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Impact of Yeast Vitality on Beer Flavor Development During Fermentation

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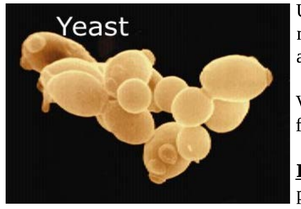
INTRODUCTION – WHAT IS VITALITY



Unlike yeast ***viability*** which only measures yeast cells with intact membranes. Yeast ***vitality***, refers to a yeast cell with quantifiable metabolic activity and an ability to multiply.

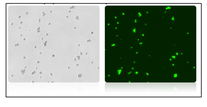
Vitality of yeast during fermentation is an especially important consideration for proper cell growth, consistent flavour and optimum production yield.

IMPORTANT – A yeast cell may be viable but not necessarily vital (actively proliferating).

FINDINGS

HEALTHY YEAST = HIGH VITALITY = BETTER BEER

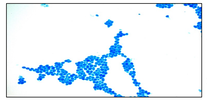
MATERIALS AND METHODS



VITALITY MEASUREMENT

Image Cytometric Analysis (Cellometer)

Measures enzymatic activity. Esterase in vital yeast will cleave the CFDA-AM dye molecule and make it fluoresce green.



VIABILITY MEASUREMENT

Methylene Blue Staining

Measures enzymatic activity. Vital yeast cells convert methylene blue to a colorless solution through cellular dehydrogenase activities.

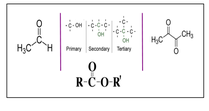
YEAST STRESSORS

Heat

Fermentations were completed at 25° C

High Alcohol

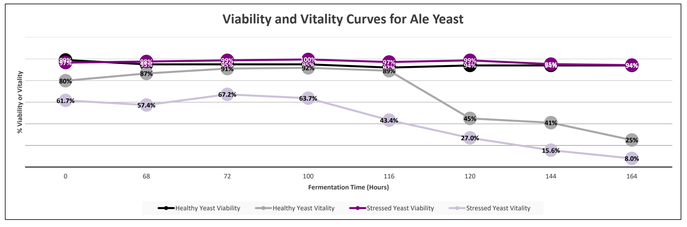
Yeast were fermented in very high gravity wort 23 degree Plato

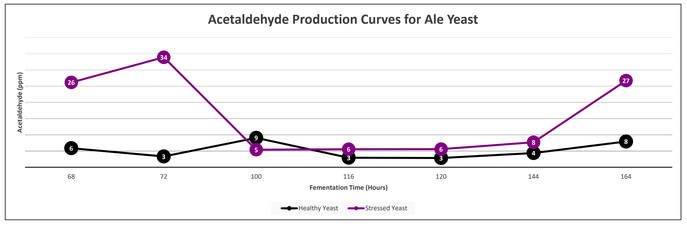


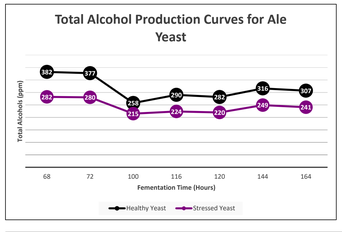
FERMENTATION PERFORMANCE INDICATORS

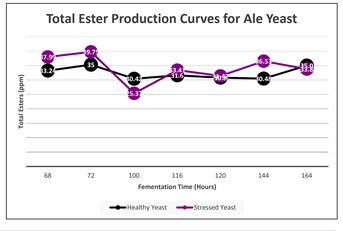
Viability vs Vitality
Aldehyde Production
Alcohol and Ester production
Reduction of 2,3-Butanedione

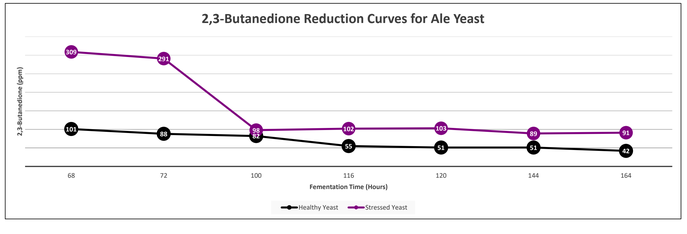
RESULTS AND DISCUSSION











VIABILITY vs VITALITY

Viabilities were in the high 90% range for all yeast during the entire fermentation. In contrast, vitality measurements showed trends that could be directly linked to the increasing physiological stresses on the yeast. At 116 hours when the fermentation was at near terminal gravity there was a rapid decline in the vital cell concentration. This decline may be attributed to changes in the environment within the fermentation tank such as sugar and nutrient depletion, increased CO2 and ethanol concentration and higher temperature. The vitality results show that even though yeast may be highly viable (i.e. with intact cell membranes), the metabolic activity or vitality can be significantly different.

ACETALDEHYDE PRODUCTION

Acetaldehyde is one of many flavour active compounds formed during fermentation. In small quantities acetaldehyde contributes to beer flavour, but in excess leads to “grassy odors” or “bruised apple” or “cidery” tastes. The less viable ale yeast (stressed) showed greater acetaldehyde production than the fresh, highly viable ale yeast. After the initial acetaldehyde peak during the beginning stages of fermentation, the level of acetaldehyde dropped to a minimum and then slowly rose toward the end of fermentation. This increase was associated with the start of SO2 production during fermentation.

ESTER AND ALCOHOL FORMATION

In general, the formation of flavour active components in beer is determined by a yeasts ability to grow, and in doing so metabolize the nitrogenous constituents of wort. Ale yeast with low vitality that have undergone significant stress take up less α-amino nitrogen, produce less higher alcohols and less of the most flavour active esters.

2,3-BUTANEDIONE REDUCTION

Diacetyl (2,3-Butanedione) and 2,3-Pentanedione are vicinal diketones (VDK) formed during beer fermentation as by-products of amino acid synthesis (valine and isoleucine, respectively) in brewing yeast. A greater uptake of valine by yeast cells resulted in less diacetyl being formed during fermentation. Changes in cell membranes directly influence valine transport into the cell. There is a direct relationship between healthy ale yeast with high vitality and stressed ale yeast with low vitality and diacetyl production and reduction.