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Chemical Clarification of Sugarcane Juice Using Response Surface Methodology

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The potential of chemical clarification of sugarcane juice was assessed using Response Surface Methodology (RSM). The proportions of gelatin, tannin and citric acid were estimated by Central Composite Rotatable Design (CCRD) for the adequacy of clarification characteristics which were measured in terms of colour and turbidity of sugarcane juice. Minimum turbidity was observed from the addition of 12.20 mg per cent gelatin, 8.48 mg per cent tannin and 0.58 g per cent citric acid. After regressing and analyzing, the optimum proportion for maximum reduction of color and turbidity was observed as 12.26 mg per cent gelatin, 9.10 mg per cent tannin and 0.59 g per cent citric acid respectively.

INTRODUCTION

Sugarcane is an important commercial cash crop in India that provides raw material for the second largest agro-industry. India stood second in 1998 in terms of acreage (3.96 million hectare) and production (265.00 million tonnes) of sugarcane, next to Brazil (4.94 million hectare and 338.35 million tonnes). This crop is mainly utilized for the production of sweeteners, *i.e.*, white sugar, jaggery and khandsari. A small quantity is used to produce juice, which is consumed as soft drink due to its flavour, nutritive and therapeutic values[1].

At present sugarcane juice (SCJ) is extracted by small vendors often under unhygienic conditions during summer season effectively. Despite its vast potential sugarcane juice is not being commercially processed and available due to its short shelf life and problems faced during processing such as browning, sedimentation and loss of its typical aroma and taste. Inadequate clarification reduces the shelf life of sugarcane juice[2]. Process optimization using Response Surface Methodology has been reported by various researchers[3, 4]. Chemical clarification of sugarcane juice using lime and carbonation or sulphitation is used for commercial sugar production. However, no work has been reported on clarification of sugarcane juice for use in fruit beverages. The present study was undertaken with a view to study the effect of gelatin-tannin and citric acid on the clarification characteristics of sugarcane juice using Response Surface Methodology.

EXPERIMENTAL

Sugarcanes (var. CoPant 84212) procured from Crop Research Centre (CRC) of G.B. Pant University of Agriculture and Technology, Pantnagar, were utilized for sugarcane juice extraction. Gelatin, tannin and citric acid were obtained from E. Merck India Limited, Bombay.

Sugarcane juice extraction: Sugarcane was peeled lightly to remove buds (actively growing part of cane stalk), waxy bloom, dirt and dust from the sugarcane surface. Juice was extracted at room temperature using a double-roller hand-operated cane crusher. The cane crusher was washed thoroughly with distilled water after each extraction.

Experimental design and Statistics: Clarification of sugarcane juice was carried out using gelatin, tannin and citric acid as per central composite rotatable design (CCRD) given in Table-1. The observed responses for colour and turbidity were regressed against gelatin, tannin and citric acid levels for second order polynomial model and contour plotting.

TABLE-1
PLAN OF EXPERIMENT FOR THE STUDY OF PHYSICO-CHEMICAL CHARACTERISTICS OF CLARIFIED SUGARCANE JUICE BY GELATIN, TANNIN AND CITRIC ACID

Experiment No.	Experimental and coded values					
	Gelatin (mg %)		Tannin (mg %)		Citric acid (g %)	
1.	8.433	−1	2.433	−1	0.122	−1
2.	15.567	1	2.433	−1	0.122	−1
3.	8.433	−1	9.567	1	0.122	−1
4.	15.567	1	9.567	1	0.122	−1
5.	8.433	−1	2.433	−1	0.478	1
6.	15.567	1	2.433	−1	0.478	1
7.	8.433	−1	9.567	1	0.478	1
8.	15.567	1	9.567	1	0.478	1
9.	6	−1.682	6	0	0.3	0
10.	18	1.682	6	0	0.3	0
11.	12	0	0	−1.682	0.3	0
12.	12	0	12	1.682	0.3	0
13.	12	0	6	0	0	−1.682
14.	12	0	6	0	0.6	1.682
15.	12	0	6	0	0.3	0
16.	12	0	6	0	0.3	0
17.	12	0	6	0	0.3	0
18.	12	0	6	0	0.3	0
19.	12	0	6	0	0.3	0
20.	12	0	6	0	0.3	0

Colour and turbidity were estimated as per the standard methods[5]. Total soluble solid (TSS) of the samples was measured using hand held refractometer (Range 0–50°, Brix, Gardener Corporation, New Delhi) at 20°C. Titratable acidity of the samples was estimated by potentiometric titration[6].

RESULTS AND DISCUSSION

The sugarcane juice is generally clarified by sulfitation process, which results in high residue of calcium. This may enhance post storage haze in the beverages; therefore a method based on gelatin, tannin and citric acid clarification was adopted. The effect of gelatin, tannin and citric acid, in different combinations, on the turbidity is given in Figs. 1, 2 and 3. Minimum turbidity was noticed from the addition of 12.20 mg per cent gelatin and 8.48 mg per cent tannin. Thereafter an increase in turbidity was observed as the gelatin concentration increased. An increase in citric acid concentration resulted in reduction of the turbidity. The

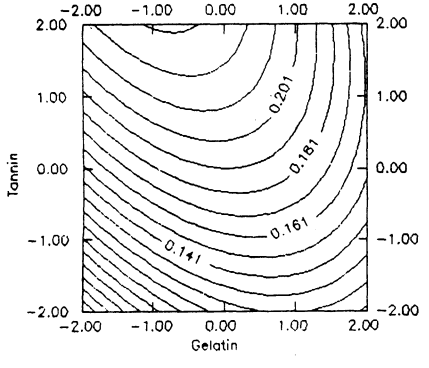

Fig. 1. Effect of gelation on sugarcane juice turbidity.

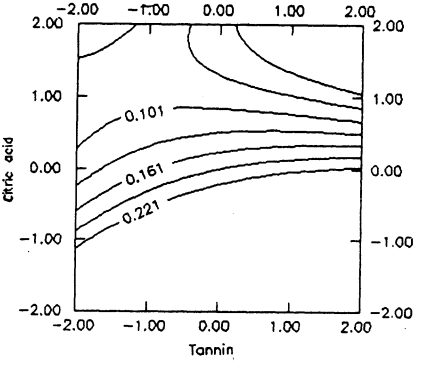

Fig. 2. Effect of tannin and citric acid on sugarcane juice turbidity.

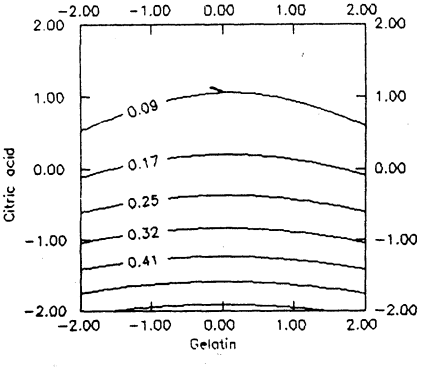

Fig. 3. Effect of gelatin and citric acid on sugarcane juice turbidity.

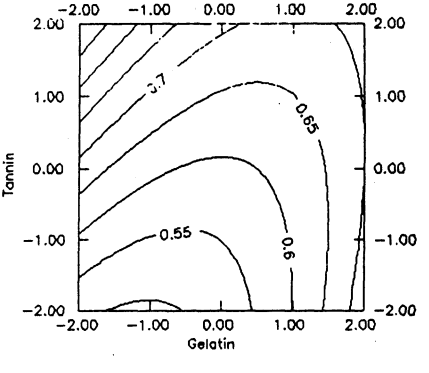

Fig. 4. Effect of gelatin and tannin on sugarcane juice color.

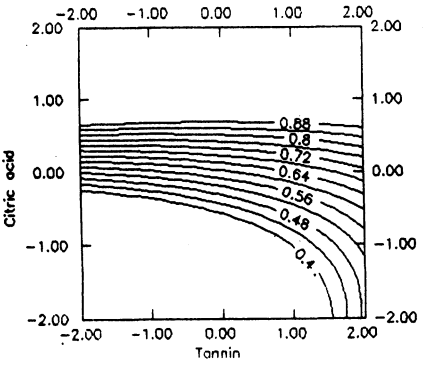

Fig. 5. Effect of tannin and citric acid on sugarcane juice color.

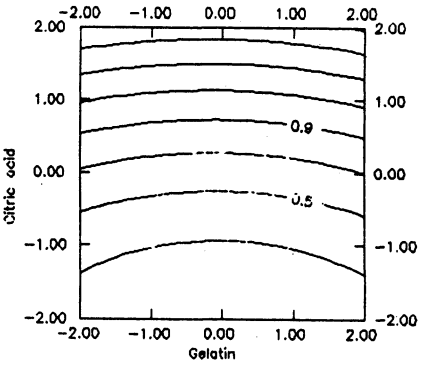

Fig. 6. Effect of galatin and citric acid on sugarcane juice color.

turbidity decreased from 1.235 to 0.110 from the addition of citric acid from 0 to 0.58% respectively.

Minimum colour was noted from the addition of 12.14 mg per cent gelatin, 7.80 mg per cent tannin and 0.60 g per cent citric acid (Figs. 4, 5 and 6). As the concentration of tannin and citric acid increased, colour values were increased. After regressing and analyzing Figs. 1 to 6, the optimum combination for maximum reduction of colour and turbidity was observed as 12.26 mg per cent gelatin, 9.10 mg per cent tannin and 0.59 g per cent citric acid respectively. The data may prove to be beneficial when adopted for gelatin-tannin clarification.

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