Asian Journal of Chemistry Vol. 19, No. 7 (2007), 5029-5033

Studies of Decolourization of Cane Juice Using TiO_2 Pellets

S.R. BAMANE
Department of Chemistry, Shivaji University, Kolhapur-416 004, India
E-mail: sambhajibamane@yahoo.com; sambhajibamane@sancharnet.in

Prototype expert system has been developed for decolourization of cane juice. Though much work has been done in the direction of removing colour in the clarification process during sugar manufacture but much success has yet not been achieved. Conventional clarification process cause environmental problem. TiO_2 catalyst has emerged as an effective alternative method. In the present study, attention has been paid decrease the pigments, which causes sugar colouration, cane juice treated with TiO_2 pellets during clarification process. The experiment supported that the TiO_2 pellets work achieve significant decrease of polyphenols due to their reduction in to derivatives. The decolourization efficiency was found to be in the range the 64-40 % at 470 nm for TiO_2 pellets. Most attention has been given to TiO_2 because of its high catalytic activity resistance to corrosion, biological immunity low cost and no formation of toxic intermediate products.

Key Words: TiO_2, Pellets decolourization, Polyphenols, Cane juice.

INTRODUCTION

In recent years, there have been many attempts at developing expert system in the field of environmental science, these expert systems are related to waste water management (BATA, WATERX expert system for anaerobic digester) air pollution control and monitoring process (expert system for gas purification process for power plant) but only few attempts have been made for developing expert system for decolourization of cane juice. Hence an attempt has made in this field by developing a prototype expert system. The colour of the cane juice is mainly due to organic pigments, chlorophyll, xanthophylls and carotenes are removed in clarification or destroyed during boiling and is not using constituents of raw and refined sugar[1]. Constituents that retained and occur as colourants in raw and refined sugar are polyphenols and related compounds.

In sugar manufacturing process, colour-causing compounds are the reaction products of polyphenols and iron related from the factory equipments and lime used. All of these polyphenols darken when in contact with air in alkaline solution and form very dark coloured compound with ferric

ions. Literature survey reported that polyphenols are responsible for sugar colouration[2]. Gupta *et al.*[3] observed decolourization of cane juice over nickel piece. The polyphenolic content in clear juice during decolourizing process conventional chemicals like CO_2, SO_2 and line requires during clarification process. High quality of sugar manufactured using nickel because nickel acts as a catalyst, eco-friendly and is eliminated along with filter cake[4].

Much research has been conducted using thin TiO_2 film by the sol-gel method[7-9]. However, the technical difficulty of coating affects the consistency and quality of the film, leading to variable reducing efficiencies and loss of the catalyst during the reaction process.

Recent worldwide studies have demonstrated that photo catalysis can be used to degrade colour compound using titanium dioxide (TiO_2) and UV light[5]. Variety of oxide powers (FeO, ZnO, TiO_2, CaO, MnO) acting as catalysts have been used.Various methods such as plasma spray decomposition of oxides, precipitation, sol-gel, *etc*. could be used to produce high-purity oxide powder and however these techniques have not received much commercial importance because of the use of expensive raw materials and many processing steps[13]. Recently, microwave assisted combustion synthesis technique has been effectively used to powder in shorter times in comparison with the conventional synthesis[14].

Most attention has been given to TiO_2 because of its high catalytic activity resistance to corrosion, biological immunity, low cost and no formation of toxic intermediate products.

In the present research work, Titania media as pellets was used instead of this film. This form of Titania has the advantage of being easy to handle during industrial application. The reduction efficiency of polyphenols was obtained at various concentrations of juice. When juice was treated with TiO_2 at 60ºC temperature a significant reduction in the polyphenolic content as well as colour was observed. This may be due to the degradation property of TiO_2 due to which polyphenols are reducing to cyclohexanol derivative.

EXPERIMENTAL

Powder preparation

A solid mixture containing requisite quantities of $TiCl_4$ and urea (AR grade) was taken in a Pyrex glass dish and was irradiated with microwaves domestic microwave oven (BPL India Ltd. Model.No. BMO-600T). Within a few minutes of irradiation reaction mixture was converted into clear solution and stared boiling further 2 min of irradiation white fumes started coming out from the exhaust opening. The concentrated mixture solution burst into flames and resulted into porous TiO_2 powder. It represent an

environmental friendly and clean chemical technology and with potential applications to remove colour from industrial sources[10-11].

TiO_2 pellets used were cylindrical in shape will dimension of 10 mm diameter and 2.5 mm thickness under isostatic pressure of 5000 kg/cm^2 TiO_2 pellets ensure that maximum contact occurs with juice and other desirable feature include the ability to very UV light intensities.

The studies of colour measurement was performed by method described in Parathasarthi *et al.*[12]. 5 mL of cane juice was taken in a 100 mL volumetric flask and then diluted of to the mark. Then 5 mL of this solution was pipette in 100 mL flask and 5mL of sodium tungstate (10 %) and 4 mL of H_2SO_4 solution. (0.7 N) were added and stirred well. It was allowed to stand for 0.5 h and than 1 mL of H_2SO_4 solution was added.

The content of the flask was then filtered through whatmann filter paper number. 42 in a 50 mL of volumetric flask. Then 4 mL of H_2SO_4 solution followed by 2 mL of freshly prepared $NaNO_2$ (8 %) was added. Then 5 mL of NaOH (10 %) was added and made up to 50 mL with distilled water. The orange colour was allowed to develop for 5 min and the intensity of colour was immediately measured under 470 mm on UV-Visible spectrophotometer (spectronic 20 D)

The experiment was repeated by taking different quantities 10, 15, 20, 25 mL of juice kept in contact for 4 h with TiO_2 pellets.

Preparation of standard curve of polyphenols

Stock solution of 100 ppm of phloroglucinol was prepared by dissolving 100 mg of phloroglucinol in 1000 mL of distilled water. Then different concentrations of solution from one to nine ppm were taken from the stock solution and readings were noted at 470 nm of the UV-Visible spectrophotometer after developing the orange colour standard curve was plotted against the concentration of phloroglucinol (Fig. 1).

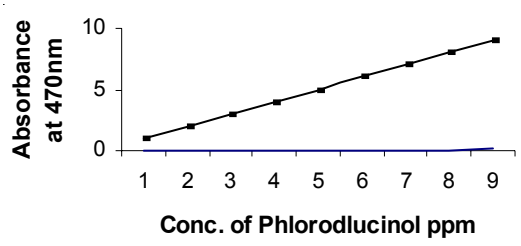

Fig. 1. Standard curve of polyphenols
Decolourization of cane juice was observed at λ_{max} = 470 nm

It was observed that the observance of cane juice in presence of TiO_2 pellets at the same time intervals (Fig. 2). It means that the rate of decolourization is favourable affected by TiO_2 pellets. A plot of absor-

bance *vs.* time was linear and hence, this decolourization follows pseudo first order kinetics. The rate constant of this decolourization was determined by expression. K = 0.01175 (2.303 * slope (0.0051).

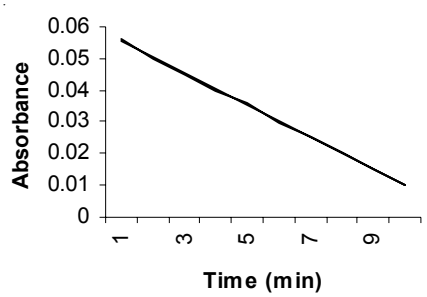

Fig. 2. Graph between absorbance *vs.* time (min)

RESULTS AND DISCUSSION

A study of colour by measuring absorbance at 470 nm UV-Visible spectrophotometer was performed in various quantity of juice in presence of TiO_2 pellets. Sugar cane of variety CO LK 8001 was taken for this study. The colour readings in pure juice of verity CO LK 8001 were 0.055 per 10 mL and 0.075-absorbance 15 mL 0.095 absorbance per 20 mL and 0.114 absorbance per 25 mL. When the juice were kept in contact with TiO_2 pellets for period of 4 h. A decrease in colour was observed and colour was found to be 0.020 absorbance per 10 mL, 0.035 absorbance per 15 mL, 0.050 absorbance per 20 mL and 0.068 absorbance per 25 mL of juice.

When the juices were kept in contact with nickel piece[3] for 4 h, it was 0.029, 0.045, 0.062 and 0.079 absorbance for 5, 6, 7 and 8 mL of juice.

From Table-1, it is clear that the colour of pure juice was due to presence of polyphenols as one of the colouring constituents, significant decrease in the colour was observed when these samples were mixed with

TABLE-1
VARIATION OF ABSORBANCE WITH JUICE QUANTITY IN PRESENCE TiO_2 PELLETS (VARIETY CO LK 8001)

Volume of juice (mL)	Absorbance 470 nm		
	Colour of juice	Colour of juice kept in contact with TiO_2 pellets	Colour of juice kept in contact with nickel piece[3]
10	0.055	0.020	0.029
15	0.075	0.035	0.045
20	0.095	0.050	0.062
25	0.114	0.068	0.079

TiO_2 due to which coloured polyphenols are converted in to colourless cyclohexenol derivatives. The decolourzation efficiency was found to be in the range the 64-40 % at 470 nm for TiO_2 pellets.

Conclusion

This study indicates that using TiO_2 pellets as catalyst can be applied successfully to decolourize the colour of polyphenols, which is major problem of sugar industry in manufacturing better quality of sugar.

REFERENCES

1. Farber and Carpenter, Colourants and Minor Constituents of Cane and Sugar ISSCT, pp. 1589-1600 (1971)
2. Scheneller, The Colouring Matter of Cane Juice, I.S.J., pp. 180-184 (1919).
3. S. Upadhay and A.K. Gupta, *Res. J. Chem. Environ.*, **8**, 40 (2004).
4. K. Singh and B.G. Singh, Extraction and Chemical Analysis of Filter Cake from a Sugar Factory in India Punjab, I.S.J., Vol. 6, pp. 101-105 (2004).
5. S. Malato, J. Blanco, C. Richter, D. Curco and J. Gimenez, *J. Water Sci. Tech.*, **35**, 157 (1997).
6. S Kanmani and R. Chitra, *J. IAEM*, **32**, 131 (2005).
7. S. Hager, R. Bauer and G. Kurdielka, *Chemsphere*, **41**, 1219 (2000).
8. K.H. Wang, H.H. Tsai and Y.H. Hsieh, *Appl. Catal. B*, **17**, 313 (1998).
9. H. Yoneyama and T. Torimot, *Catalysis Today*, **58**, 133 (2000).
10. R.S. Varma, *Green Chem.*, **3**, 146 (2001).
11. A. Loupy, A. Patil, J. Hamelin, T. Boullet, P. Jacqualt and D. Mathe, *Synthesis*, 1213 (1998).
12. Parathasarthi and V. Saradhi, *Curr. Sci. (India)*, **158**, 270 (1958).
13. J. Lin and J. Yu, *Chemistry*, **116**, 63 (1998).
14. R.H.G. Kiminami, A. Moreli, M.R. Folz and D.C. Clark, *Bull. Am. Ceram. Soc.*, **79**, 63 (2000).

(*Received*: 9 May 2006; *Accepted*: 24 May 2007) AJC-5670