATION

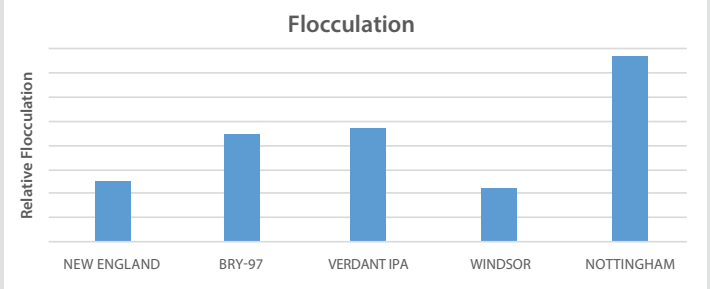
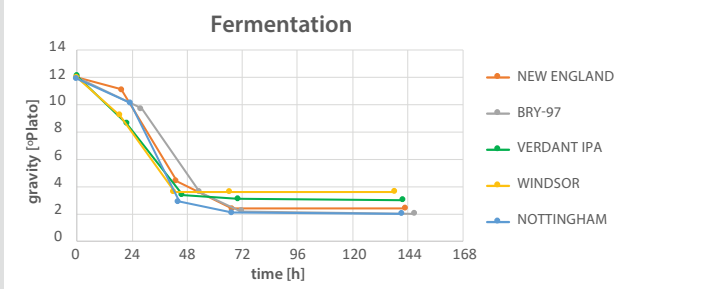


Figure 1: Fermentation kinetics of different IPA yeast strains. A standard pale 12°P wort was prepared from malt extract, pitched with 100g/hL of yeast and fermented at 20°C.

Figure 2: Relative flocculation of traditional IPA yeast strains according to ASBC method Yeast-11 (Helm assay).

BIOTRANSFORMATION

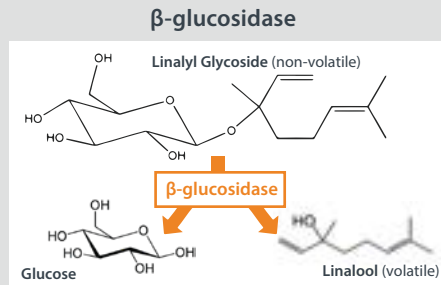


Figure 3: β-glucosidase activity results in the release of an aromatic terpene (and a glucose molecule) from a non-aromatic terpenyl glycoside. Terpenes can have diverse flavor impacts (citrus, floral) and higher levels of terpenes are associated with greater overall hop aroma intensity (OHA). In this example, aromatic linalool is released from a non-aromatic linalyl-glycoside.

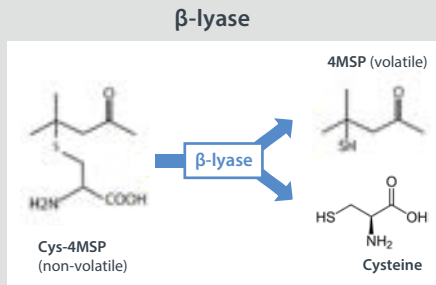


Figure 4: β-lyase activity results in the formation of volatile sulfur compounds called thiols, which are usually associated with tropical aroma and are active at very low flavor thresholds. In this example, aromatic 4MSP is released from a non-aromatic cysteinylated precursor.

Biotransformation activities of IPA yeast strains

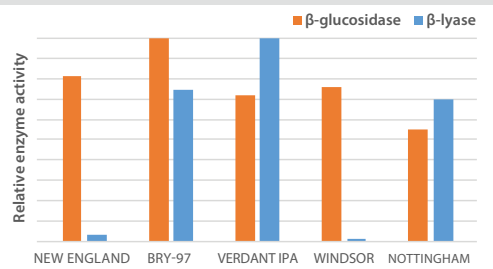


Figure 5: Relative activities of β-glucosidase and β-lyase in different IPA yeast strains. β-glucosidase was measured as secreted enzyme activity using a standard chemical glycoside substrate. β-lyase activity was measured by growth on selective media containing a specific sulfur-based precursor. Relative activities are shown for comparison, but β-glucosidase and β-lyase activities cannot be directly compared with each other.

BEER STYLE CHART

In addition to the traditional IPA yeast strains, many brewers are experimenting with alternative yeast strains to produce hoppy beer styles. The **LalBrew Koln™** strain produces an excellent fruity ester profile and has β-glucosidase activity levels similar to the LalBrew® New England strain. The **LalBrew Voss™** strain produces citrus aromas and has high β-glucosidase and medium-low β-lyase activity. The **WildBrew Philly Sour™** strain is ideal for Sour IPAs – kettle bittering hops can be used with this hop tolerant *Lachancea* yeast species capable of producing lactic acid and ethanol during primary fermentation. The **ABV Aromazyme™** pure β-glucosidase enzyme gives the brewer greater control over biotransformation activity.

STRAINS BY BEER STYLE	BRY-97	NEW ENGLAND	NOTTINGHAM	VERDANT IPA	WINDSOR	KOLN	VOSS	PHILLY SOUR	AROMAZYME
BLACK IPA	✓	✓	✓	✓	✓	✓	✓	✓	✓
BRUT IPA	✓	✓	✓	✓	✓	✓	✓	✓	✓
DOUBLE IPA	✓	✓	✓	✓	✓	✓	✓	✓	✓
ENGLISH IPA	✓	✓	✓	✓	✓	✓	✓	✓	✓
NEW ENGLAND IPA	✓	✓	✓	✓	✓	✓	✓	✓	✓
SESSION IPA	✓	✓	✓	✓	✓	✓	✓	✓	✓
SOUR IPA	✓	✓	✓	✓	✓	✓	✓	✓	✓
WEST COAST IPA	✓	✓	✓	✓	✓	✓	✓	✓	✓
TRADITIONAL IPA STRAINS	✓	✓	✓	✓	✓	✓	✓	✓	✓
ALTERNATIVE IPA STRAINS	✓	✓	✓	✓	✓	✓	✓	✓	✓
HOP AROMA ENZYMES	✓	✓	✓	✓	✓	✓	✓	✓	✓