Influence of Storage Temperature on the Quality of Some Sugar and Date Syrups

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Abstract

The storage stability of a laboratory prepared and commercial date syrups, and the syrups of sugar cane, carob, and grapes was investigated. Syrups were stored at 4º, 25º, and 45ºC for six months. The study showed an increase in 5-Hydroxymethylfuraldehyde (HMF) with increasing storage temperature. The formation of HMF in syrups stored at 45ºC is strongly correlated with their fructose (F) content (R^2=0.87) as well as their glucose (G) content (R^2=0.74). It has also been found that the higher the value of moisture/ G+F the less likely the HMF to be produced (R^2=0.92). Syrups showed a marked variation in sugars as well as total soluble solids and moisture content. No significant effect was shown in the yeasts and molds count due to syrup type. Storage temperature had no significant effect on total microbial count, yeasts, and molds. No evidence for coliform and *Staphylococcus. aureus* presence was detected at the end of storage period.

Introduction

Dates are considered to be a stable crop in Saudi Arabia, where they represent an economic security to supply high-energy food, basic livestock feed and raw material for several home applications (Hamad et al 1983). Date syrup (Dibs) is a by -product of dates, at the rate of 3% through pressure applied to stored dates (Assoc. Consulting Engineering 1959). Normally, dates are consumed as a fruit, but they are also cooked to extract

the syrup which is usually used in preparing some local popular dishes (Hamad et al 1983). Yearly consumption of syrups in Saudi Arabia was around 16.3 thousand tons costing more than 7.64 million Dollars (Saudi General Statistics Agency 1995). The production of liquid sugar from dates has been studed by many workers (Aligedi and Beshkov 1976; Nowatzyk 1976; Wolf et al 1976; Ehrenberg 1977; Nakahara and Telsujiro 1977; Mustafa et al 1983; Hamad et al 1983; El-Shaarawy et al 1989a,b).

Moisture content is a major factor that determines the keeping quality of syrups since it bears a direct relation to the likelihood of undesirable fermentation. The effect of excessive temperatures or duration on the syrup sugars can be recognized by the production of 5-Hydroxymethylfuraldehyde (HMF), which is a breakdown product of sugar solutions particularly those containing glucose and fructose. The presence of an extensive amount of HMF in syrup might be considered as evidence of overheating, and it implies loss of freshness of the syrup. The main sugars of date syrup are fructose and glucose. The differences in sugar composition may be of practical importance in syrup keeping. Sugars are responsible for much of the physical nature of syrups as well as its hygroscopy. They, therefore, provide a useful basis for comparing different syrup types and their potential for maximum good storage quality. The chemical and microbiological properties of syrups subjected to high temperature and long storage have received minimal attention. There has been no research recorded on the storage stability of date syrups. It might be informative to compare properties of these syrups when stored at different temperatures.

The objectives of this study were to: 1) investigate the effect of storage temperature and duration on the chemical and microbiological properties of laboratory prepared and commercial date syrups from the market of Saudi Arabia, and 2) study the correlation between sugar types and HMF in syrups stored for six months.

materials and Methods

Sampling:

Two farmer-produced date syrups (dibs), from cultivars Khalas (Kh) and Ruzeiz (Rz), were obtained from the local date market Hoffuf, Saudi Arabia. These syrups formed due to natural dripping of dibs as a result of applied pressure for at least two weeks. Syrups from the Kh and Rz cultivars were also prepared in the lab by heat extraction (autoclaving for 10 min) as explained by (Mustafa et al 1983), then concentrated by heating at 80ºC in open air (El-Shaarawy et al 1989a). The other commercial imported samples were Zahdi dibs (Alremahi Trade Mark, Iraq), Egyptian black sugar molasses (International Trade Representative Corporation, Egypt), Pure carob syrup (Saloom Brothers, Selaata, Lebanon), and grape syrup (Dirani Brothers, Lebanon). Samples were stored in glass containers at 4º, 25º, and 45ºC for six months.

Chemical evaluation :

Sucrose (S), Glucose (G) and Fructose (F) were determined using High Performance Liquid Chromatography (HPLC) as follows: Triplicate 5g date syrup samples were weighed in a 50ml volumetric flask and the volume completed to 50 ml by adding distilled water. The samples were homogenized for 2 min. The mixtures were filtered and the filter paper was washed with extra 10 ml distilled water. The extracts were analyzed on Varian HPLC equipped with RID 6A refractive index detector. A Carbohydrate column was used for the separation of sugars using the eluant acetonitrate/ water mixture in the ratio of 86/14. The flow rate was adjusted to 2.0 ml/min . The peaks from the recorder were compared with peaks from a standard water solution of glucose/ fructose/ sucrose (Mustafa et al 1983).

Moisture content was determined using Abbe refractometer at a constant temperature (25ºC). The reading was converted to moisture content (percent by weight) according to Saudi Arabian Standard Organization (SASO) No.102, procedure No. 3.3 (1987). Total Soluble Solids (Brix) were determined by means of Abbe Refractometer according to SASO standards No.102, procedure No. FA-225 (1987).

5-Hydroxymethylfuraldehyde (HMF) was determined using spectrophotometer (UV/V Spectrophotometer, Perkin Elmer, Lambda 3B, Model No. 618-0437) at 550nm wave length as explained by Pearson (1976).

Microbiological evaluation:

Syrups subjected to different storage temperatures were examined for total aerobic plate count as described by Gerhard et al (1981), yeasts and molds count according to Koburger and Marth (1984), the presumptive coliform count using violet red bile agar procedure and *Staphylococcus aureus* according to Tatini et al (1984).

Experimental design:

The effects of three storage temperatures on the chemical and microbiological properties of eight syrup types were studied. The measured parameters were total soluble solids (TSS), HMF, moisture content, total microbial, yeast, and mold count. A complete block design was used in this study. The experiment was repeated three times. Analysis was conducted using PROC GLM and PROC REG (Lindman 1991) with SAS Software, ver. 6.02. Predicted mean values of HMF from the input data and the estimated model were generated and plotted against sugar type to better fit the regression line using PLOT PREDICTED.

RESULTS AND DISCUSSION

The values resulting from the effect of storage temperatures on the syrups (Table 1) were analyzed using GLM analysis (Table 2). There was a high significant dependence attributable to syrup type ($p<0.0001$) on the TSS, HMF, moisture content, and total microbial count. The TSS and moisture content for syrups (Table 2) was also confirmed to be significantly influenced by storage temperature ($p<0.001$). Moreover, there was a strong interaction (syrup type*storage time) effect on the TSS, HMF, moisture, total microbial count, yeast, and mold ($p<0.0001$).

The formation of HMF in syrups stored at 45ºC for 6 months is strongly correlated (Fig. 1) with their fructose content ($R^2=0.87$) as well as their

glucose content (R^2=0.74). It has been found that the higher the value of (moisture/ G+F) the less likely the HMF to be produced (R^2 =0.92) for syrups stored at 45ºC as shown in Fig. 2. This finding suggests that the HMF production is not only a function of sugars content but is also a function of the ratio of moisture content to sugars (G+F). Storage at 25ºC did not prevent some HMF formation; the amount varied according to the syrup type, and depended upon fructose and glucose content. It has been found that storage at 45ºC considerably increased the HMF content of all syrups except for Rz, Zahdi, and Grape syrups. Heat extracted Kh, Rz, Zahadi, and Grape syrups exhibited high initial HMF compared with their farmer (cold pressed) counterparts. This was due to the autoclaving temperature in the extraction process.

Syrups showed a marked variation in sugars (Fig. 3) as well as TSS and moisture content. For example, local Kh and heat extracted Kh syrups initially had moisture content of 13.9 and 25.4% respectively. Moisture loss in syrups stored at 45ºC proceeded at higher rate compared with syrups stored at low temperatures (4º and 25ºC). No noticeable variation in TSS was observed among syrups during storage.

It has been found that the main sugars in date and grape syrups are fructose and glucose, and on average these together accounted for around 62% of the syrups. However, black syrup molasses and carob exhibited a total (G+F) of only 12% and 30% respectively.

No significant effects were shown in the yeast and mold counts among syrup types, and storage temperature caused no significant effect on total bacterial, yeast, and mold count (Table 2). It has been found that syrups stored at all temperatures were free from coliform and *S. aureus*. However, these results are expected since syrups have high sugar content as well as high osmotic pressure.

Conclusions

The effect of excessive storage temperature or storage time on syrups can be recognized by the high production of HMF. Variations and chemical changes exist among the studied syrups. Date syrups should not be stored at temperatures around 45ºC.

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Fig. 1. Relation between HMF produced by syrups stored at 45C for 6 months and the predicted values of fructose and glucose.

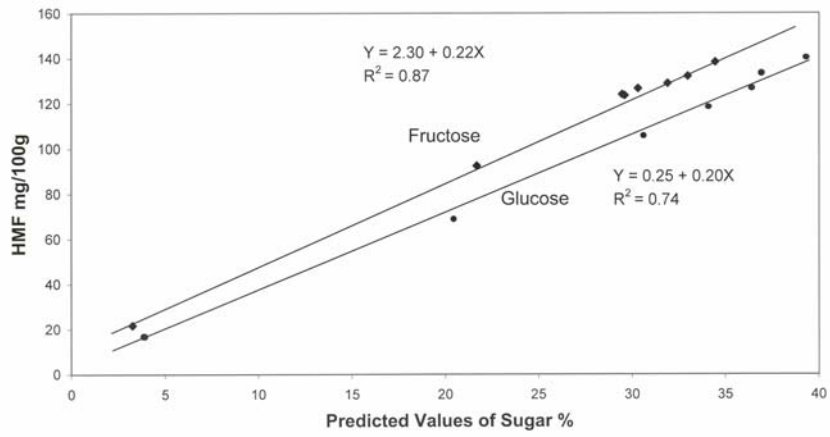
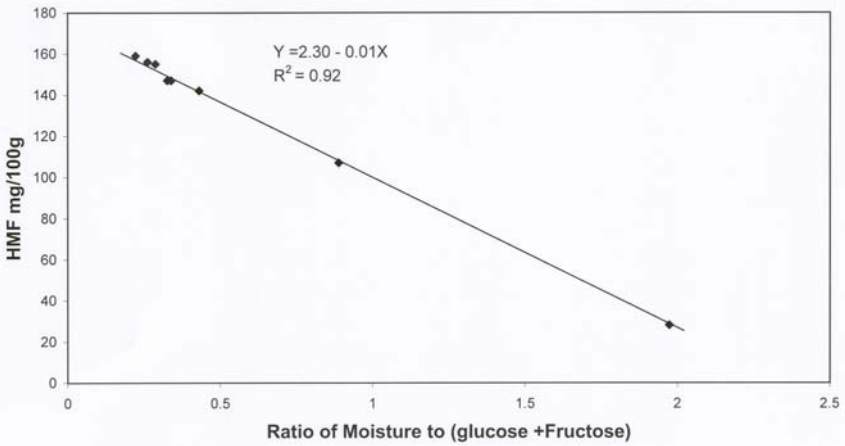


Fig. 2. Relation between HMF produced for syrups stored at 45C for 6 months and the ratio of moisture to flucose+fructose.



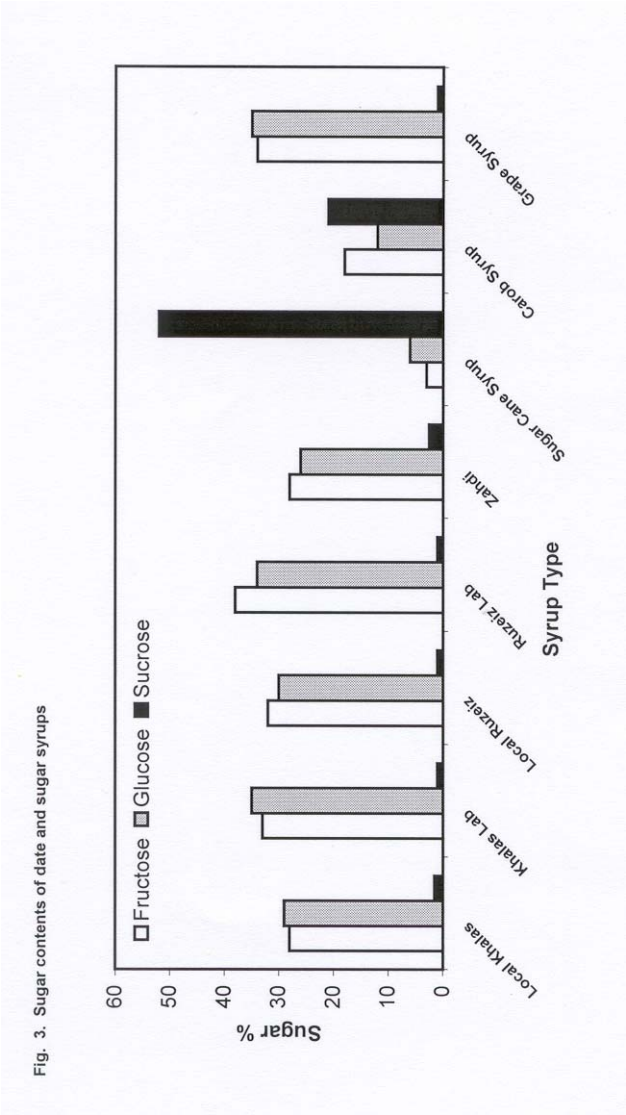


Fig. 3. Sugar contents of date and sugar syrups

تأثير درجة حرارة التخزين على جودة بعض أنواع دبس التمر ودبس السكر

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ملخص

تم دراسة الثباتية التخزينية لكل من دبس التمر المحضر معمليا، دبس التمر من مصدر تجاري، دبس قصب السكر، دبس الخروب، ودبس العنب. تم تخزين العينات عند درجات حرارة ٤، ٢٥، ٤٥م لمدة ٦ شهور. لوحظ إرتفاع في تركيز الهيدروكسي ميثايل فورفورال نتيجة لزيادة درجة حرارة التخزين. كان معامل الإرتباط قوي بين الزيادة في تركيز الهيدروكسي ميثايل فورفورال لعينات الدبس المخزنة على درجة حرارة ٤٥م ومحتواها من سكر الفركتوز ($R^2 = 0.87$) وكذلك محتواها من الجلوكوز ($R^2 = 0.74$) . وجد أيضا بأنه كلما كانت قيمة العامل

(الرطوبة / الجلوكوز + الفركتوز) عاليا كلما قلت فرصة تكون الهيدروكسي ميثايل فورفورال ($R^2 = 0.92$) . سجلت عينات الدبس تباينا ملحوظا في محتواها من السكريات، المواد الصلبة الذائبة والرطوبة. لم يلاحظ أي تأثير معنوي على عدد الخمائر والفطريات نتيجة لنوع الدبس. كما أن درجة حرارة التخزين لم تبدي أي تأثير معنوي على العد الكلي الميكروبي، الخمائر ، والفطريات لعينات الدبس، كانت العينات خالية من بكتريا الكوليفورم Coliform والستافيلوكوكاس S.aureus طوال فترة التخزين.