Monitoring method for brown sugar decolorization ion-exchange resin

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Abstract

primary objective of refining raw sugar is the removal of color from other impurities, in order to produce sugar with good color and good crystallographic homogeneity. The response surface methodology allowed optimizing bleaching brown sugar. Optimal color values (300UI, 841UI) and pH (8) are met with a type of well refined syrup and resin age of 04 weeks. The study highlight the important role of driving a good discoloration which helped us to realize a comparison between the resins when they are at the beginning and end of their life cycles.

Key words: sugar technology, bleaching, ion exchange resin, RSM.

1. Introduction

Making white sugar based on physicochemical principles of sucrose crystallization They remain rather obscure. It is absolutely necessary to characterize the effects of process parameters throughout the process of crystallization and thus to control the quality of the finished consumer product . Direct consumption sugar Algeria is high and represents approximately 70% of total consumption against an average of 30 % in the European Union [1]. Sugar industrially from sugar cane and sugar beet . During its extraction , the impurities are occluded inside the crystals is or are grafted to the surface there . Henceforth , refining is an important step that allows to reach , after exhaustion of impurities, a good white sugar , ready to be consumed. To extract, refine and concentrate the sugar content of the cane, it must be subjected to a treatment that has become very complex over the years. The objective is to sweets from the purest raw material and can produce , with an optimum yield, quality sugar . The sugar industry is primarily a separation and purification . A large number of unit operations and separation are implemented [2]. Today , the process is highly mechanized and allows to obtain a product of high purity . The cane juice is heated in the presence of agents such as calcium carbonate , calcium hydroxide , carbon dioxide (carbonic clarification calc) and sulfur dioxide , precipitating proteins and other secondary substances . Thereafter , the sugar solution is filtered and subjected to an initial evaporation , followed by evaporation in vacuum to form a syrup having signs of initial crystallization . This syrup , which is given the name of cooked mass is subjected to a further evaporation process until the crystallization is advanced . Thereafter , the sugar crystals are separated from the liquid by centrifugation. The liquid , which still contains sucrose and a small amount of non- crystallizing sugars , is molasses[3].
For this purpose , one of the most important criteria to ensure quality is the color of sugar . For

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this, it is necessary to ensure the proper functioning and stability of the sugar refining process , including key steps of the reduction of color. In this perspective focuses our work with a monitoring process of refining raw sugar on ion exchange resin in order to better understand the effect of different sections on the color of the sugar.

2. Materials and Method

2.1. Abbreviations

CCD : central composite design
ICUMSA: International Commission for Unification Méthods for Sugar Analysis.
LS : Standard liquor.
R1 : Sugar first jet.
RSM : réponse surface methodology
SD : Discolored syrup.
SF : syrup Filter.
SR : Syrup overhaul.
TD : Rate of discoloration.
df: degree of freedom

2.2. samples

The study was to monitor the color from the filtered syrup to white sugar, while appreciating the role of section discoloration and its influence on the quality of white sugar. Table 1 shows samples having parameters studied. On different syrups, we realized an appreciation of the color over time, and the white sugar (finished product), control the physico-chemical quality was made. As regards the monitoring of the color samples are taken from various sections of an industrial scale precisely at the junctions. Thus, a valve located at each junction collects an aliquot (sample).

2.3. physicochemical analyzes

2.3.1. pH measurement

The pH measurement is made by a pH meter with a glass electrode. It is based on a reaction involving the free H^+ ions in a solution.

2.3.2. Colour Measurement syrups (ICUMSA GS 1/3-7, 2002)

The color of the solution is determined from the value of the absorbance measured at 420nm.

color = (1000xAbs)/(bxc) "Eq.1"

Abs : Absorbance of the solution;

b: Thickness (1cm) cell (optical path within the solution) ;

c : Concentration (g/ml) of the sugar solution.

2.3.3. calculating the rate of discoloration

The fading rate formula is shown in the following equation:

decolorization rate = (color of SF-color of SD)x100/ (color of SF) "Eq.2"

2.3.4. Evaluation of the quality of white sugar

2.3.4.1 Polarization of white sugar (ICUMSA GS 2/3-1,1994)

The optical rotation of a solution of sugar is the algebraic sum of the effect produced by its major sucrose content of the product and by traces of other optically active components.

3. Results

3.1. Optimization fading brown sugar by Response Surface Methodology

The variation values of the color and the pH are shown in Table 1.

Table 1. The experimental conditions and the response values observed CCD

std	run	Factor 1:A type of Syrup	Factor 2:B Age resin	Response 1 color	Response 2 pH
1	1	1.00	1.00	483.5	7.76
2	2	1.00	2.00	534	7.51
3	3	1.00	3.00	539.2	7.66
4	4	1.00	4.00	464.2	7.65

5	5	2.00	1.00	230.2	8.24
6	6	2.00	2.00	219.5	8.04
7	7	2.00	3.00	245	8.20
8	8	2.00	4.00	192	8.14
9	9	3.00	1.00	274.5	8.19
10	10	3.00	2.00	221	8.02
11	11	3.00	3.00	246.5	8.09
12	12	3.00	4.00	182	8.21

3.1.1. Analysis of the variance of the effect of different parameters on color

The effect of the type of syrup and age of the resin on the color is shown in Table 2 and shown in Figure 1.

Table 2. Analysis of variance (ANOVA) for quadratic response surfaces (color) Model for color when fading brown sugar

Source	Somme square	df	F-value	p-value prob > F
Model	2.139	5	63.73	<0.0001
A-type syrup	1.504	1	224.13	<0.0001
B- age resine	2580.70	1	3.85	0.0976
AB	996.00	1	1.48	0.2689
A^2	57193.61	1	85.23	0.0001
B^2	2661.14	1	3.97	< 0.0936
Residual	4028.85	6	-	-
Cur total	2178.85	11	-	-
Std Dev	25.91	-	-	-
mean	319.31	-	-	-

CV%	8.11	-	-	-
Press	20812.45	-	-	-
R_Squart	0.9815	-	-	-
Adj R source	0.9661	-	-	-
Pred r squart	0.9045	-	-	-
Adeq precisior	18.574	-	-	-

The p-values indicate that the words A, A^2, have significant effects ($p < 0.05$) in the process for the color fading of the p-Value terms also indicate that B, B^2 have no significant effect ($p > 0.05$) on the color hang fading. The relative amplitude coefficients estimation (Equation 3) indicates the significant effect on the color type of syrup (173.13), followed by the age of the resin (-19.68) with a non effect significant.

$$Color = +249.29+137.13*A-19.68*B-14.97*A*B+148.45*A^2-20.51\,B^2 \quad \text{"Eq.3"}$$

These results indicate that the less color decreases with increasing age of the resin without being influenced by the type of syrup (non-significant effect on the color of the quadratic term B^2)[4].Further, the interaction term effect insignificant effect on the color. The nature of the response surface curves showing the interaction between the variables. From the curve of response surfaces (Figure 1) it is clear that the color is more important (dark) for the SD and SF LS, so the color decreases and as the fading process syrups (significant effect). Regarding the age of the resin, it is noted from the same curve response surface that as the age of the resin increases, the color signs decrease less.

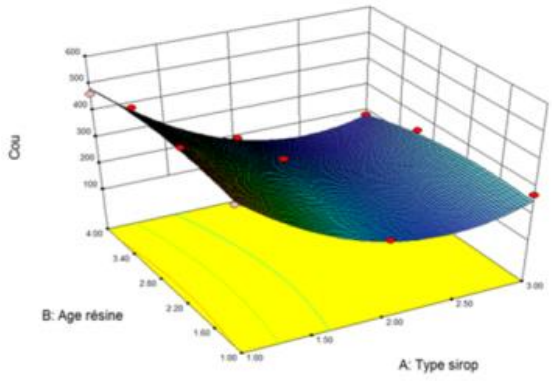

Figure 1. Surface responce the effect of type of syrup and the age of the resin on the color

3.1.2. Analysis of the variance of the effect of different parameters on the pH

The p-values indicate that the words A, A^2, have significant effects ($p < 0.05$) over the pH during the process of fading the p-value indicates that the terms B, B^2 have no significant effect ($p > 0.05$) on the pH during bleaching syrups. The relative amplitude coefficient estimation (Equation 4) indicates the significant effect of type of syrup (+8.09), followed by the age of the resin (-0.03) with a non-significant effect.

$$pH = 254+8.090.24*A-0.03*B-0.023*A*B+0.27*A^2-0.13*B^2 \qquad \text{"Eq.4"}$$

These results indicate that the pH decreases with the type of syrup without being influenced by the age of the resin (non significant effect on the pH of the quadratic term B^2) Further, the interaction term has an insignificant effect on the pH . From the response surface curve (Figure 2) it is seen that the pH increases with increasing the type of syrup (elliptical shape of the curve) and the LS to a higher pH than the SD, itself higher the SF (significant effect of type of syrup). Regarding the age of the resin, it appears that the pH is not influenced (slightly circular shape of the curve).

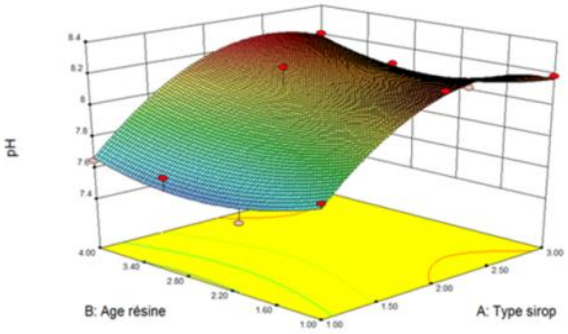

Figure 2. Surface responce the effect of type of syrup and the age of the resin on the pH

Best for bleaching brown sugar conditions were determined to obtain the minimum color and neutral pH (Table 3). In this study, the optimal values in the case of fading is achieved with a type of syrup (1.50: well refined syrup), and age resin 4 weeks At this point, the color and optimal pH were calculated. respectively as 8 and 300 821 IU. So we can push the use of the resin to a period of 4 weeks if we start the fading process with a well refined filtered syrup [5][6].

Table 3. constraints and optimization fading brown sugar

Name	Global	Limite	weights	weights	importance
A :Type syrup	Is in range	1	1	1	3
B:Age Resin	maximise	1	1	1	3
Color	minimise	182	1	1	3
pH	objectif=8	7.51	1	1	3
		Solution			
Number	Type syrup	Age resin	Color	pH	Desirability
1	1.50	4.00	300.82	8.00	0.874

4. Discussion

R^2 values indicate that more than 95% of the experimental data are consistent with data values predicted by the model and only 5% of the total variations are not explained by the model. The mathematical expression of the relationship a response with the variables shown in equation 1 and 2 .

The greater the amplitude of the value of F is high and that of P , the smaller the corresponding coefficient is significant, the value of " Prob > F " lower than 0.05 indicate that the models are significant factors , the higher value 0.05 indicate that the model factors are not significant .

For this study A, B, A ² B ² are the terms of models with effects on color and pH. Linear , quadratic response surface effects , the sign and magnitude of the coefficients indicate the effects of variables on the response. For the interaction level of positive one interactive variable may increase while the other decreases in order to achieve a constant value of the response.

Conclusions

Through this study , we have attempted to contribute to the monitoring of sugar decolorization , this study focused syrup during the bleaching step . The results show that the raw material complies with the standards color three samples ≤ 900 IU regulated value . The color values of the filtered syrup randomly changing with time depending on values of between 463 and 811 IU , however, there is stability in the color values of between 135 and 100UI , the pH of the SF has an average of 7.65 , the SD1 and SD2 pH however, are more basic due to the regeneration and replacement of the resin e resin gives lower pH SD1 and SD2 of (6.21) .

Overall results , we found that the major problem generated is the instability of the color (> 800 IU) [7]. This is probably due to the exhaustion of the resin as well as the judgment of the column that produces a caramelized syrup and the flow of training. Our study measured the impact of fading on the quality of white sugar. Indeed, refining raw sugar is a very delicate process requiring continuous monitoring resulted in white sugar , including fading (determining step) , gives a finished product whose color varies between 24UI 35UI and knowing that the maximum value is of 60UI . In the end , the discoloration is to discolor the syrup filtered prior refined and carbonated, has a very important role in the welfare of the quality of white sugar [8] .

Acknowledgements

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