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Impact of zinc on yeast membranes and cell physiology during brewing fermentations

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Yeasts require a range of metals for optimal growth, metabolism and fermentation performance. In production of fermented beverages, zinc is of prime importance, with levels of at least 0.3 ppm preferable for optimal fermentation and avoidance of stuck ferments. Zinc is a co-factor for numerous important biosynthetic and metabolic enzymes including, significantly, various glycolytic enzymes and alcohol dehydrogenase. In addition it plays critical regulatory roles through the action of Zn-finger DNA binding proteins, and affects yeast-yeast flocculation. Zinc is also known to modulate yeast stress responses, mainly due to its role as a co-factor for the antioxidant enzyme superoxide dismutase. Furthermore, zinc ions are thought to have some effects on stability and dynamics of cell membranes, which may lead to downstream effects on cell permeability and signalling systems. In brewing fermentations, zinc is actively assimilated by yeast from malt wort. However, in some instances its bioavailability may be limiting due to decrease of zinc levels during mashing, lautering and boiling through complexing in precipitated trub. Consequently low zinc levels in wort may lead to slow and incomplete fermentations.

We have studied the impact of varying zinc levels in a model brewing situation, utilising a wort medium initially depleted of zinc. The zinc was depleted by biochelation using yeast cells, providing a wort normal in all aspects except zinc levels. A brewer's strain of *Saccharomyces cerevisiae* was extensively cultured in low zinc medium to deplete cellular zinc levels, and then pitched into worts containing zinc concentrations ranging from 0 to 10 ppm (provided as zinc acetate). In addition to growth and fermentation parameters we assessed membrane fluidity by measuring Generalized Polarization of the membrane-localising fluorescent probe laurdan (6-lauroyl-2-dimethylamino naphthalene). We observed that zinc levels impacted upon growth rate, ethanol yields and membrane fluidity. The membrane fluidity varied with culture age and ethanol accumulation, as well as in relation to cellular zinc levels. Results will be discussed with reference to the impact of zinc on brewing yeast fermentation performance and stress physiology.