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Adsorption Behaviour of Clarified Sugarcane Juice

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Colouring substances in sugarcane juice are undesirable impurities and are classed as non-sugar impurities. The present paper deals with the purification of colouring impurities through the adsorption process using activated charcoal as an adsorbent. The study indicates that an effective purification of CSJ (clarified sugarcane juice) can be obtained at a concentration of 0.04 g carbon/g CSJ for 25 min carbon-CSJ contact time at an ambient temperature (30 ± 2°C) in purification process.

INTRODUCTION

During the processing and storage of fruit juices several changes as loss of volatile compounds, destruction of vitamins and amino acids, hydrolysis of carbohydrates, development of undesirable odours and tastes and browning reaction can occur[1]. One of the most common and certainly most important of these alterations is browning[2], mainly due to the nonenzymatic processes that are caused by the Mallard reaction[3].

Adsorption is commonly used to purify contaminated fluids that are unacceptable in smell and taste. In vapour phase its applications are recovery of organic solvents, separation of air contaminants and gas drying. Associated with the liquid phase are separation of water contaminants, removal of colour impurities from sugar solutions and impurities from vegetable oils. Additional liquid phase applications are related to pharmaceutical needs and those involving the improvement of fruit juices and their derivatives. Typical adsorbents include activated carbon, natural and synthetic zeolites, clays, ion exchange resins, silica gel, activated alumina and some synthetic polymers[4].

Colouring substances in sugarcane juice are undesirable impurities and are classed as non-sugar impurities. These are extracted with sugarcane juice and constitute about 0.17% of sugarcane juice. These non-sugar impurities are the major hurdle in the utilization of sugarcane juice in different value added products. Therefore, the attempts were made to explore the possibility of activated carbon for the removal of colour and maximization of quality attributes in sugarcane juice.

EXPERIMENTAL

Sugarcane (var CoPant 84212) procured from Crop Research Centre (CRC)

of G.B. Pant University of Agriculture and Technology, Pantnagar, was utilized for sugarcane juice extraction. Activated carbon (powdered extra pure) was obtained from E. Merck India Limited, Mumbai, India.

Clarified sugarcane juice (CSJ), obtained using Deola extract[5] was used for the adsorption behaviour in terms of colour, indicator value, turbidity and adsorption efficiency. Activated carbon (as an adsorbent) was weighed in a glass beaker prior to addition of sugarcane juice (100 g/beaker) so that the concentration of activated carbon is in the range of 0–0.2 g activated carbon/gm CSJ. Thereafter, all the beakers were put in a controlled temperature water bath at 30 ± 2°C for 2 h to reach equilibrium conditions. The samples were then centrifuged at 10,000 rpm for 2 min and sugarcane juice, as obtained was analyzed for colour, turbidity and adsorption efficiency.

Adsorption behaviour was conducted using optimum dose of activated carbon for the colour removal. The samples containing activated carbon were then put into controlled temperature water bath at 30 ± 2°C and taken out after 5, 10, 15, 20, 25, 30, 45, 60, 90 and 120 min time interval. The samples were then subjected to centrifugation and followed by analysis for color, turbidity and adsorption efficiency.

For the color, indicator value and turbidity evaluation, samples were adjusted to pH 4, 7 and 9 using buffer of appropriate pH. Buffers of pH 4, 7 and 9 were prepared, by mixing 1 N ammonia and 1 N acetic acid in appropriate proportion using pH meter. It was used with sample to a dilution factor of 5 or 10 and absorbance of these samples was measured at 420 nm. The colour, indicator value were then calculated by following the standard procedures[6, 7]. Turbidity of the samples was examined by UV-VIS spectrophotometer (Beckman DU-7) at a wavelength of 720 nm. Adsorption efficiency (Z) was calculated as the per cent decrease in absorbance of treated clarified sugarcane juice at 420 nm and expressed as

$$Z\,(\%) = \frac{A_0 - A}{A_0} \times 100$$

where A_0 = initial absorbance at 420 nm and A = Final absorbance at 420 nm.

RESULTS AND DISCUSSION

Problem of dark colouration and jaggery flavour are associated with clarified sugarcane juice when used in higher concentration for replacement of sugar in Ready to Serve (RTS) beverages. Therefore, replacement of sugar in higher proportion in Ready to Serve (RTS) is merely not possible unless it is properly purified by adsorption techniques.

Fig. 1 shows the variation in color, indicator value (I.V.), turbidity and adsorption efficiency with the change in concentration of activated carbon. An increase in adsorption efficiency, 0 to 93.82%, was observed with increase in concentration of activated carbon from 0 to 0.2 g carbon/g sugarcane juice in the clarified sugarcane juice (CSJ). As the concentration of activated carbon increased from 0 to 0.2 g carbon/g clarified sugarcane juice, the CSJ color, indicator value

and turbidity were decreased from 19.19 to 1.19, 5.99 to 1.12 and 0.251 to 0.137 respectively. Reduction in these values verified the trend of increased adsorption efficiency. Statistical analysis showed that activated carbon concentration used in the ratio of 0.04 g carbon/g CSJ was the most significant and thereafter the concentration was found to have insignificant effect on colour reduction with $CD_{5\%}$, 0.79.

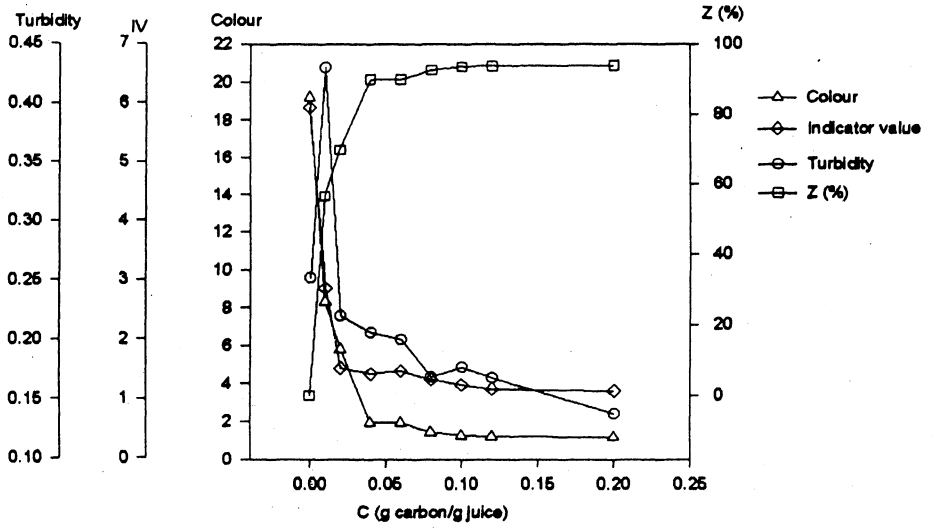

Fig. 1 Effect of carbon concentration in clarified sugarcane juice on colour, indicator value, turbidity and Z(%) decrease in the colour

The above results show that activated carbon concentration, 0.04 g carbon/g CSJ, can be effectively used for the purification of clarified sugarcane juice. This optimum amount was used further to determine the appropriate carbon juice contact time for the purification process.

Fig. 2 shows the effect of carbon contact time on colour, indicator value, turbidity and adsorption efficiency. The colour, indicator value, turbidity and adsorption efficiency were decreased from 19.19 to 1.83, 5.90 to 1.32, 0.251 to 0.095 and 0 to 90.45% respectively as the time increased from 0 to 120 min. The decrease in absorbance was found initially at a faster rate followed by gradual reduction and then equilibrium was approached asymptotically (Fig. 2). Nearly 50% of the total adsorption was observed in the first 10 min followed by 87.44% reduction in 25 min of contact time. The time interval of 25 min was also found to be significant statistically. The higher contact time than 25 min was found to be insignificant ($p \leq 5$). The study well indicates that an effective purification of sugarcane juice can be obtained at a concentration of 0.04 g carbon/g CSJ for 25 min carbon clarified sugarcane juice contact time at $30 \pm 2°C$ in purification process.

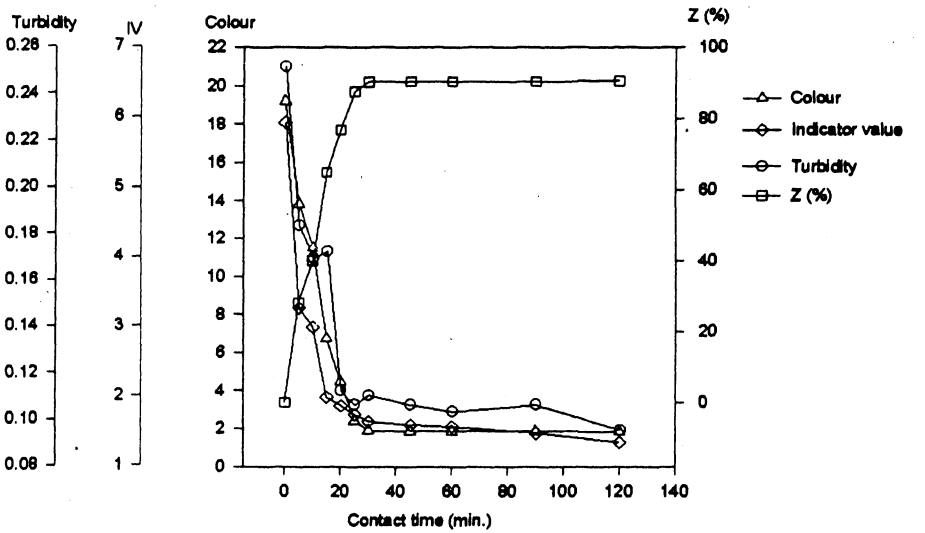

Fig. 2 Effect of carbon concentration in clarified sugarcane juic on colour, indicator value, turbidity
and Z(%) decrease in the colour

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