EVALUATION OF A SUBSTITUTE FILTER MEDIUM FOR REMOVAL OF HAZE IN BEER

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SUMMARY

Diatomaceous earth (DE) is widely used in the filtration of beer to remove suspended yeast and other particulate material that can cause cloudiness or haze in the final product. The DE used has a particle size diameter of between 60 and 100 μm. However, health and safety concerns arise from its human carcinogenic classification in 1997 from Category 2 (Probable Human Carcinogen) to Category 1 (Human Carcinogen) by the IARC[1]. In a confidential study[2] conducted at Adelaide University[3], zeolite-A, a hydrated aluminosilicate of alkali earth metals, showed promising filtration capabilities when used in the removal of haze in white wine. Zeolite-A is non-toxic via oral, dermal, ocular and respiratory exposure as well as safe for the environment at disposal. An experimental study to investigate zeolite-A as a possible substitute for DE in the brewing industry was therefore undertaken. The particular zeolite-A used was selected as it was judged as nearly the same as that manufactured within the Department of Chemical Engineering, Adelaide University from naturally occurring deposits of kaolin.

Two size-grades of zeolite-A (large diameter particles of 125-250 μm and small diameter particles of 63-125 μm) were selected to cover the particle size range of widely used DE (as Celite 503[4]). These two zeolites, together with filter sand (200 μm diameter particle size) and silica were experimentally evaluated against DE in the clarification of beer simulants and commercial beer product. Flux-time experiments on each of three packed beds of each of the five filter media (3.63, 11.23, 18.83 g) with three values of pressure driving force (70, 125, 180 kPa) were carried out in a specially constructed pilot plant, initially in the laboratory and later *in situ* in a commercial brewing plant[5]. This special pilot plant, together with protocols for the preparation of media, simulated conditions and practices in current use in the brewing industry.

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[1] International Agency for Research on Cancer (IARC) 1997/1998. International Diatomite Producers Association *Reclassification of Crystalline Silica*. Long Beach, CA 90803.

[2] Davey K R, Kadir J and Pecanek J 1997. An assessment of six (6) alternate filter media for the polishing of wine. Department of Chemical Engineering, University of Adelaide, Food Technology Research Group, *Confidential Report*. 60 pp.

[3] *formerly* The University of Adelaide.

[4] Marketed by FilChem Pty Ltd, Victoria.

[5] Coopers Brewery Ltd, Leabrook, SA 5068.

The flux obtained from the small grade zeolite-A (particle size 63-125 μm) was significantly lower compared to DE, i.e. respectively, 22 $mLm^{-2}s^{-1}$ and 390 $mLm^{-2}s^{-1}$ (using 18.83 g media at 180 kPa). Large grade zeolite-A (particle size 125-250 μm) showed comparable flux properties to DE with flux rate of 290 $mLm^{-2}s^{-1}$.

Microbiological analyses were carried out initially on eight selected filter media - which also additionally included pumice, perlite and cellulose (as cotton wool) - to assess effectiveness in removing haze forming constituents from a simulated beer (yeast solution) and two home-brewed beer types. The pumice, perlite and cellulose were rejected as alternative filter media because of poor performance in haze removal. Microbiological, chemical and sensory analyses were carried out on each of the five remaining media. Results of the microbial analyses highlighted that DE and zeolite-A were the best filter media because practically all yeast cells were retained on the filter cake from both the simulated beer and the home-brewed beers.

With filtration of commercial beers using small grade zeolite-A as the filter medium *in situ* at Cooper's Brewery an increase in pH value of the filtrate of 2.0 pH units was observed. For large grade zeolite-A the pH increase of the filtrate was less than 0.5 pH units. This increased pH of the filtrate with both grades of zeolite-A was demonstrated to be due to the release of sodium ions from the filter medium. Additional experiments were conducted to exhaust the sodium from the filter media of both the small and large grade zeolite-A. The pH of the filtrates was monitored for between 8 and 16 h of continuous filtration to determine if all sodium could be exhausted from the medium. A practical constraint was that the filter cake became clogged with yeast and other solid particles from the beer haze before a noticeable change in pH of the filtrate could be observed.

Sensory analyses of filtrates of each of the five selected media were carried out by 16 industry *noses*[6] to assess: colour, aroma, taste, clarity and *drinkability* (= overall impression). Overall the large grade zeolite-A filtrates compared satisfactorily with the DE filtrates in ratings of differences from the Descriptive Method employed in the brewery industry for colour, taste, aroma, clarity and drinkability.

[6] Professional noses from within Cooper's Brewery Ltd, Leabrook, SA 5068.

Small grade zeolite-A filtrates however compared poorly where the filtrate was regarded as inferior to DE, filter sand and silica, by all the members of the panel of noses. Small grade zeolite-A was further found to have a significant adverse effect on the filtrate taste using the Triangular Method widely employed commercially for establishing taste. Therefore small grade zeolite-A was deemed an unsuitable filter substitute for DE in the clarification and removal of haze constitutes in commercial beer.

Large grade zeolite-A however appears to be a suitable substitute filter medium for DE in the removal of haze constituents in beer. Importantly it can be readily substituted for DE without the need for significant changes in brewery industry process equipment and protocols for preparation.

The findings from this study are sufficient to strongly recommend a focused study on contributing chemical and mechanical factors to the (small) pH increase of the filtrate using large grade zeolite-A. It is not known whether a range of zeolites might also provide a practical substitute to DE, present understanding must therefore be said to be limited. Other zeolites proposed for the removal of haze from beer would need to be evaluated experimentally. The pilot plant and procedures developed for this study would be readily applicable for such an undertaking. An important justification for future work is that a suitable substitute for DE such as zeolite-A is seen as timely in view of the significant health risks associated with the established carcinogenic properties of DE.

There is no evidence available to show that zeolites have been studied as an alternative to DE for the removal of haze (in beer or wine). Therefore the findings reported in the present study for zeolite-A, together with earlier findings from the polishing of white wine, strongly indicate the basis for development of IP patent(s).

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APPENDICES