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The Occurrence of Acrylamide in Iranian Date Syrup

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ABSTRACT: The tendency to consume food with lower sugar content and alternatively healthy foods and food products are rising. High levels of sugar in date syrup might be used as a good alternative to sugar in various food products. Iran is one of the main producers of date fruit and it is possible to produce foods with high nutritional values from date to replace high-sugar content food**.** The formation of acrylamide in date syrups as the result of various procedures of heat treatment and extent of its formation has made the researchers interested in this field of study to investigate the formation of this compound quantitatively by the application of high-pressure liquid chromatography. The results indicated that some of the date syrup samples that were collected in the Iranian market had significant quantities of acrylamide. It is therefore concluded that the date syrups might be considered as a high-risk product due to the formation of acrylamide that is considered a carcinogenic compound.

Keywords: *Acrylamide, Asparagine, Date Syrups.*

Introduction

The date palm (Phoenix dactylifera L.) is one of mankind's oldest cultivated plants. It has been consumed as food for 6000 years (Amer, 1994). The world production of date fruit is estimated at 8,460,443 tonnes. Iran is considered to be one of the date producing countries. The area under the cultivation of dates is estimated around 193,368 ha and about 1,065,704 tons of date fruit is produced in 2016 (FAOSTAT, 2018).

Dates are rich in certain nutrients and provide a good source of rapid energy, due to their high carbohydrate content (70–80%). Moreover, date fruits contain fat (0.20–0.50%), protein (2.30–5.60%), dietary fibre (6.40–11.50%), minerals (0.10–916 mg/100 g dry weight), some vitamins (C, B1, B2, B3 and A) with very little or minute concentration of starch (Al-Shahib and Marshall, 2003).

Generally, the low quality (cull) dates are used to produce date syrup and date syrup concentrate, since the fruit is a good source of glucose and fructose. Sucrose is also present in a significant concentration. Sugars

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are responsible for much of the physical nature of syrups as well as its hygroscopic characteristic (Tavakolipour *et al.*, 2007). Date syrup can potentially replace sugar in food formulations where slight coloring it imparts is not critical in the quality of such prepared products.

The color of date syrup has been originated from the phenolic compounds present in dates that act as precursors for melanin formation, the brown-colored products, indicated that melanins and color substances resulted from nonenzymatic browning reactions, particularly melanoidins were the major colorants of date syrup (Roufegari-nejad, 2002).

The Maillard reaction is the reaction between naturally present amino acids and reducing sugars (e.g., glucose or fructose) when the food is exposed to high temperature. It might be responsible for the development of the desirable flavor and color in many cooked foods subjected to baking, frying, or roasting. Acrylamide is mainly formed from the amino acid asparagine and the reducing sugars; glucose and fructose(Lineback *et al*., 2012). Due to the possibility of formation of acrylamide in date syrups, the amount of acrylamide in the syrups produced by various methods in Iran have been quantitatively evaluated.

Materials and Methods

The date syrups produced by different methods from various regions of Iran were purchased from the local shops in Tehran.

Acrylamide concentration was determined according to the procedure adopted by Mastovska (2006), followed by the application of the sample into a YOUNGLIN 9000 HPLC High-Performance Liquid Chromatography equipped with UV/VIS Detector where the mobile phase consisted of water-acetonitrile. Standards were made of different concentrations of acrylamide a calibration curve was made to determine the acrylamide concentration in the date syrups

Results and Discussion

The calibration curve was drawn by plotting peak area against the concentration of acrylamide. The regression equation was determined as: $y = 67.096x + 50.652$ ($r^2 = 0.998$), where x is the concentration of acrylamide (ppm) and y is the peak area. The peak area is linearly related to the concentration of acrylamide.

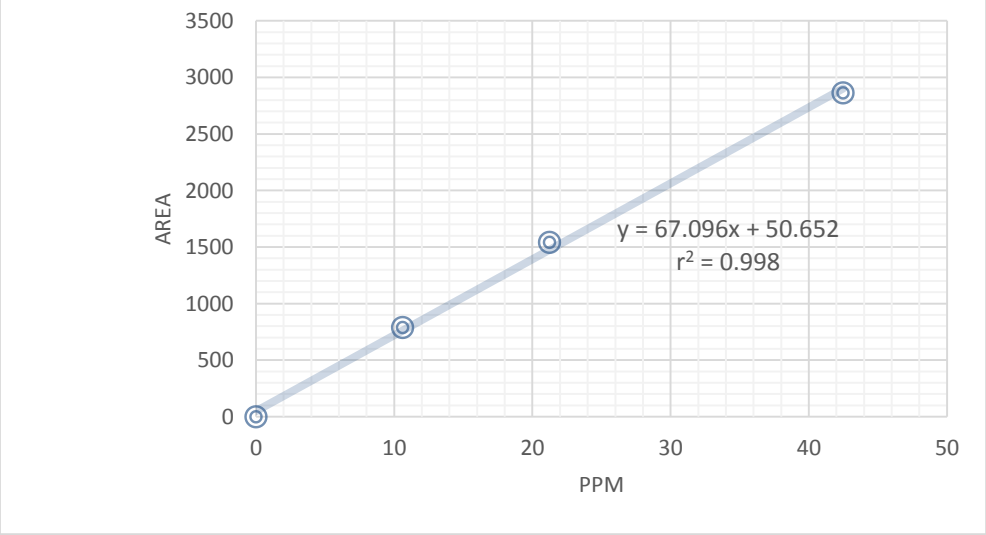

Fig. 1. The calibration curve indicating the acrylamide concentration against the area of the peak by HPLC

The Maillard reaction is shown to be the main pathway for acrylamide formation at high temperature in a wide range of foods containing mainly asparagine and reducing sugars as precursors (Mottram *et al*., 2002).

Various factors, such as the initial concentration of reactants and their ratio, temperature and time of processing, and pH and water activity, have been shown to influence the formation levels of acrylamide in heat-processed foods (Friedman, 2003).

The influence of temperature on the formation of acrylamide has been repeatedly demonstrated (Tareke *et al*., 2002).

The levels of acrylamide in various date syrup are shown in Table 1.

Table 1. Acrylamide content in date syrup samples

Sample name	Area	Con. ppm
S A	0	0.000
S B	80	0.302
S C	0	0.000
S D	100	0.508
S E	75	0.199

As stated earlier, acrylamide formation in the food products will depend on the recipe and composition of the food material and the technological process at which the product will be subjected.

Asparagine is considered to be the main precursor for acrylamide in foods and its

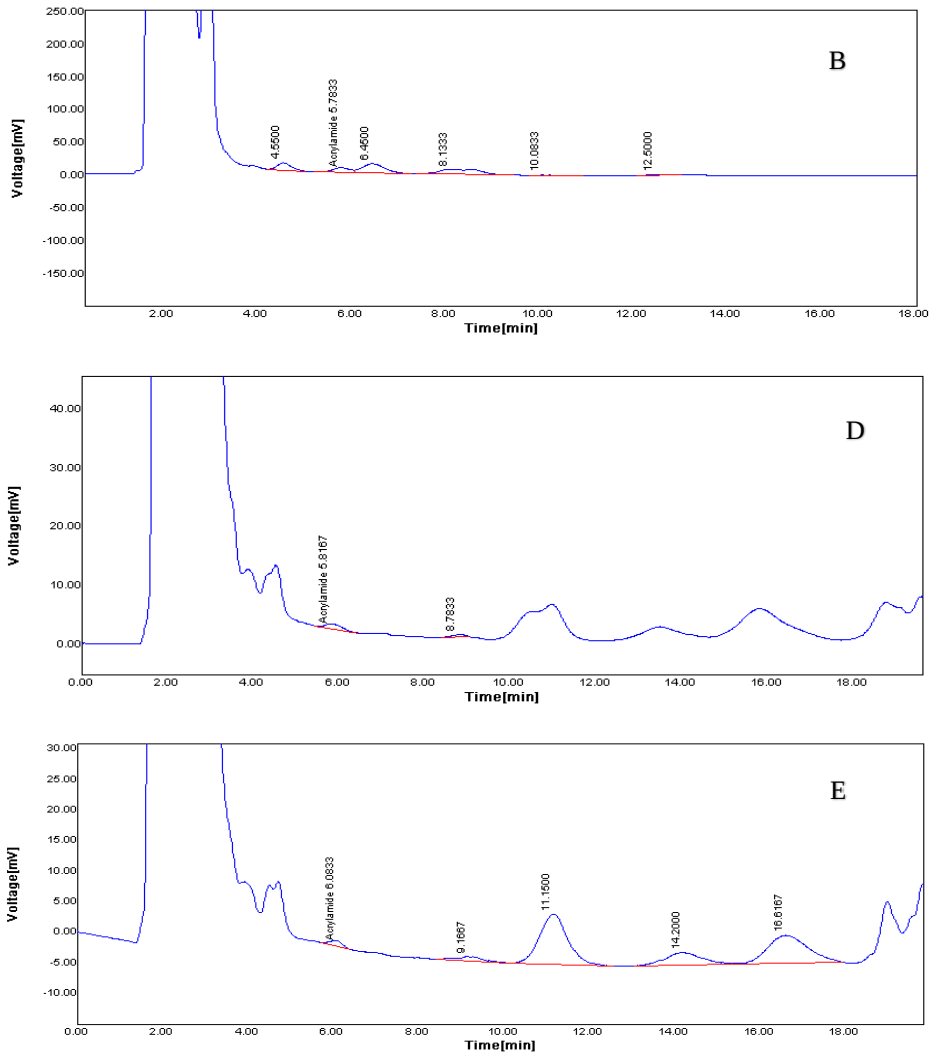

Fig. 2. The HPLC chromatograms of acrylamide analysis in samples

content has been confirmed to be the limiting factor for acrylamide formation. (Amrein *et al.*, 2004)

Reducing sugars are also dominant and comprise ~96% of date syrup total sugar content. Reducing sugars together with asparagine cause the formation of acrylamide in foods. The type and concentration of sugars also play a crucial role in the development of acrylamide formation.

Formation and degradation of acrylamide occur simultaneously during heating at elevated temperatures and at lower temperatures acrylamide is formed along the time until reaching an upper level. However, at higher temperatures, maximum acrylamide formation is reached in a short period of time and then acrylamide concentration is decreased due to a high rate of degradation. (Açar *et al.*, 2010)

Conclusion

Acrylamide is a known human neurotoxicant and might be considered as a carcinogen even at low concentration. In this study, the amount of acrylamide was evaluated in the date syrups produced and sold in markets, using High-Performance Liquid Chromatography. Although the acrylamide was not detected in some date syrups, but some samples indicated its presence. Although date syrups with high sugar content might be employed to replace sugars in food formulation but the quality assurance of the date products is the most important factor that should be considered.

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