

## **The Effects of Different Methods of Date Syrup Purification on the Physicochemical Properties of Produced Date Syrup Powder**

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**ABSTRACT:** Date syrup powder is a new product which can be used as sugar substitute. First, the date syrup was spread out on a foil and placed in the oven at 60°C for 24 hours. Date syrup was separated from the foil and grinded. 2% agar and 2% starch were added and syrup with agar and starch that was in a lumpy shape were crushed and spread on the foil and placed at 60°C for 24 hours. Powdered granules, agar and starch were grinded for the second time, and spread out on the foil and placed at 60°C for 4 hours. Finally, granules were milled once more, and the color, moisture, sugar content, solubility and turbidity of the powder solution were measured. Statistical results were assessed by the use of SPSS19 Software and Paired samples test. Color strength, moisture and turbidity of purified powder solution with gelatin and Bentonite were evaluated. Solubility and fructose content were higher for the purified powder using alkaline method. Purified syrup using alkaline method is superior due to the fact that amino acids, pectin and colloids compounds are eliminated. As the result the color of the powder was more clear, moisture and turbidity were lower with higher solubility.

**Keywords:** *Alkaline Purification, Bentonite, Date Syrup Powder, Date Syrup, Gelatin.*

### **Introduction**

Iran has always been among the countries that produces dates. According to the statistics published in 2006, Iran produces 880000 tons of dates annually and it has a high position in the world regarding date production. A part of this product is converted to a valuable product namely (Gohari Ardebili *et al.*, 2005). Date syrup is one of the most valuable secondary product of date that contains natural sugars (glucose and fructose) with low concentration of sucrose. In terms of physiology, fructose does not require insulin to be used by the body. Therefore, it is a suitable sugar for diabetic patients and has higher sweetness as compared to glucose and sucrose with the

same energy distribution (Ahmad Nia & Sahari, 2008). Today, in terms of nutrition, tendency to use foods with lower sugar content is more since practically sugar cannot be omitted from some foods. Therefore, it is recommended to replace sugar in these foods with other substitutes. Because of very high sugar content, date syrup powder might be used as a natural sweetener instead of sugar. Long-term maintenance of date syrup with high brix is accompanied by granulation problem and in low brix with microbial problem (Ahmad Nia & Sahari, 2008). Production of date syrup powder increases durability and decreases the microbial pyosis. Moreover, using date syrup powder is easier in industrial scale. Since date syrup powder is

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produced based on drying method, studies and research concerned with date and date syrup has been carried out extensively. Shahdadi *et al.* (2011) carried out a search on the effect of drying process related to the amount of phenolic compounds and the anti-oxidant activity of two types of Mazafati and Kalouteh dates. Their results indicated that drying decreases the phenolic compounds and consequently the antioxidant activity of date (Sharifan *et al.*, 2005). When drying temperature is higher, the amount of extracted phenolic compounds and the antioxidant activity of the extract are lower. Sharifan *et al.* (2005) performed a study in the field of drying date paste and investigated drying process on solubility and reduced sugar of the final powder. The results showed that heating process increases the solubility percentage and reduced the sugars (Sharifan *et al.*, 2005). Limited studies have been carried out concerned with date drying, date syrup and production of date syrup powder. Date syrup powder is used as a skimmed sweetener and is useful for the users concerning the health aspect and to some extent might affect the economy in term of sugar import. Purification and decolorization methods of date syrup affect its behaviors during drying and naturally affect the properties of date syrup consisting of color, solubility, moisture content and drying speed, sugar percentage and turbidity of date syrup. In order to study this issue, date syrup and the properties of produced powders were compared by two methods of purification and decolorization.

### **Materials and Methods**

20 kg of date variety of Shahani was selected and after manual washing and kernel removal, it was converted to paste and syrup. In order to prepare date syrup, first Rapidase smart enzyme (DSM Company, the Netherlands) was diluted with distilled water in its optimal amount that is 10 times as thin and was added to date paste

and water mix in optimal pH of enzyme activity that is 4.5 (by 20 ml of 85% phosphoric acid during 1 minute) at 45°C. The mixture was mixed for 2 hours by a mechanical mixer with a speed of 30 rpm and then extraction stages were carried out using the reciprocal method. To make the syrup clear, optimal amount of enzyme was added in a suitable condition of activity (pH of 4.5 at 45°C). The enzyme was then mixed by a mechanical mixer with a speed of 10 rpm for 90 minutes. In the next stage, to decrease turbidity of produced date syrup, purification operation was performed by two methods of alkaline purification and purification by gelatin and bentonite. Liquidated date syrup by the alkaline method is called “a” syrup, and date syrup liquidated by gelatin and bentonite is called “b” syrup. In the alkaline purification, the pH of the date syrup increased to 9.5 using lime milk to denature the proteins at this stage. In the next stage, purification operation was performed by the addition of phosphoric acid to deposit colloid compounds (Saravacos & Maroulis, 2010). In order to decolorize the product, thin syrup was manually transferred from a column with the length of 1m and volume of 250ml including nonionic resin (model PAD 900, Purolite Company, the Netherlands). Purification by gelatin and bentonite were carried out and activated carbon was employed for purification. Production of date syrup powder is based on drying. This method consisted of three stages of drying date syrup with the first brix of 70, and no primarily condensation operation on the date syrup. In this method, the date syrup was spread on the foil as a thin layer and was left in an oven at 60°C (model BC70, Behdad, Iran) for 24 hours. The partially dried date syrup was removed from the foil and was ground by the household mill (national-Panasonic model, Osaka company, Japan). 2% agar and 2% starch were added to the mixture (Fatemi, 2008). Ground syrup with

agar and starch is adhesive and were spread on the foil and left in the oven at 60°C (model BC70, Behdad, Iran) for 24 hours. The product was then removed from the oven and the granules of date syrup, agar and starch were again spread on the foil and were put in the oven at the temperature of 60°C for 4 hours. The obtained granules were again ground. Finally, factors of color, moisture content, sugar, solubility and turbidity of “a” and “b” date syrup powders were measured and compared. Color of date syrup powder was measured by the digital photography by the Hunter lab instrument. Moreover, analysis of color pictures was carried out by the Photoshop software. Moisture contents of date syrup powders “a” and “b” were calculated by the drying method in the oven (model BC70, Behdad, Iran). In order to measure the turbidity, 5% solutions of “a” and “b” date syrup powders were prepared, and powder turbidity was measured by the turbidimeter (Hana HI9370 model, America). The sugar contents of “a” and “b” date syrup powders were measured using Fehling method. To measure the solubility, one piece of filter paper was weighed. Then, some date syrup powder was dissolved in the distilled water and passed through the filter paper and the filter paper was washed by the distilled water to remove any sugar remained on the filter paper. To make sure of the absence of sugar on the filter paper, the Molisch test was applied. The filter paper was put into the oven for 24 hours to be completely dried. Filter paper was weighed, and solubility percentage of date syrup powder was calculated by the solubility percentage determination formula. Finally, meaningfulness of the result was studied by the Paired Samples Test by the SPS 19 software in confidence level of 95%. Each

test was repeated in triplicate order.

### Results and Discussion

The results concerned with “a” and “b” samples indicating a, b and L factors are presented in Table 1.

Factors a, b and L are measured by the Photo Shop software. Factor a shows the red to green color, factor b indicates yellow to blue color and factor L measures the brightness, therefore, when factor L is higher, date syrup powder color is brighter. Moreover, a/b represent the ratio of red to yellow pigment in the date syrup powder. Numbers related to date syrup powder color are means of three replicates measurement by the Fehling method. Analysis of the results obtained from measuring color intensity of two types of samples indicates that color intensity in two types of date syrup powders is significantly different. As mentioned earlier (Table 1), factor L of a and b samples are 62.06 and 59.07, respectively. Therefore, “a” syrup powder is less turbid than “b” syrup powder. Moreover, a/b in the “b” date syrup powder is more. During alkaline purification, natural pigments and amino acids available in date syrup are omitted, therefore, reaction intensity and presence of yellow and red pigments in the “a” date syrup powder are less. Moreover, the presence of Melanoidins pigments obtained from Millard reaction and anthocyanins that are not omitted during process of purification by the gelatin and bentonite increase a and b factors in the sample “b” date syrup powder (Poel *et al.*, 1998). In addition, research performed in the field of measuring thermal resistance of the two types of “a” and “b” samples indicated that thermal resistance (color change based on time) of purified date syrup by the alkaline method is less (Shafiee *et al.*,

**Table 1.** a, b, L factors in the “a” and “b” date syrup powders

	A	b	L	a/b
“a” date syrup powder	5.20	61.22	62.021	0.085
“b” date syrup powder	6.32	63.44	59.071	0.099

2012). Therefore, thermal resistance of “a” date syrup powder is also less and regarding the fact that the drying process period for the two types of date syrup is the same, color in the date syrup is more intense in the “b” date syrup. The most important application of the date syrup powder is its use as a skimmed alternative for sugar and other sweeteners. Therefore, date syrup powder solubility in water is very important. The results obtained from water solubility measurement for the samples are presented in Table 2.

Water solubility percentage of date syrup powder purified by the alkaline method is 88% and that purified by the gelatin and bentonite is 79%. Regarding the high correlation coefficient in the confidence level of 95%, solubility percentage of the two types of date syrup powder is significantly different. The compound obtained from the reaction and the presence of colloid compounds like proteins and fatty acids affect the solubility of date syrup powder (Chikin & Makeeva, 1976). One important factor in the powder solubility is protein. Basically, special structure of proteins, due to the general weakness of forces, is sensitive, and some factors and conditions affect its structure. The process that causes such changes is called denaturation that means losing natural state of protein (Fenema, 1996). Among the factors that cause denaturation of proteins, heat and pH have specific roles. Heat destroys the stabilizer bonds of protein structure and opens them. Denaturation of proteins occurs at temperatures between 55-85°C. Moreover, very high or very low pH increases similar amount of electrical load inside protein and as the result, repulsion forces are provided and the protein structure

is opened and denatured (Fenema, 1996). Therefore, it can be concluded that some parts of proteins available in “a” and “b” date syrup are denatured during extraction. During alkaline purification operation and purification with gelatin and bentonite, some parts of denatured and not denatured proteins available in the date syrup are omitted by surface absorbance of calcium phosphate and also bentonite, and some parts of them also remain in the the syrup (Gould *et al.*, 2009). Denatured proteins available in the syrup are exposed to high temperature for a long time during drying and powder producing stages. As the result of denaturation, due to the presence of hydrophobic groups in the protein level, their water absorbance powder decreases. If denaturation occurs in the extensive level, molecules of protein are connected to each other, and in this state, water absorbance power decreases due to a decrease in protein level that can connect water molecules (Fenema, 1996). It is clear that conditions that negatively affect proteins water absorbance decrease its solubility and can practically be very problematic (Sarkar, 2011). Therefore, denaturation of proteins during stages of producing and processing date syrup and also during stages of date syrup production decreases proteins solubility and as the result decreases the solubility of date syrup powder (Fenema, 1996). The edible part of the dates contains fatty substances that usually form about 0.6-0.72 of dates weight (Keramat & Khorvash, 2002). Short-chained fatty acids are solved in water and long-chain fatty acids are completely insoluble in water. Fatty acids available in purified date syrup by the alkaline method are saponified and extracted from the environment, but in date syrup,

**Table 2.** Solubility percentage of “a” and “b” date syrup powders

	<b>solubility percentage</b>	<b>Correlation coefficient</b>	<b>Standard deviation</b>
“a” date syrup powder	88 <sup>a</sup>	0.996	0.1202
“b” date syrup powder	79 <sup>b</sup>	0.996	0.0088

from the environment, but in date syrup, purified with gelatin and bentonite, since the pH of acid date syrup is about 4.5, fatty acids available in date syrup are not saponified and remain in the syrup (Ehrenberg, 1997). Therefore, “b” date syrup powder, due to the presence of fatty acids with other factors that decrease solubility like denatured proteins, has less solubility than a syrup powder. The results obtained from the measurement of date syrup powder color intensity indicate more intensity of reaction in the “b” date syrup. It can therefore be concluded that compounds obtained from the reaction like nonpolar and insoluble compounds like Hydroxymethylfurfural and furfural in the “b” date syrup powder are more and the presence of these insoluble factors is effective in decreasing the solubility of “b” date syrup powder. The results obtained concerning the moisture of date syrup powder have been presented in Table 3.

Regarding the fact that the conditions of drying and producing powder are the same for the two types of date syrup, numbers related to moisture percentage indicate that the two types of date syrup are not dried in oven with the same speed. While in the oven, in fact the concentration of soluble solid substances that include pectin, protein and other colloid compounds increases by increasing the brix of the syrups. Presence of such impurities in date syrup decreases the heat transfer and decreases evaporation rate

(Saravacos & Maroulis, 2010). Evaporation rate in fact indicates brix changes in terms of time and can be referred to as an index for drying speed. The results of conducted research concerned with measuring and comparison of evaporation rate of “a” and “b” syrup indicate that evaporation rate of “a” date syrup is higher (Shafiee *et al.*, 2012). Moistures of “a” and “b” date syrup powders are 1.75 and 2.48, respectively. Regarding the high correlation coefficient with the confidence level of 95%, moistures of “a” and “b” date syrup powder are significantly different. The results concerned with the measurement of turbidity of 5% solution of date syrup powder are presented in Table 4.

Due to the differences in the purification method, turbidity of the date syrup purified with gelatin and bentonite is higher than that of date syrup purified by the alkaline method. The results in Table 4 show that factors that provide turbidity in the powder of “b” date syrup exist at higher ratio. Naturally the presence of non sugar and colloid compounds like pectin available in the syrup cause turbidity in solution including date syrup powder (Asadi, 2007; Eski, 2000). Moreover, as the result of heating during drying the syrup in the oven with the available pectin in the syrup combines with proteins and causes the turbidity to increase (Fatemi, 2008). It should be noted that starch and agar added to the powder (used as factors that absorb

**Table 3.** Moisture percentage of “a” and “b” date syrup powders

	Moisture percentage	Correlation coefficient	Standard deviation
“a” date syrup powder	%1.75 <sup>a</sup>	0.998	0.0152
“b” date syrup powder	%2.48 <sup>b</sup>	0.998	0.0218

**Table 4.** Turbidity of 5% solution of “a” and “b” date syrup powders

	“a” date syrup powder	“b” date syrup powder
Turbidity (FTU)	6.86	104

**Table 5.** Sugar percentage of “a” and “b” date syrup powders

	Fructose percentage	Glucose percentage	Sucrose percentage
“a” date syrup powder	45	50	0
“b” date syrup powder	44.2	51.5	0

moisture) are effective in increasing solution turbidity (Asadi, 2007). The research carried out, indicated that the acidic condition and also high heat provide turbidity in solutions containing starch and agar (Ahurst, 1995). Therefore, regarding the fact that the pH of "b" syrup is acidic, higher turbidity of 5% solution seems logical than powder of a syrup. Results obtained by measuring date syrup sugar percentage of "a" and "b" date syrup powders are presented in Table 5. The determinations were carried out by Fehling solution in triplicate order.

### **Conclusion**

A comparison was made between the properties of powders produced by the alkaline method and the method employing gelatin and bentonite. The results have shown that the color of the latter powder obtained from the syrup undergoes less changes during production stages. Moreover, the solubility and brix changes are also higher. Therefore, using the syrup purified by the alkaline method is better for the production of date syrup powder. Energy consumption and processing time are saved due to the higher water evaporation rate. Therefore, it is recommended to use powder of the date syrup purified by the alkaline method as an alternative to sugar in products that clearance of the solution is regarded important.

### **References**

- Ahmad Nia, A. & Sahari, M. (2008). Using date powder in formulation of chocolate toffee. *J Sci Food Tech.* 5(3), 1-8.
- Ahurst, P. R. (1995). Production and packaging of non-carbonated fruit juices and fruit beverages. 2ed ed. pp, 311-317.
- Asadi, M. (2007). Beet-sugar handbook. Wiley-Interscience. pp, 333-335.
- Chikin VLS, G. A. & Makeeva, T. M. (1976). *Prak Sorhtsionnykh Protsessov.* pp, 101-102.
- Ehrenberg, J. (1977). Production of liquid sugar from dates: *Zucker*; 30(11).
- Eski, A. (2000). Juice clarification. 2ed ed.

Translated by Piroozi fard M. Urumia: Urumia University Press. pp, 46-50.

Fenema, O. R. (1996). Food Chemistry. In Marcel Dekker. pp, 931-937.

Fatemi, H. (2008). Food chemistry. 7nd ed. Tehran University Press. pp, 313-332.

Gohari Ardebili, A., Habibi Najafi, M. & Haddad Khodaparast, M. (2005). Effect of date syrup as a substitute for sugar on the physicochemical and sensory properties of soft ice cream. *J Sci Food Tech.* 2(1), 23-32.

Gould, K., Davies, K. M. & Winefield, C. (2009). Anthocyanins: biosynthesis, functions, and applications. Springer. pp, 289.

Kempf, W. & Schneider, F. (1980). Sugar Analysis, ICUMSA Methods. Official and Tentative Methods Recommended by the International Commission for Uniform Methods of Sugar Analysis (ICUMSA), herausgeg. vom. *Starch - Stärke.* 32(9), 325-6.

Keramat, J. & Khorvash, M. (2002). The chemical composition of 12 varieties of Iranian dates. *journal of science and technology of agriculture and natural resources.* 6(1), 189-198.

Poel, P. W., Schiweck. & Schwartz, T. K. (1998). Sugar technology: beet and cane sugar manufacture. Verlag Dr Albert Bartens KG. p, 484.

Shafiee, S., Hojjatoleslami, M., Shokrani, R., Sharifan, A. & Loghmani khouzani, V. (2012). A study effect of date syrup purification different methods on the candy physical and chemical particularity. *Iranian J Nut Sci Food Tech.* 8(1), 63-70.

Sarkar, F. H. (2011). Nutraceuticals and Cancer. Springer. pp, 208.

Saravacos, G. D. & Maroulis, Z. B. (2010). Food process engineering operations. Taylor and Francis. pp, 323.

Shahdadi, F., Mirzaei, H., Maghsoudlou, Y., Ghorbani, M. & Daraei Garmakhany, A. (2012). Effect of drying process on the phenolic-compounds content and antioxidant activity of two varieties of date-palm fruit Kaluteh and Mazafati. *J Food Tech and Nutr.* 6(3), 67-74.

Sharifan, A., Mortazavi, A. & Shafafi Zonoozian, M. (2005). The effect of date palm powder production process on the powder solubility and the amount of reducing sugar in the final product. *J Food Tech and Nutr.* 2(3), 27-35.

