Premixing of Isinglass and Silica Gel to Obtain Improved Beer Stability

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ABSTRACT

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Isinglass and silica gel have both been used successfully for clarification and stabilization of beer for many years. Most applications involve separate additions, but premixing is a possibility. This study investigated the effects of premixed treatments on filtration and stability. Kettle finings are also used extensively to remove proteinaceous material during wort boiling. This study was extended to observe the effects of finings on fermentation rate, filtration and stability. Isinglass and silica hydrogel treatment gave the most rapid filtration rate,but using them in combination gave no apparent benefit. The addition of kettle finings resulted in a more vigorous fermentation, although they did not appear to improve beer stability. Following storage at 4°C for 12 months, the most stable beer resulted from treatment with a combination of isinglass and silica xerogel, indicating that this form of treatment is a desirable method of beer stabilization.

Key words: Beer stability, filtration, kettle finings, isinglass, silica gel.

INTRODUCTION

Isinglass finings consist mainly of collagen. The solubilized molecule is *amphoteric* meaning that it possesses both positive and negative charged areas and can thus bind to both negatively charged yeast cells and positively charged proteins. Fining accelerates particle settling by increasing their size and weight. Isinglass treated beers have been shown to exhibit improved foam stability, possibly due to the removal of lipid material. Isinglass is removed at filtration and is not present in packaged beer[4,7].

Silica gels are available in two main forms, as a hydrogel containing approximately 70% water and as a xerogel with 5% water. Both types have a porous structure and the surface is covered with silanol (SiOH) groups. These groups bind to proteins, particularly to those containing high levels of the amino acid proline. Haze causing protein in beer contains high levels of proline and thus silica is a very effective stabilizing treatment. This selectivity is also advantageous for foam stability, as silica does not remove foam inducing polypeptides[2].

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Kettle finings consist of the sulphated polysaccharide carrageenan and bind to proteins, and possibly polyphenols, in boiled wort as it cools causing better removal in the whirlpool. They have not been found to damage foam stability[3].

Combined treatments using isinglass and silica have been employed using separate additions, however in order to simplify the addition process, the possibility of combining the treatments as a premixed solution was investigated. While the isinglass molecule is too large to enter silica pores, interactions between active surface groups may be possible. This study investigated whether combined treatments offered any advantages over the individual treatments by displaying synergistic effects. All the treatments were carried out with and without the addition of kettle finings, in order to measure the effects of this material on beer physical stability.

MATERIALS AND METHODS

Beer production and treatment

Beer was produced in the ICBD's two-hectolitre pilot brewery. Two all malt 15°P lagers were produced, one brewed with the addition of kettle finings at 30 mg/litre, the other without the addition of kettle finings.

Treatment was carried out on conditioned beer during transfer to another vessel. The beers were divided into six aliquots of 50 litres. Isinglass was prepared from a standard powder to give a working solution with a total nitrogen content of 650 mg/litre and was added at 500 g. Hydrogel and xerogel were added at 30 g being slurried in 200 mL water. The combined treatments consisted of 30 mg of hydrogel or xerogel being slurried in 500 g of isinglass. These quantities are typical for production scale beers of this gravity. One control aliquot was left untreated.

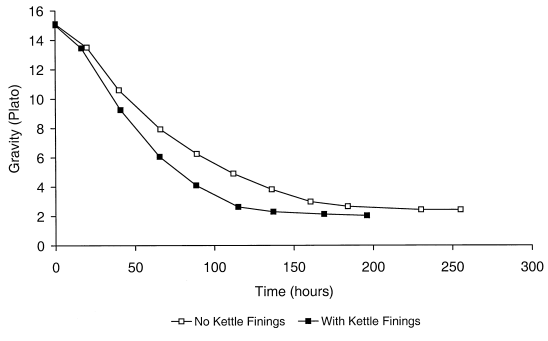

FIG. 1. Effect of kettle finings on fermentation rate.

Fermentation rate

Fermentation vessels were sampled daily and gravity determined using an Anton Paar DMA46 gravity meter.

Filtration performance

The cumulative filtrate volume collected during filtration was recorded at intervals of 30 s.

Beer stability

Sensitive protein and tannoid levels were measured using a Pfeuffer Tannometer1. Foam stability was measured according to Rudin[5]. Haze was measured on a Hach 2100N Turbidimeter.

Storage

Following filtration, the beers were bottled and stored at 4°C for 12 months and haze was measured at intervals of three months.

Residual isinglass

Solid material was recovered from the beers by centrifugation at 20,500 rpm for 10 min. Material from each isinglass-treated beer was obtained as well as from the control beer. Isinglass was added to a control sample to act as a positive control.

Samples were vortexed with 10 mL hydrochloric acid (50% v/v) for 1 h. The contents were transferred to distillation flasks and the liquid evaporated. The residues were dissolved in 2 mL water and any brown colour was removed with activated charcoal. Following filtration, 1 mL copper sulphate (12.5 g/litre) and 1 mL sodium hydroxide (2.5M) were added and the samples placed in a water bath at 40°C for 10 min. One mL of hydrogen peroxide (6% w/v) was added followed by another 10 min at 40°C with mixing at intervals. After cooling to 20°C, 4 mL sulphuric acid (83 mL/litre) was added, followed by 2 mL of p-dimethylaminobenzaldehyde solution (5 g in 100 mL isopropanol). The samples were placed in a water bath at 70°C for 15 min. The appearance of a red/pink colour indicated the presence of isinglass and a yellow colour its absence.

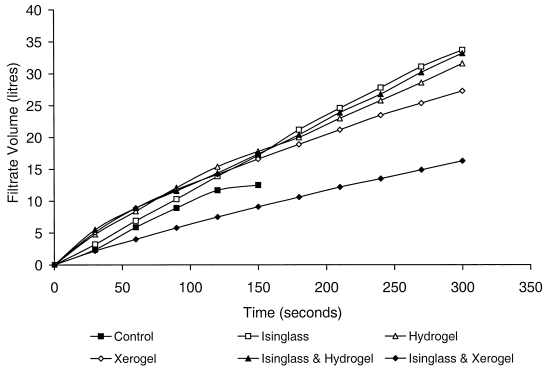

FIG. 2. Effects of treatments on filtration rate (no kettle finings).

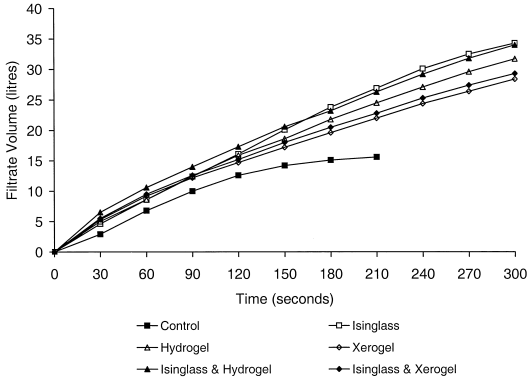

FIG. 3. Effects of treatments on filtration rate (with kettle finings)

RESULTS AND DISCUSSION

The fermentation carried out with the addition of kettle finings was faster than the one without (Fig. 1). Finings reduced the time taken to achieve attenuation by 59 h. It has been suggested that the improved wort clarity obtained by the addition of kettle finings could adversely affect the fermentation rate by removing some of the proteinaceous nutrients required to maintain yeast activity and possibly reduce the level of unsaturated fatty acids[6]. However these results indicate a rate improvement, this is possibly due to the removal of larger trub particles which are not usable by yeast and could impede their growth, rather than protein in the form of amino acids and small peptides which yeast can utilize.

Filtration rates for the beer without kettle finings are shown in Fig. 2. Unstabilized beer was filtered until the

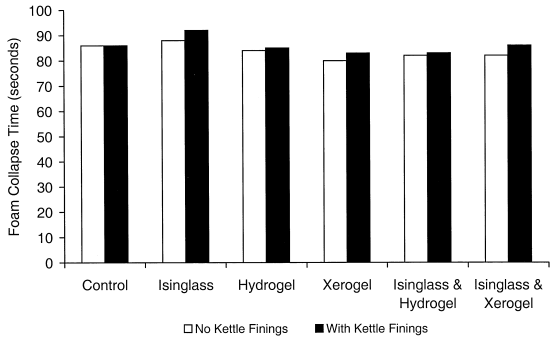

FIG. 4. Effects of treatments on foam stability.

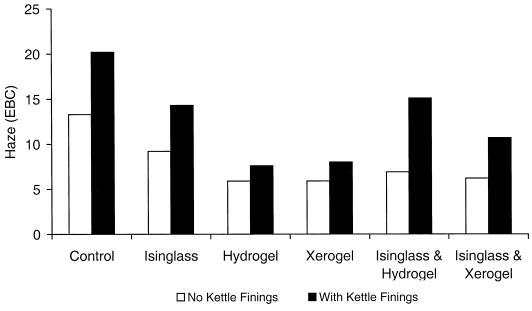

FIG. 5. Effects of treatments on sensitive protein levels.

filter blinded after 12.5 litres had been collected. Treatment with isinglass, hydrogel, xerogel and isinglass & hydrogel resulted in a significant improvement in filtration rate and volume collected. Treatment with isinglass & xerogel resulted in a much slower filter run, but this did not cause the filter to blind. Filtration rates for the beer treated with kettle finings are shown in Fig. 3. Untreated beer yielded a total filtrate volume of 15.6 litres before the filter blinded. This represents an increase of 3.1 litres in volume filtered when compared with untreated beer which had not been treated with kettle finings. All treated beers exhibited similar filtration profiles to those in Fig. 2, with the exception of the isinglass & xerogel treated beer, where the filtration rate was significantly increased.

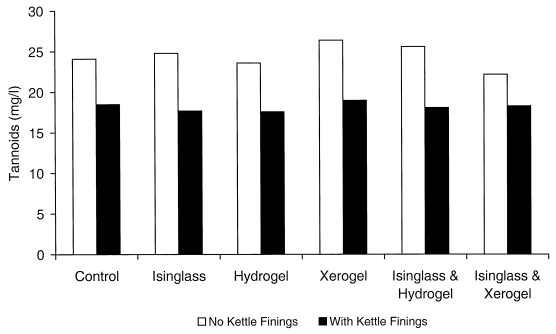

FIG. 6. Effects of treatments on tannoid levels.

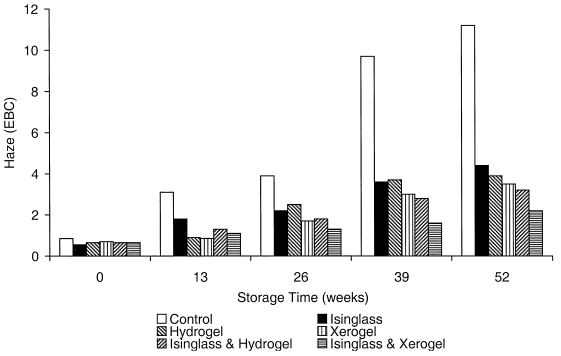

FIG. 7. Effects of treatments on haze following long term stability (no kettle finings).

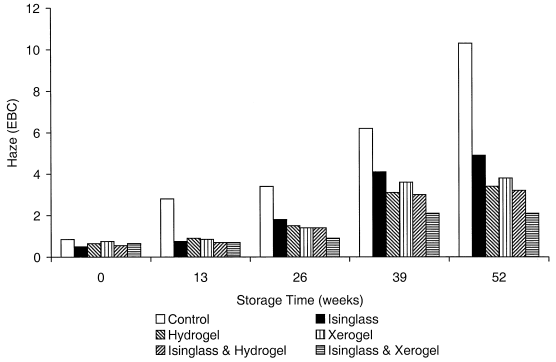

FIG. 8. Effects of treatments on haze following long term storage (with kettle finings).

The presence of kettle finings slightly increased foam stability for all the treatments (Fig. 4). Treatment with isinglass, in the absence of kettle finings, caused an increase in collapse time from 86 to 88 sec, this effect was enhanced in the presence of kettle finings, from 86 to 92 sec. This supports the reports that kettle finings do not damage beer foam, and that isinglass treatment is beneficial to foam stability[3].

The level of sensitive (haze forming) protein was reduced by all treatments (Fig. 5). The most effective treatments were the silica gels used as single treatments; there was no apparent benefit from using the combined treatments. Although isinglass is used primarily as a clarification agent, it can be seen that it reduced the level of sensitive protein when used as a sole treatment. Although this reduction was not as great as that resulting from the use of silica, this indicates that if isinglass is used as a clarification agent, it will also improve beer physical stability. The level of sensitive protein in beer produced with kettle finings was higher than in beer without finings, but the pattern of reduction by the treatments used was broadly similar. Tannoid levels are shown in Fig. 6. The presence of kettle finings reduced the level of tannoids by approximately 30%, but there was little difference between the various treatments.

Long term storage results are shown in Fig. 7 (no kettle finings) and Fig. 8 (with finings), and it can be seen that if beer is untreated, it will develop a haze quickly. The final haze of the unfined control was 11.2 EBC, the presence of kettle finings only reducing this to 10.3 EBC. All the treatments improved long term stability. Samples treated with kettle finings had lower hazes at 26 weeks but at 52 weeks there was no difference between the non-kettle fined and kettle fined beers. The most effective treatment was the combination of isinglass & xerogel, which gave a haze of 2.2 EBC after 52 weeks storage (2.1 EBC with kettle finings). Isinglass as a single treatment was the least successful, and was not suitable as a sole choice for stabilizing treatment.

All the beers treated with isinglass tested negative for this material. This indicated that all of the isinglass used, was removed during maturation and filtration.

CONCLUSIONS

This study has shown that various stabilization materials can be used in combination to produce a beer with superior physical stability to what would be achieved by using only one stabilization material. The use of kettle finings gave no apparent benefit in relation to long-term physical stability, but improved the rate of fermentation, lowered tannoids and enhanced foam stability. The use of single and combined treatments gave improved filtration rates and a reduction of haze causing protein.

Optimal stabilization was achieved by a combination of isinglass & silica xerogel. While this beer appeared to be slower to filter, such treatment combined the protein removal selectivity of silica and the foam positive and haze reducing qualities of isinglass, both of which were removed by filtration. This treatment method is therefore a highly recommended way of ensuring beer physical stability.

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