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Effect of Addition of Separan at Different Concentrations as a Flocculants on Quality of Sugar Cane Juice

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Abstract**—**The study was designed to evaluate the use of low concentrations of separan flocculent (Less than 3 ppm) on physicochemical properties of sugar cane juice. Colour, pH, purity, turbidity, pol, brix, reducing sugars tannins and polyphenols of crushed cane (green and burned) juice, mixed juice and clarified juice were studied. The results showed that pol, brix, reducing sugar and turbidity are higher in crushed cane juice. Clarified burned juice had low turbidity, reducing sugars, pol and brix but had significantly lower pH, purity and colour when compared to crushed juice. Polyphenols of the crushed juice (1.19%) decreased significantly in the clarified juice to 0.006%. Addition of separan at a concentration of 0.015 ppm reduced significantly colour, polyphenols and tannins and reducing sugar compared to the control.

Keywords**—**Separan, Sugar cane, Reducing sugar, Polyphenols, Clarified juice.

I. Introduction

COLOUR of the sugar crystals is an important factor that determines its value in the market and acceptability for various uses. Besides, these juices contain a series of natural colouring compounds and other constituents such as polyphenols, chlorophyll and the anthocyanin amino acids, etc. All these constituents could not be eliminated during the process of clarification and generate colour during the post-clarification process up to the raw cane [1]. During milling they are extracted with the cane juice and constitute a portion of the non-sugars matter that should be eliminated at the subsequent processing of the sugar. In addition, other colouring materials are formed during juice processing operations as a result of chemical reactions, such as caramalisation and the reactions between certain non-sugar materials. The type of cane, soil, and growing conditions, geographical area, and the milling and refining process employed have impact on developing of such reactions during processing [2]. The production of both raw and refined sugars and the removal of the coloured impurities become extremely important; particularly in view of the increasing demands for exceptionally high quality white refined sugar [3]. Mathur [4] reported that polyphenols formed brown iron complexes where as others generate colour by polymerization due to the effect of high temperatures used in the processing operations. Although these colouring factors and constituents could not be eliminated during processing, efforts can be made to reduce the formation of brown iron complexes and polymerization of colouring matters by suitable measures. The coloured non-sugars material present in cane juice cans be removed by various chemical or physical processes. This may involve removal by precipitating agents such as lime, phosphoric acid and separan [5]. Flock formation can be improved by the use of high molecular weight water soluble synthetic resins like "Separan". The use of polymers in the treatment of refractometer juices has become normal practice and less expensive than correcting phosphate deficient juice bythe addition of phosphates. Separan is usually added to the limed juice at a concentration of 2 to 3 parts per million. However, the method of the addition of Separan is of great importance for achieving the required clarification [6]. Accordingly, our paper was directed to investigate the use of low concentrations of separan as cane juice clarifier and to compare that with the standard concentrations used.

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II. Materials and Methods

A. Materials

Green and burned samples of sugarcane (variety CO997) were collected from the fields of Kenana Sugar Company. Burned sugar cane were processed in Labourites of the Sugarcane Research Department and juice samples; crushed (untreated), mixed (water imbibitions), and clarified (separan AP30 added) juice were prepared and stored at 4 °C for subsequent analysis.

B. Determination of the pH

The pH of the juice solution was measured using a pH-meter (HANNA-pH 210).

C. Determination of the Sucrose Content (Pol)

Sucrose content (Pol) in sugarcane juice was determined by the double Polarization Method using a refractometer

(ICUMSA Method GS 4/7-1, 1994).

D.Determination of (Soluble Solid) the Dry Matter Content (Brix)

Brix of cane juice was determined as the corrected reading of the refractometer following ICUMSA method [7].

E. Determination of Reducing Sugar

Reducing Sugars in Cane juice was determined following Lane/Eynon Procedure (Method GS 1/3/7-3 – ICUMSA, 2005) using Fehling solution as oxidizing agent. Johnson's Table was used to calculate the percentages of the reducing sugars.

F. Determination of the Colour Value

Fifty grams of the juice sample was diluted according to the need of the experiment and filtered using bunchier funnel with 0.45mm membrane filter. The pH of filtrate was adjusted to pH 7. Brix and absorbance degree of the filtrate was recorded using the refractometer, and telemeter receptively. Colour value was calculated as:

Colour value= Reading (Telemeter) x brix factor = Mau. (ICUMSA 2005).

G.Determination of Turbidity

The hot clarified juice sample was cooled under running tap water to room temperature (30°C). Then the nester tube filled by the sample that to be determined and read, the reading is in NTU units [7].

H.Separan AP30 Clarification Experiment

Three milligrams of separan were mixed in 1000 mL distilled water preparing a solution with a concentration of 3 ppm (control). Sepapran solutions with different lower concentrations (0.001-0.015 ppm) were prepared. A separan-free mixed juice sample was obtained from the factory and heated to 90 °C for hr. The heated mixed juice samples in sedimentation apparatus were treated with different concentrations of separan (0.001-3 ppm). Then the clarified juice samples were examined for physicochemical properties.

İ. Statistical Analysis

Data with five replications were subjected to analysis of variance. The data were analyzed using MSTATC program and means were compared and significance difference was accepted at P ≤ 0.05.

III. Result and Discussion

A. Effect of Milling on Physicochemical Properties of Green and Burned Cane

Physicochemical properties of green and burned sugar cane juice are presented in Table 1. Cane juice pol (sucrose), brix, reducing sugar (RS), purity and pH of both green and burned cane were found to be similar and did not differ significantly (P ≤ 0.05). A significantly (P ≤ 0.05) higher colour value was found in green cane juice (53600) compared to the burned cane juice (2600). The presence of chlorophyll in the green cane may be responsible for the dense colour value observed. Sugar cane variety and its amount of chlorophyll were reported to be the factors that governed the colour value of the cane juice [8 & 9].

B. Effect of Processing on Physicochemical Properties of Burned Cane Juice

Physicochemical parameters of crushed, mixed and clarified juice are presented in Table 2. Results showed that pol and brix of the crushed juice are significantly higher (P ≤ 0.05) than those of the clarified and mixed juice. The above quality parameters of both mixed and clarified juice are comparable and not different significantly. The higher Brix reading in the crushed juice (18.26) may be due to the presence of high amount of colloidal matters [10]. Colour reading in the three juice samples is significantly varied and the clarified juice scored the highest value (13009). The high colour value of the clarified juice could be due to changes occurred in sugar and non-sugar matters due to factors such as heat, pH, iron from equipments, and the added chemicals such as lime [11 & 12] The application of heat or addition of chemicals during clarification process brings about flocculation or coagulation of the colloidal matters and reduced clarified brix reading [13]**.** The results indicated that the pH of the clarified cane juice (6.80) is significantly (P ≤ 0.05) higher compared with those of the mixed (5.36) and the crushed (5.42) juice samples. Spencer and Meade [14] demonstrated that the purification process in cane juice by addition of lime lead to neutralization of the organic acids originally contained in the juice and hence resulted in high pH readings in the clarified versus the mixed juice.

TABLE I
EFFECT OF MILLING ON PHYSICOCHEMICAL PROPERTIES OF GREEN AND BURNED CANE JUICE

Treatment	Pol %	Brix%	Purity	Color/ Icumsa	R.S	pH
Green cane	18.15 ±1.27	20.56 ±1.12	88.28 ±4.70	5360* ±0.49	0.79 ±0.52	5.40 ±0.09
Burned cane	18.14 ±0.94	20.93 ±0.66	86.67 ±1.88	2600 ±0.32	1.10 ±0.36	5.40 ±0.20

Values are means ±SD of five replicates. Means with star superscript are significantly different at (P≤0.05)

C. Effect of Separan AP30 Concentration on Physicochemical Properties of Cane Juice

Physicochemical properties of the mixed sugar cane juice as affected by separan concentration are presented in Fig. 1 to 6. Results illustrated that pol (Fig. 1), brix (Fig. 2), reducing sugars (Fig. 3), purity (Fig. 4), turbidity (Fig. 5) and pH (Fig. 6) of the mixed cane juice treated with separan at the level of 3 ppm (control) were 85.61, 7.36, 7.36, 13068, 13.06, 16.36

TABLE II
PHYSICAL AND CHEMICAL PROPERTIES OF RAW, MIXED AND CLARIFIED BURNED CANE JUICE

Treatment	Pol%	Brix%	Purity	pH	Color/ Icumsa	RS	Turbidiy NT
Crushed juice	15.76* ±1.82	18.26* ±1.85	84.26 ±2.56	5.42 ±0.81	5569 ±0.81	1.04 ±0.52	14.00 ±1.04
Mixed juice	12.24 ±2.90	12.86 ±1.27	95.18* ±3.55	5.36 ±0.11	3445* ± 0.83	0.80 ±0.32	12.09 ±0.75
Clarified juice	12.99 ±1.87	13.68 ±0.09	94.96* ±2.80	6.80* ±0.20	13009* ±0.76	0.83 ±0.32	9.47 ±0.73

Values are means ±SD of five replicates. Means having stars in columns differ significantly ($p \leq 0.05$). Pol, Sucrose; RS, Reducing sugar.

and 0.66. Results also revealed that addition of separan with concentrations range of 0.001-0.015 ppm did not change significantly pol and purity of the mixed juice. Turbidity, pH, brix and reducing sugars are varied significantly. However, separan dose of 0.015 ppm resulted in a significantly ($P \leq 0.05$) lower turbidity (4.94) compared to the control sample. Moreover, mixed juice treated with separan concentrations of 0.001-0.015 ppm showed significantly ($P \leq 0.05$) higher pH values (7.25-7.49) compared to pH of the control sample (6.91). The mixed juice samples treated with separan at levels of 0.001 to 0.015 resulted in significantly ($P \leq 0.05$) lower values for colour, brix and reducing sugars compared to those of the control. Spri [5] stated that coluored non-sugars that are present in cane juice can be removed by various chemical or physical processes**.** This may involve removal by precipitating agents such as lime, phosphoric acid and separan that are used in clarification. The decrease in polyphenols and tannins (data not shown) may support this postulation.

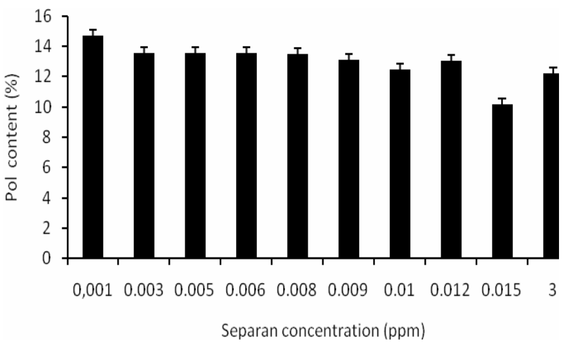

Fig. 1. Effect of separan concentration on pol content of burned sugar cane juice.

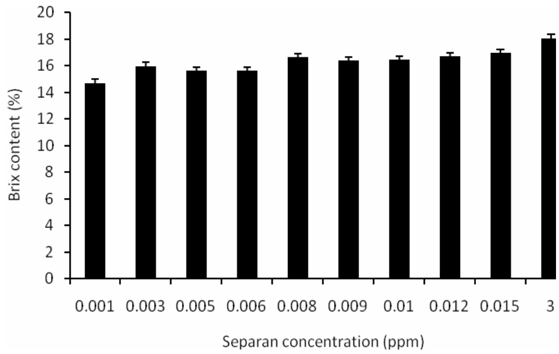

Fig. 2. Effect of separan concentration on brix content of burned sugar cane juice.

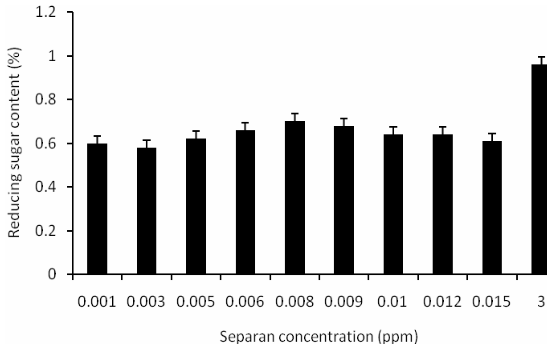

Fig. 3. Effect of separan concentration on reducing sugar content of burned sugar cane juice.

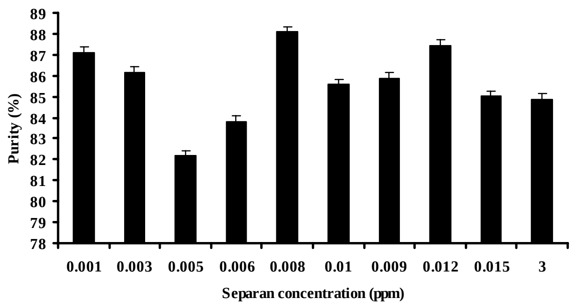

Fig. 4. Effect of separan concentration on purity of burned sugar cane juice.

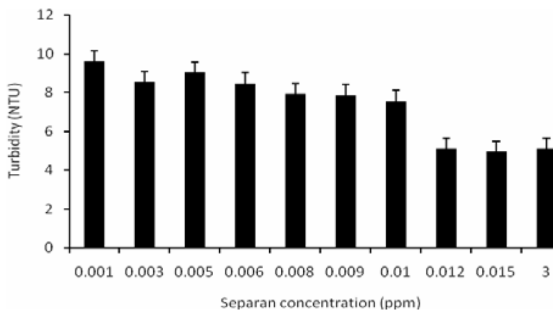

Fig. 5. Effect of separan concentration on turbidity of burned sugar cane juice.

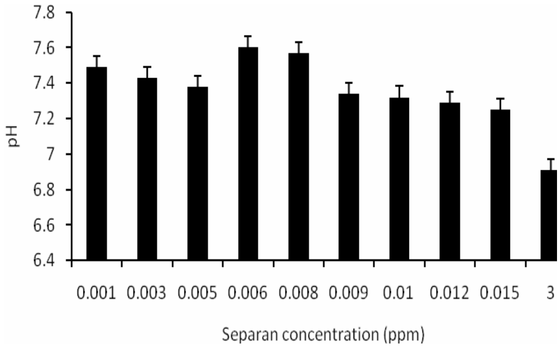

Fig. 6. Effect of separan concentration on pH of burned sugar cane juice.

IV. CONCLUSION

Addition of separan AP30 at low concentration (0.015ppm) resulted in a significantly better quality clarified juice as compared to the standard processing practice (3 ppm separan). This indicates the possibilities of obtaining high quality clarified juice with low economic value.

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