

Saccharomyces cerevisiae CULTURE TECHNIQUE

The implications of composite dark purple rice malt on phenolic acid profiles, 4-vinyl guaiacol reduction and enhancing the antioxidation of beer

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Abstract

Ale beer was fermented in a 5 L double-jacketed Winpact One vessel (FS-06-220) with DO, pH, foam and temperature probes. Barley malt was substituted with 40–100% Riceberry rice malt and fermented with POF+ and POF– yeasts; 40–80% rice malt retained higher p-coumaric acid, vanillic acid, anthocyanin and antioxidant activity with lower 4-vinylguaiacol.



Winpact Model: FS-06-220
(Winpact One, FS-06 Series)

Introduction

Motivation: hydroxycinnamic acids carried over from malt are decarboxylated by yeast into 4-vinylguaiacol, a phenolic off-flavour that is undesirable in most beer styles while also marking the loss of antioxidant phenolics.

Gap: the effect of rice malt — as adjunct or as base malt — on phenolic acid dynamics, antioxidation and volatile phenolic compounds had not been investigated.

Objective: track phenolic acids, antioxidant activity and 4-vinylguaiacol through mashing, fermentation and maturation for composite Riceberry rice / barley worts fermented with a phenolic-off-flavour-positive and a negative yeast.

Materials and Methods

Bioreactor configuration:

A complete Winpact One fermenter system with a 5 L double-jacketed vessel (FS-06-220, Winpact Scientific, Saratoga, CA, USA) held 4.2 L of oxygen-saturated wort. The vessel was monitored through a control unit with dissolved oxygen probe, pH probe, foam detection probe and temperature probe, with a coolant system connected to the heat exchanger (Winpact One FS-06 Series).

Fermentation conditions:

Impeller set at 100 rpm for gentle mixing and shorter time to attenuation; 72 h at 20 °C; impeller then stopped for yeast flocculation over 6 days at 4 °C. 50 mL samples were taken every 12 h.

Treatments and controls:

Riceberry rice malt substituted barley malt at 40, 60, 80 and 100% (w/w), with 100% barley malt as control; each wort fermented separately with POF+ (*S. cerevisiae* var. *diastaticus*) and POF– (*S. cerevisiae*) yeast.

Analysis:

Sugar and ethanol, phenolic acids and 4-vinylguaiacol by HPLC, beer colour by spectrophotometry, and antioxidant activity.

Results

Rice malt wort carried higher anthocyanin and vanillic acid than all-barley wort. Fermentation and maturation lowered phenolic acids and antioxidant activity across all treatments, but beers made from 40–80% rice malt retained more p-coumaric acid, vanillic acid, anthocyanin and antioxidant activity while containing less 4-vinylguaiacol; all-barley beer was higher in ferulic and sinapic acid. POF+ yeast produced more 4-vinylguaiacol than POF–, so either rice malt or POF– yeast can be used to suppress the off-flavour. Fermentor relevance: all ten malt–yeast combinations were fermented in a Winpact One 5 L double-jacketed vessel under the same settings (100 rpm, 20 °C, 72 h) with DO, pH, foam and temperature monitored, after which the impeller was stopped and the beer held at 4 °C for a 6-day flocculation rest in the vessel.

References

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