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BREWING FERMENTATIONS MORE PROFITABLE

Lima L, Brandão T, Lima N, Teixeira JA
Department of Biological Engineering
Email: luislima@deb.uminho.pt

KEYWORDS

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ABSTRACT

High gravity brewing has been presented as an alternative to make beer more profitable. The fermentation of high concentrated wort normally stops prematurely due the high stress conditions imposed by osmotic pressure and high ethanol content. In this wort, initial oxygen content and yeast preconditioning were applied and compared when used to accelerate very high gravity (VHG) fermentations. This work showed that using pure oxygen instead of air, the fermentation time can be reduced in about 24h without changes in the higher alcohols and esters production profile. When the yeast is preconditioned with a mixture of unsaturated fatty acids and salts before pitching the wort, the fermentation batch can be reduced from 7 to 5 days achieving lower residual extract. This difference in the residual extract results in a beer with 1 % more ethanol, which corresponds to an increase of 18% in the productivity.

INTRODUCTION

The amounts of beer produced by a world spread brand mark and the competitiveness of this market drive consistent research programs in order to improve and make the brewing process more profitable.

High gravity fermentations have been researched and presented as an alternative for raising the beer productivity without changing layouts of industries (Huuskonen et al. 2010). However, some limitations related with yeast usage appear when the wort concentration is increased above certain values. High sugar concentration slows fermentations and the physiological state of the yeast slurry collected for reuse can be compromised. The potential osmotic and ethanol stresses at the beginning and at the end of the fermentation, respectively, can be minimized by manipulating environmental parameters of the fermentations such as temperature, pitching rate and wort composition (Erten et al. 2007).

For a brewery, it can be profitable to prepare the microorganism for such task by enriching the yeast with nutrient before pitching the wort (Bafrncov and Šmogrovi˘ 1999). In previous work, some nutrients with proved positive effect on the fermentation performance (Wang et al. 2007) were applied to pre-conditioning the yeast slurry before pitching VHG fermentations with the yeast in study.

The initial oxygen dissolved in the wort is an important key for the success of the yeast. Most breweries oxygenate the wort with air on the cold side after the wort cooler increasing in this way the oxygen solubility. At the end of the fermentation the green beer is completely free of oxygen (Verbelen et al. 2009). Considering the air composition, the aeration only gives 7-11 ppm of molecular oxygen to the wort. The oxygen is only introduced in the system before pitching the wort with yeast slurry. It is all the oxygen that yeast has to produce cell membrane constituents whose depends on that gas. Membrane lipids (unsaturated fatty acids and sterols) are extremely important for the yeast protection during fermentation (Blagovi et al. 2001). The oxygen concentration given by the aeration could not be enough for VHG fermentations.

This work presents the comparison between two scenarios: (1) yeast supplementation with an unsaturated fatty acids mixture and salts and (2) wort oxygenation with pure O_2 (24 ppm of molecular oxygen).

METHODS

Lager fermentations were carried out using an industrial brewer's yeast strain of *Saccharomyces cerevisiae*. The yeast slurry was collected from the industrial storage tank with a viability of 91%.

Yeast preconditioning was done by adding linoleic acid, tween 80, magnesium sulfate and zinc chloride to the yeast slurry. After gentle mix, the yeast slurry was kept in contact with nutrients before being transferred to the fermenter.

Brewing fermentations were carried out in 2 L EBC tubes at constant temperature of 18ºC using 22ºP wort and a

pitching rate of $20x10^6$ cells/ml. Beer samples were analyzed for alcohol and extract content by Beer Analizer, Anton Paar. Superior alcohols, esters, beer bitterness and SO_2 were analyzed according Analytica-EBC.

RESULTS & CONCLUSIONS

Brewing fermentations with increased initial dissolved oxygen increased the fermentation rate (see Figura 1). The fermentation is stopped when, in 24 h, the extract reduction is equal or less than 0.1ºP. According to that criterion, the fermentation time is reduced in about 24h using initial O_2 concentration of 24 ppm instead of 10 ppm given by aeration.

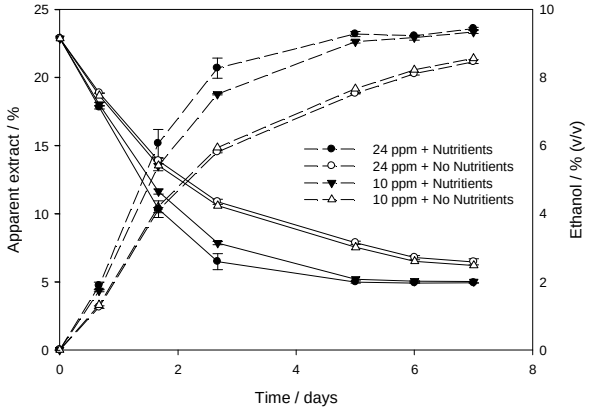

Figura 1: Extract consumption (continuous line) and ethanol production (discontinuous line) profiles during 22ºP wort fermentations at 18 ºC.

Figure 1 shows that the nutritional supplementation of the yeast during the 24h prior pitching increased not only the fermentation rate but also the extent of the process, reaching a lower residual extract. The fermentation time was reduced from 7 to 5 days and the final green beer had more 1 % (v/v) of ethanol. The production capacity was increased 18% using the nutritional treatment of the yeast. At the end of the fermentations with preconditioned yeast, the fermenter had two times more yeast settled on the cone than non-preconditioned yeast, suggesting that tested nutrients induced a higher metabolic state to the slurry (data not showed). Final diacetyl, bitterness and SO_2 had direct relationship with the yeast slurry used in the fermentation. Diacetyl was two times lower when the wort was fermented by preconditioned slurry. Bitterness loss was observed when preconditioned yeast was used.

Fermentation with preconditioned yeast resulted in a final beer with more 12.5 % of superior alcohols (mainly n–propanol), and consequently lower esters content. The decrease on esters amount is more noticeable, about 50 % (mainly ethyl acetate). This fact is important for a Brewery once the goal of the fermentation is not only to produce higher amounts of alcohol but also keep the identity of their beer.

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AUTHOR BIOGRAPHY

LUIS LIMA was born in Joane and went to the University of Minho (UM) in 1998, where studied Biological Engineering and obtained the degree in 2003. He concluded the pos-graduate studies in Industrial Engineering at Production and Systems Department at the UM in 2006. Since 2007 he is doing his PhD project in the UM in Very High Gravity Brewing Fermentations with cooperation of UNICER S.A.
E-mail: luislima@deb.uminho.pt