

# Effects of mineral ions on yeast performance under very high gravity beer fermentation

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## ABSTRACT

The effect of three divalent cationic concentrations of  $Zn^{2+}$ ,  $Mg^{2+}$ , and  $Ba^{2+}$  on yeast (*Saccharomyces pastorianus*) fermentative performance was investigated at independent and four variable combinations in 24 experimental runs in accordance with the experimental design. Very high gravity wort of 21°P was prepared from barley malt, hops and water, to which the metal and their combinations were supplemented and subsequently pitched using lager brewing strain *S. pastorianus* and allowed for 96 h fermentation. After 96 h of fermentation, highest wort fermentability of %F = 30.16 and %F = 29.53 which were not significantly different ( $p \geq 0.05$ ) were obtained for wort medium supplemented with 12, 900, and 4 ppm ( $Zn^{2+}$ ,  $Mg^{2+}$ , and  $Ba^{2+}$ ) and 900 and 4 ppm ( $Mg^{2+}$  and  $Ba^{2+}$ ) respectively. Maximum ethanol yield of 8.4347% (v/v) was obtained in wort medium supplemented with the metal combination ratio of 12:900:4 ( $Zn^{2+}$ ,  $Mg^{2+}$ , and  $Ba^{2+}$ ). For the individual metal concentration levels tested, high wort fermentability of %F = 27.94 and %F = 26.03 which were not significantly different ( $p \geq 0.05$ ) was obtained for wort media supplemented with 700 ppm  $Mg^{2+}$  and 2 ppm  $Ba^{2+}$ . High ethanol yield of 7.8844% (v/v) and 7.6245% (v/v) was recorded for  $Mg^{2+}$  and  $Ba^{2+}$  at concentration of 700 ppm and 2 ppm, respectively. Wort pH of 4.75 was found optimal for the yeast activity. Concentrations of 10 ppm  $Zn^{2+}$  and 4 ppm  $Ba^{2+}$ , were found to reduce yeast performance. Thus, the study established relationships between the metal ions on yeast fermentative performance and the impact of  $Ba^{2+}$  on yeast fermentation process – with concentrations of 1 and 2 ppm  $Ba^{2+}$  found significant ( $p \leq 0.05$ ).

**Keywords:** Very high gravity fermentation, brewer's yeast, yeast stress, yeast stress tolerance, yeast performance, mineral ions, fermentability, ethanol yield.