

Comparative Study of Date Syrup Decolourization Efficiency with Ion Exchange Resins and Bone Char

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Date syrup is an important date by-products with about 67-72 % solids containing *ca.* 95 % reducing sugars. This product can be used as sweetener in different food industries but its brownish colour is a limiting factor. The aim of this work is to investigate the possibility of date syrup's colour substances removal by bone char and ion exchange resins. In this study decolourization effect of bone char and Amberlit IRA 410 (a strongly anionic resin) was studied in the form of factorial experiment using completely randomized design, contact time considered to be 10, 20, 30 and 60 min and the decolourizing substances quantities were 2, 4, 6, 8, 10, 20 and 30 %. Satisfactory result was obtained and decolourization rate for bone char and ion exchange resin was 89 and 87.6 %, respectively. Some chemical characteristics of decolourized date syrup was also investigated. The results indicated that replacement of invert sugar and glucose syrup with date liquid sugar would be possible.

Key Words: Bone char, Date syrup, Decolourization, Ion exchange resin.

INTRODUCTION

Iran is one of the major date producing countries in the world and produces about 900,000 t of dates annually. After harvesting, processing and packaging, a significant proportion is discarded as waste. Date syrup is an important by-product of date, with 67-72 % solids content consist to 95 % reducing sugar, but its brownish colour is a limiting factor for use as sugar and glucose syrup replacer in the food industries. A little information is available on the nature of date syrup colourants involved, However, according to Mohamed and Ahmad¹ melanoidins account for the major part of the colourants of date juice originating from maillard reactions between amino acids and reducing sugars. Other colourants identified by these authors

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are alkaline degradation products of hexoses and iron-polyphenol complexes. In accordance with their observations, an efficient clarification of date syrup has been achieved by the use of calcium phosphate precipitation. Ehrenberg² worked on the decolourization of date extract with lime then cationic and anionic exchanger yielded syrup with a purity of 99.26 %.

Wolf *et al.*³ assessed decolourization ability of ion exchanger resins and concluded that anionic ones with divinylbenzene-styrene matrix have higher selectivity for date juice's colourants. According to Bento's work styrenic resins have higher decolourization power than cationic because of their ability to fix colourants both through ionic bond and hydrophobic interactions with the resin matrix^{4,5}.

Nakahara and Tetsujiro⁶ have used membrane based techniques for decolourization purposes and obtained clear syrup by ultra filtration through a 20000 Da membrane. Lewandowski *et al.*⁷ compared decolourization efficiently of ultrafiltration and electrodialysis with ion-exchanger resin and concluded that the higher decolourization capacity of latter.

In this work we are concerned to assess possibility of date syrup decolourization *via* ion exchange resin and bone char to meet liquid sugar requirements.

EXPERIMENTAL

Date syrup preparation: The variety of Kabkab dates are used for date syrup preparation. Dates were placed in water (80 °C) and completely mixed, then filtrated juice was concentrated up to 70-75° Brix with rotary evaporator at 40 °C.

Decolourization of date syrup: A diluted solution of date syrup was decolourized *via* two different technique as follow:

-2, 4, 6, 8, 10, 20 and 30 % bone char

-2, 4, 6, 8, 10, 20 and 30 % anionic resin (Amberlite IRA 410).

In all of the above methods conduction time between date juice and decolourization agents was 10, 20, 30 and 60 min.

Analysis of decolourized samples: After decolourization pH, brix, ash and coloure was measured according to references methods and colour removal per cent by this equation⁸:

$$\% \text{ Decolourization} = (1-A/B)/100$$

A = Absorbance after decolourization; B = the Absorbance befor decolourization.

Analysis of decolourized and commercial syrups: Date syrup samples were analyzed for total sugars and reducing sugars using the 'lane-Eynon' volumetric method, the sucrose content was determined using 'Lane-Eynon' method before and after inversion and glucose evaluated by iodometric procedure, other measurements taken were of pH, brix (obtained from the refractive index), ash (by conductimetric measurements) and colour (express in ICUMSA units)⁹.

Statistical analysis: Statistical analysis was performed using SPSS v 10. Eeperimental design for decolourization efficiency comparison was factorial on the basis of three replicated randomized complete.

RESULTS AND DISCUSSION

Decolourization of date syrup with ion exchange resin: The result of statistical analysis for decolourization by resin IRA-410 have been shown in Table-1. Table-1 indicates that there are meaningful relationship in different levels of decolourizing material, conduction time (CT) and cross effect of two factors.

TABLE-1
ANALYSIS OF VARIANCE ON MEASURED PARAMETERS ON
DECOLOURIZED SYRUP WITH AMBERLITIRA410

Source of variation	df	Analyzed parameters (mean squares)		
		Ash × 1000 (%)	Colour (IU)	DR (%)
Amount of Amberlit IRA410	6	34**	2826123**	7203.9**
Contact time	3	62**	1362824**	3495.6**
Amount of Amberlit IRA410 × Contact time	18	3**	1591530**	402.1**
Error	56	0.002	344	0.64
Coefficient variance (%)		0.44	1.40	2.43

ns = non-significant at $p > 0.01$ **significant at $p > 0.01$.

Ion exchange resins used in the sugar industry as decolourizers, their matrix is usually composed of one of two types of polymeric material *i.e.*, polystyrenic or acrylic. Styrenic ones are more prone to fouling by organic compounds than acrylic resins and need more special acid regeneration. Studies on the decolourization ratio proved that the anionic resins have a slightly lower selectivity for colourants unlike bone char and with 30 % resin (CT 30-60 min), 20 % (CT 60 min) this factor will be 87.6 % and date juice colour 245 IU.

According to Bento's research styrenic resins do not remove the majority of flavonoids and caramels present in feed liquer but melanoidins and MADP'S (hexose alkaline degradation products), being anionic in alkaline media, are strongly retained media, are strongly retained⁴.

Decolourization of date syrup with bone char: The result of statistical analysis for decolourization by bone char have been shown in Table-2. Table-2 indicates that there are meaningful relationship in different levels of decolourizing material,

TABLE-2
ANALYSIS OF VARIANCE ON MEASURED PARAMETERS ON
DECOLOURIZED SYRUP WITH BONE CHAR

Source of variation	df	Analyzed parameters (mean squares)		
		Ash × 1000 (%)	Colour (IU)	DR (%)
Amount of bone char	6	30**	1780523**	45449**
Contact time	3	27**	2135750**	5474.7**
Amount of bone char × Contact time	18	2**	87531**	213.8**
Error	56	0.027	127	0.029
Coefficient variance (%)		0.30	0.84	0.53

ns = non-significant at $p > 0.01$ **significant at $p > 0.01$.

conduction time (CT) and cross effect of two factors. The results indicated that bone char has a higher capability for adsorbing minerals so in the samples with more bone char and longer conduction time, ash to be decreased.

Bone char is used extensively in sugar refining as a decolourization adsorbent. After use it is regenerated by washing and kiln heating so that the char can pass through many cycles of operation before its activity has decreased to an unacceptably low level⁶. Decolourization with bone char need more conduction time than others and maximum decolourization ratio will be 89 % by 30 % (CT 60 min) with juice colour 201 IU. Nevertheless, bone char still occupies a prominent position in virtue of its relative cheapness, ease of operation and activation, long life and additional removal of ash. The use of bone char followed by styrenic resins in series has been suggested and gave better performance than bone char. The quality parameter of produced liquid sugar with ion exchange resin and bone char has been compared with commercial date syrup (Table-3).

TABLE-3
COMPARISON OF DATE SYRUPS QUALITY PARAMETERS
WITH DECOLOURIZED SYRUPS

Quality parameter	Brix	Total sugar (%)	Reducing sugar		Sucrose	Ash	Odor	Colour (IU)
			Glucose	Fructose				
Commercial date syrup	75	73.5	37.8	29.2	6.5	1.5	+	1990
Decolourized syrup with bone char	72.5	71.3	35.8	29.1	6.4	1.2	-	200
Decolourized syrup with Amberlit	73.5	71.3	37.4	27.4	6.5	2	-	308

Conclusion

Studies on comparative tests for two different techniques for decolourization show that bone char has higher selectivity for colourants and can be used in industry (Fig. 1). The liquid sugar made from date can be used as an effective substitution for other sweetener that be used in food industry like invert sugar, glucose syrup and sucrose .

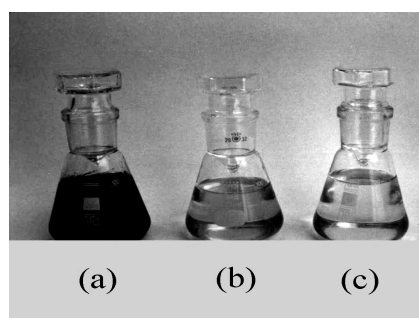


Fig. 1. Comparison of decolourized syrups (a) commercial date syrup (b) decolourized date syrup with anionic resin (c) decolourized date syrup with bone char

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