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# Research Article
# Evaluation of Physico-chemical Properties of Some Date Varieties and Yoghurt Made with its Syrups

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## Abstract

**Background and Objective:** Date is a rich composition of carbohydrates, minerals, dietary fiber, vitamins, fatty acids and amino acids. Date syrup is directly consumed or used as an ingredient in some food formulation such as ice cream, drink, confectionery, bakery products and jam. The purpose of this study was to use the date syrup, extracted from some date varieties cultivated in Egypt (Salma, Magdy and Khalas), to improve the acceptability and nutritional value of yoghurt. **Materials and Methods:** The date extract was centrifuged at 7,000 rpm for 30 min and concentrated under vacuum at 70°C to obtain one fourth or third of the total extract volume (~25-28% TS). Date syrup (Salma, Magdy and Khalas) was added individually to the standardized milk (~3.0% fat and ~15.0% TS) at rate of 15.0% (as the best percentage according to the pre-experimental) to create 3 treatments ($T_1$, $T_2$ and $T_3$, respectively). The collected data were statistically analyzed by one way-ANOVA using SPSS software program. **Results:** The results showed that, all date varieties were rich in sugars especially glucose and fructose, minerals especially K, Fe, Na and Mg and vitamin C as well as exhibited antioxidant activity against DPPH$^{\cdot}$. Date syrup had no significant effect on pH value and whey syneresis of resultant yoghurt compared with control. Also, using date syrup in yoghurt manufacture had no adverse effect but may enhance the viability of starter culture. However, both the viscosity and the whiteness degree have been negatively affected by using the date syrup. **Conclusion:** It was concluded that the yoghurt made with date syrup was more acceptable (more softness, smoothness and more sweetness) especially that made with Magdy date syrup ($T_2$).

Key words: Chemical properties, phenolic content, antioxidant activity, physical properties, date varieties, date syrup

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

## INTRODUCTION

Date or date palm *(Phoenix dactylifera* L.) is a flowering plant species in the palm family, *Arecaceae*, cultivated for its edible sweet fruit. The importance of the date in human nutrition comes from its rich composition of carbohydrates, minerals, dietary fiber, vitamins, fatty acids, amino acids and protein[1,2] as well as it's an excellent material for producing refined sugar, concentrated juice, confectionery pastes and fermentation products[3]. Also, dates have strong antioxidant, anticancer and antiviral activities[4-6] as well as reduced risk of several chronic diseases such as coronary heart disease, cardiovascular disease, aging, atherosclerosis and neurodegenerative diseases[2,7]. The anticancer activity of dates may be attributed to the high polysaccharide content in dates[8].

To produce more healthy and popular products, food industries take advantage of various flavors such as chocolate, honey and strawberry to modify milk taste and formulate different kinds of milk products[9]. Yoghurt is one of the most important groups of fermented dairy products containing enough count of live microorganisms and influencing host health[10,11]. Also, yoghurt has been reported to provide a range of beneficial properties to human beings, including assimilation of cholesterol, anti-tumorigenic effect and prevention of gastrointestinal infection and lowering of blood pressure. Yoghurt can be commercially produced with substantial variety in composition, flavors and additives. Consumption of yoghurt has steadily increased over the last 30 years in many countries of the world. The use of different fruit-flavour in yoghurt manufacture has been attempted increasingly.

Date syrup is directly consumed or used as an ingredient in some food formulation such as ice cream, drink, confectionery, bakery products, jam and some other[12]. Research proves that when dates are eaten alone or as mixed meals with yoghurts they have low glycemic indexes[7]. Therefore, the aim of this study was to use the date syrup as a suitable ingredient to improve the acceptability and nutritional value of yoghurt as a functional dairy food.

## MATERIALS AND METHODS

**Materials:** Three varieties of dates, *Phoenix dactylifera* L., (Salma, Magdy and Khalas) were collected from Cairo-Alexandria Desert Road, 63 Km, Egypt. Cow's milk was obtained from farm of Fac. Agric., Cairo Univ., Giza, Egypt. Skim milk powder was purchased from local market at Cairo, Egypt. Starter cultures (*Lactobacillus delbrueckii* ssp. *bulgaricus* and *Streptococcus salivarius* ssp. *thermophilus)* were obtained from stock cultures of Dairy Microbiology Lab., National Research Centre, Giza, Egypt. Starter cultures were activated individually by three successive transfers in sterile 11% reconstituted skim milk powder at 37°C for 24 h.

**Methods:** After collecting the samples during August and September, 2016, the study was carried out at the laboratories of the National Research Centre, Giza. Egypt.

### Date properties

**Chemical analysis:** Moisture, ash, protein, fat, fiber, total sugars, reducing sugars, non reducing sugars and vitamin C of date samples were determined according to AOAC[13].

### Phenolic compounds of dates

**Extraction:** The date samples were alkaline hydrolyzed according to Kim *et al.*[14]. Briefly, sample was placed in quick fit conical flask and 200 mL of 2 M NaOH was added. The flasks were flushed with $N_2$ and the stopper was replaced. The samples were shacked for 4 h at room temperature. The pH was adjusted to 2 with 6 M HCl. The samples were centrifuged at 5000 rpm for 10 min and the supernatant was collected. Phenolic compounds were extracted twice with 50 mL mixture of ethyl ether and ethyl acetate (1:1). The organic phase was separated and evaporated under vacuum at 45°C and the samples re-dissolved in 3 mL methanol.

**Determination of total phenolic content of dates:** The total phenolic content of dates sample was determined according to the Folin-Ciocalteu procedure[15]. The total phenolic content was determined by means of a calibration curve prepared with gallic acid and expressed as µg of gallic acid equivalent (GAE) per g of sample.

**Determination of total flavonoid content of dates:** The total flavonoid content was determined according to Zilic *et al.*[15]. The total flavonoid content was expressed as µg of catechin equivalent (CE) per g of sample.

**Identification of dates phenolic compounds:** Phenolic compounds were estimated using HPLC analysis. The procedure was carried out using Agilent Technologies 1100 series liquid chromatograph equipped with an auto sampler and a diode-array detector. The analytical column was an Eclipse XDB-C18 (150 X 4.6 µm; 5 µm) with a $C_{18}$ guard column (Phenomenex, Torrance, CA). The mobile phase consisted of

acetonitrile (solvent A) and 2% acetic acid in water (v/v) (solvent B). The flow rate was kept at 0.8 mL $min^{-1}$ for a total run time of 70 min and the gradient programmed was as follows: 100-85% B in 30 min, 85-50% B in 20 min, 50-0% B in 5 min and 0-100% B in 5 min. The injection volume was 50 µL and peaks were monitored simultaneously at 280 and 320 nm for the benzoic acid and cinnamic acid derivatives, respectively. All samples were filtered through a 0.45 µm Acrodisc syringe filter (Gelman Laboratory, MI) before injection. Peaks were identified by congruent retention times and UV spectra and compared with those of the standards.

**Determination of radical scavenging activity of dates:** Free radical scavenging capacity was determined using the stable 1,1-Diphenyl-2-picrylhydrazyl ($DPPH^{\cdot}$) according to Grzegorczy *et al.*[16]. Inhibition percentage of the DPPH free radical was calculated by the following equation:

$$\text{Inhibition (\%)} = \frac{A_{control} - A_{sample}}{A_{control}} \times 100$$

Where:

$A_{control}$ = Absorbance of the control

$A_{sample}$ = Absorbance of the treatment

**Date syrup**

**Preparation of date syrup:** The weighed flesh of date samples were boiled in sufficient amount of hot water (80-85°C) for 20 min and blending with mixer machine. The slurry was filtered through a cloth with a hand press. The residue pulp was rewashed with hot water for 10 min and filtered again twice, to make up the water/pulp ratio as 2, 2.5 and 3.0 $L^{-1}$, respectively. The collected raw date juice was then centrifuged at 7,000 rpm for 30 min. The clear extract was concentrated under vacuum using rotary evaporator apparatus at 70°C to obtain one fourth or third of the total extract volume (~25-28% TS). The produced date syrup was packed in sealed glass bottles and stored at 4±2°C until used.

**Yoghurt manufacture:** Fresh cow's milk was standardized to ~3.0% fat and ~15.0% total solids using skim milk powder and divided into four equal portions. Date syrup (Salma, Magdy and Khalas) was added individually to the standardized milk at rate of 15.0% (as the best percentage according to the pre-experimental) to create 3 treatments ($T_1$, $T_2$ and $T_3$, respectively). The latter batch had no date syrup. All mixtures were preheated to 60°C, homogenized using laboratory double stage homogenizer (13.6/3.5 MPa), then heated to 85°C for10 min and cooled to 42°C. All mixtures were inculcated with 3.0% of mixed starter culture (1:1), dispensed into plastic cups (150 mL) and incubated at 42°C until a uniform coagulation was formed. The yoghurt samples were stored at 4± 2°C and analyzed at day 1, 7 and 15 of storage. Three replicates were made from each treatment.

**Bacteriological analysis:** Yoghurt samples were diluted and subsequently plated in duplicate onto selective media. MRS medium was used to enumerate *L. bulgaricus*[17] and the plates were incubated at 37°C for 48 h. *S. thermophilus* was enumerated on M17 agar after aerobic incubation at 37°C for 48 h[18].

**PH value:** The changes in pH value in the yoghurt samples during storage were measured using a laboratory pH meter with glass electrode (HANNA, Instrument, Portugal).

**Determination of colour:** The colour of dates syrup and yoghurt samples was evaluated using a Spectro Colorimeter (Tristimulus Color Machine) with the CIE lab color scale (Hunter, Lab Scan XE - Reston VA, USA) in the reflection mode. The color was expressed in terms of L, a and b.

Where L, value represents darkness from black (0) to white (100); a, value represents color ranging from red (+) to green (-) and b, value represents color ranging from yellow (+) to blue (-).

**Whey syneresis:** Whey syneresis was estimated as mentioned by Aguilera and Kessler[19]. An amount of 25 g of the yoghurt sample was placed into centrifuge tube and centrifuged at 1290 rpm for 20 min (Sigma Laborzentri Fugen, 2 K15, Germany). The weight fraction of the supernatant liquid was used as index of whey syneresis (mL/100 g yoghurt).

**Apparent viscosity:** The yoghurt samples were gently stirred 5 times in clockwise direction with a plastic spoon prior to viscosity measurements. Apparent viscosity was measured at 7°C using a Brookfield digital viscometer (Model DV-II, Canada) fitted with spindle-4. The yoghurt sample was subjected to selected shear rate 10 $sec^{-1}$. Apparent viscosity was expressed as Pa s.

**Sensory evaluation:** Many of consumers were selected from staff member of Dairy Science Dept., National Research Centre, Egypt, to evaluate the body and texture and flavor of the yoghurt samples. They scored the sample on the basis of nine-point hedonic scale, ranging from like extremely = 9 through like or dislike = 5 to dislike extremely = 1 as described by Piggott[20].

**Statistical analysis:** The collected data were analyzed and presented as means. Means were compared by the analysis of variance (one way ANOVA), followed by LSD test ($p<0.05$) using SPSS (Version 11.5) software program.[21]

## RESULTS AND DISCUSSION

### Properties of dates

**Composition of date varieties:** Chemical composition of three varieties of date palm (Salma, Magdy and Khalas) were determined and presented in Table 1. The obtained results showed that moisture, protein, ash, reducing sugars and non-reducing sugars contents ranged between 43.5-45.5, 2.21-3.02, 1.69-1.85, 23.03-28.18 and 51.87-59.22%, respectively. In particular, Salma date has the highest ash as well as reducing sugars and lowest protein content ($p<0.05$), while Magdy date has the lowest reducing sugars and vitamin C and the highest non- reducing sugars compared with other dates verities. The protein and vitamin C contents were higher in Khalas date. Values for date fleshes were within the range of results previously published results in the literature[5,12,22-24].

**Minerals content of date varieties:** As shown in Table 2, Salma date characterized with the higher content of phosphorus, sodium and potassium (71, 64.02 and 62.30 mg/100 g), respectively, while Khalas date was higher in zinc (2.7 mg/100 g) and in iron (13.87 mg/100 g). These analyses accepted with many of previous literatures which revealed that the date palm contains a suitable concentration of calcium, potassium, phosphorus and selenium which are very important for human body and metabolic operations in the human cells[25-29].

**Sugar content of date varieties:** In general, the main sugars found in the date flesh samples (Salma, Magdy and Khalas) were fructose, glucose and sucrose (Table 3). The reducing sugars (glucose and fructose) were the major sugars in all cultivars. The richness of these varieties in reducing sugars suggests the existence of pronounced invertase activity, which considerably reduces its sucrose content[30,31]. However, the sugar content was lower than those in commercial dates with high sensory quality. The obtained results showed that fructose, glucose and sucrose contents of date varieties ranged between 30.70-35.50, 35.20-41.26 and 1.97-9.25%, respectively.

**Total phenols, total flavonoids and antioxidant activity:** Antioxidant compounds in food play an important role as a

Table 1: Chemical composition of date varieties (on dry weight basis)

| | Date palm varieties | | | |
|---|---|---|---|---|
| Chemical properties | Salma | Magdy | Khalas | LSD at 0.05 |
| Moisture (%) | 45.5 | 43.75 | 43.50 | 3.651 |
| Protein (%) | 2.21 | 2.44 | 3.02 | 0.125 |
| Ash (%) | 1.85 | 1.77 | 1.69 | 0.085 |
| Total sugar (%) | 80.05 | 82.25 | 78.35 | 4.215 |
| Reducing sugar (%) | 28.18 | 23.03 | 25.11 | 2.351 |
| Non reducing sugar (%) | 51.87 | 59.22 | 53.24 | 2.951 |
| Vitamin C (mg/100g) | 24.87 | 21.20 | 33.24 | 3.012 |

Table 2: Mineral contents of date varieties (mg/100 g dry weight basis)

| | Date varieties (mg/100 g DW) | | | |
|---|---|---|---|---|
| Minerals | Salma | Magdy | Khalas | LSD at 0.05 |
| Calcium | 1.30 | 1.89 | 1.30 | 0.062 |
| Potassium | 62.30 | 57.43 | 48.27 | 2.012 |
| Iron | 11.77 | 8.12 | 13.87 | 1.250 |
| Magnesium | 20.02 | 36.52 | 14.98 | 2.641 |
| Sodium | 64.02 | 47.36 | 54.28 | 3.091 |
| Phosphorus | 71.00 | 69.00 | 58.00 | 3.275 |
| Zinc | 2.65 | 2.27 | 2.70 | 0.091 |

Table 3: Sugars contents of date varieties (mg/100 g dry weight basis)

| | Date varieties (mg/100 g DW) | | | |
|---|---|---|---|---|
| Sugars | Salma | Magdy | Khalas | LSD at 0.05 |
| Fructose | 35.50 | 32.06 | 35.17 | 2.015 |
| Glucose | 41.26 | 37.74 | 40.54 | 2.985 |
| Sucrose | 3.29 | 1.97 | 2.64 | 1.056 |

Table 4: Sugars contents of date varieties (mg/100 g dry weight basis)

| | Date varieties | | | |
|---|---|---|---|---|
| Sugars | Salma | Magdy | Khalas | LSD at 0.05 |
| Total phenolics (mg GAE $g^{-1}$) | 1.06 | 1.13 | 1.19 | 0.061 |
| Total Flavonoids (mg CE $g^{-1}$) | 3.59 | 4.28 | 4.78 | 0.402 |
| Antioxidant activity (%) | 49.07 | 48.89 | 52.65 | 2.033 |

GAE: Gallic acid equivalent, CE: (+)-Catechin equivalent

health protecting factor. Natural phenolics exert their beneficial health effects mainly through their antioxidant activity[32]. These compounds are capable of decreasing oxygen concentration, intercepting singlet oxygen, preventing 1st chain initiation by scavenging initial radicals such as hydroxyl radicals, binding metal ion catalysts, decomposing primary products of oxidation to non radical species and breaking chains to prevent continued hydrogen abstraction from substances[33].

Total phenolic and total flavonoids compounds were determined in date varieties. As shown in Table 4, the higher total phenolics content of dates was found in Khalas date (1.19 mg GAE/100 g) followed by Magdy date (1.13 mg GAE/100 g) and Salma date (1.07 mg GAE/100 g). Table 5 shows the phenol compounds investigated in date varieties. Khalas date has higher content from gallic, caffeic, chlorogenic and cinnamic acids, while lower content from chyrsin compared with other date varieties ($p<0.05$). Protochatchuic acid was detected only in Magdy date which has the content from chyrsin. Salma date characterized with the highest content from sinapic acid and ruten.

The same trend was observed in total flavonoids in Khalas, Magdy and Salma, where they were 4.78, 4.28, 3.87 and 3.59 mg CE/100 g, respectively. The free radical scavenging (DPPH) action is known to be one of the mechanisms for measuring antioxidant activity. For the DPPH radical, Khalas had higher DPPH (52.65%) followed by Salma (49.07%) and Magdy (48.89%). Ardekani *et al.*[34], Khanavi *et al.*[35] and Biglari *et al.*[36] investigated antioxidant activity of some date varieties. They demonstrate the potential of Iranian dates as antioxidant functional food ingredients. Results of this study are in agreement with those reported by Al Harthi *et al.*[6] Ardekani *et al.*[34] and Khanavi *et al.*[35].

**Properties of dates syrup:** Total soluble solids (TSS), pH value and viscosity of dates syrup prepared for yoghurt manufacturing are presented in Table 6. The results show that syrup of Magdy date was higher in TSS and lower in both pH and viscosity, however, there was no difference in the TSS content, pH value and viscosity among all syrup date varieties ($p>0.05$). Colour attributes of all syrup date varieties showed that, syrup produced from Magdy date was more darker (L = 2.57), less redness (a = 2.65) and less yellowness (b = 3.51) than these produced from both Salma and Khalas dates ($p<0.05$). The highest lightness (L) and redness (a) values were found in Salma syrup followed by Khalas syrup. The highest yellowness value (b) was found in Khalas syrup (10.21) followed by Salma syrup (9.19).

Table 5: Phenol compounds of date varieties (μg $g^{-1}$ dry weight basis)

| | Date varieties (μg $g^{-1}$ date) | | |
|---|---|---|---|
| Phenol compounds | Salma | Magdol | Khalas |
| Gallic acid | 4.44 | 10.11 | 33.59 |
| Protochatchuic acid | ND | 18.92 | ND |
| Gentisic acid | ND | ND | ND |
| Catachine | ND | ND | ND |
| Chlorogenic acid | ND | 9.52 | 18.49 |
| Caffeic acid | 3.81 | 12.35 | 15.53 |
| Syringic acid | ND | 4.04 | 11.46 |
| Vanillic acid | ND | ND | ND |
| Ferulic acid | ND | 43.1 | 23.6 |
| Sinapic acid | 34.34 | 26.92 | 6.77 |
| Ruten | 72.22 | 17.24 | ND |
| Coumarin | ND | ND | ND |
| Rosmarinic acid | ND | ND | ND |
| Cinnamic acid | 0.87 | 1.81 | 5.37 |
| Querecetin | ND | ND | ND |
| Kaempferol | ND | ND | ND |
| Chyrsin | 19.29 | 24.19 | 16.33 |

ND: Not detected

Table 6: Some properties of syrup dates syrup

| | Dates syrup | | | |
|---|---|---|---|---|
| Items | Salma | Magdy | Khalas | LSD at 0.05 |
| TSS | 25.90 | 28.01 | 27.91 | 5.375 |
| PH | 7.32 | 6.86 | 7.36 | 0.781 |
| Viscosity (mpa s) | 13.60 | 12.80 | 13.66 | 1.751 |
| **Colour attributes** | | | | |
| L | 8.47 | 2.57 | 7.41 | 2.721 |
| a | 6.81 | 2.65 | 3.51 | 1.770 |
| b | 9.19 | 3.51 | 10.21 | 2.951 |

TSS: Total soluble solids, L: Darkness from black (0) to white (100), a: Colour red (+) to green (-), b: Colour yellow (+) to blue (-)

## Properties of yoghurt made with dates syrup

**Chemical properties:** Table 7 shows pH value of yoghurt made with dates syrup during storage at 4±2°C for 14 days.

Table 7: pH value of yoghurt made with dates syrup during storage at 4±2°C for 14 days

| | | Yoghurt treatments | | | | |
|---|---|---|---|---|---|---|
| Item | Storage (days) | Cont | $T_1$ | $T_2$ | $T_3$ | LSD at 0.05 |
| pH value | 1 | 4.79 | 4.81 | 4.65 | 4.72 | 0.215 |
| | 7 | 4.68 | 4.65 | 4.62 | 4.59 | |
| | 14 | 4.58 | 4.52 | 4.48 | 4.45 | |

Table 8: Whey syneresis and viscosity of yoghurt made with dates syrup during storage at 4±2°C for 14 days

| | | Yoghurt treatments | | | | |
|---|---|---|---|---|---|---|
| Storage | Storage (days) | Cont | $T_1$ | $T_2$ | $T_3$ | LSD at 0.05 |
| Whey syneresis (mL/100 mL) | 1 | 18.63 | 19.70 | 19.90 | 18.91 | 2.71 |
| | 7 | 16.55 | 16.59 | 18.29 | 18.73 | |
| | 14 | 16.23 | 16.35 | 16.91 | 17.52 | |
| Viscosity (Pa s) | 1 | 7.15 | 6.37 | 6.40 | 7.09 | 1.66 |
| | 7 | 10.23 | 8.78 | 8.88 | 8.75 | |
| | 14 | 12.71 | 8.47 | 8.64 | 9.07 | |

Table 9: Colour attributes of yoghurt made with dates syrup during storage at 4±2°C for 14 days

| | | Yoghurt treatments | | | | |
|---|---|---|---|---|---|---|
| Colour attributes | Storage period | Cont | $T_1$ | $T_2$ | $T_3$ | LSD at 0.05 |
| L | 1 | 93.64 | 88.17 | 88.55 | 90.51 | 3.012 |
| | 7 | 93.51 | 88.05 | 88.31 | 88.61 | |
| | 14 | 93.42 | 87.15 | 88.0 | 87.90 | |
| a | 1 | 0.57 | 1.10 | 2.14 | 1.60 | 0.781 |
| | 7 | 0.85 | 0.74 | 1.55 | 0.65 | |
| | 14 | 0.58 | 0.96 | 2.06 | 1.01 | |
| b | 1 | 15.09 | 17.61 | 15.65 | 16.44 | 1.195 |
| | 7 | 15.04 | 17.26 | 15.55 | 15.78 | |
| | 14 | 16.28 | 16.05 | 16.46 | 15.80 | |

L: Darkness from black (0) to white (100), a: Colour red (+) to green (-), b: Colour yellow (+) to blue (-)

There was no significant difference in the pH value of the yoghurt samples made with all dates syrups compared with the plain yoghurt. During storage period, all yoghurt samples showed a gradual decrease in pH value with the time; the difference being significant only at day 14 ($p<0.05$). The changes in pH during storage were found to be similar in yoghurts containing inulin and probiotics[37] and in yoghurt containing cress seed mucilage[38]. Thus, the using of dates syrup in yoghurt manufacturing did not influence the starter activity during fermentation process and did not influence the changes in pH during storage.

**Physical properties:** The whey syneresis (mL/100 g sample) of yoghurt made with dates syrup compared with plain yoghurt is given in Table 8. During the 2 weeks of storage, the whey syneresis of yoghurt made with all dates syrup was higher than that of plain yoghurt; the difference was not significant. The increase in whey syneresis may be concomitant decrease in protein content in yoghurt made with dates syrup. On the other hand, slight decrease in whey syneresis was observed during storage period which it was similar in all samples ($p>0.05$). At lower temperatures, bonds between gel particles are either stronger or their numbers are greater which helps in holding water and prevents whey syneresis[38]. The same trend has been reported by many researchers as well[38-40].

As shown in Table 8, yoghurt viscosity was influenced by addition of dates syrup. In particular, yoghurt samples made with dates syrup showed the lower viscosity compared with the plain yoghurt, however, the difference being significant only at day 14 ($p<0.05$). These results could be attributed to either the lower protein content which decrease intermolecular bonds between micelles of casein. During storage period, both plain yoghurt and yoghurt made with Khalas syrup ($T_3$) showed a continued increase in viscosity being significant at days 7 and 14 for plain yoghurt whereas for $T_3$ the increase was significant only at day 7. Also, a significant increase was observed in the viscosity of yoghurt mad with Salma and Magdy syrup ($T_1$ and $T_2$) at day 7 and decline thereafter. The same trend was observed in yoghurt made with tiger-nut extract [41].

**Colour attributes:** Colour attributes of yoghurt made with dates syrup during storage at 4±2°C for 14 days are given in Table 9. In general, colour attributes of yoghurt are more

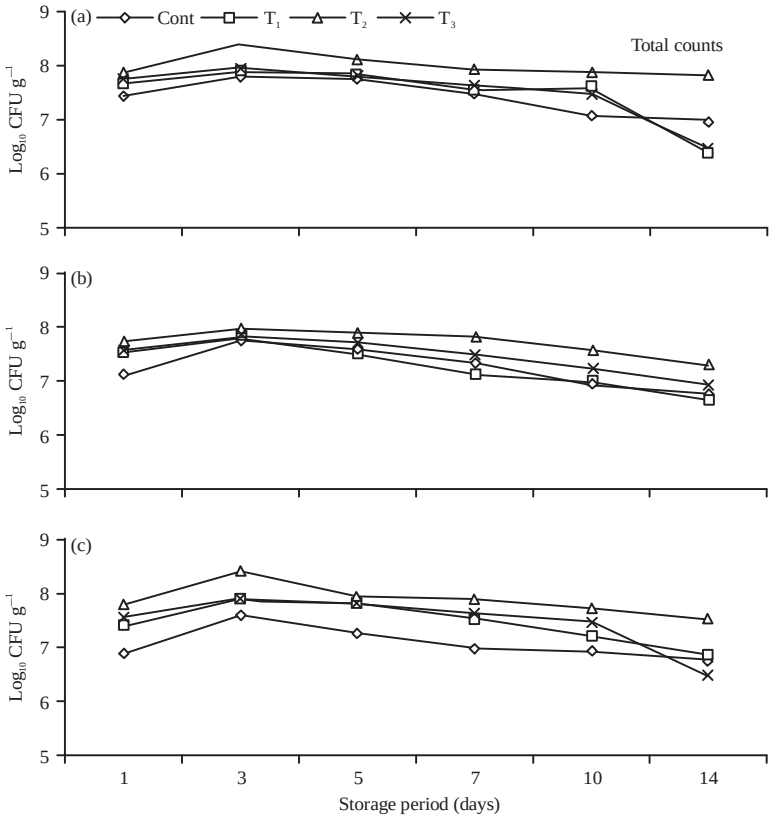


Fig. 1(a-c): (a) Total counts, (b) *L. bulgaricus* and (c) *S. thermophilus* of yoghurt made with dates syrup during storage at 4±2°C for 14 days

affected by dates syrup ($p<0.05$). Whiteness degree of all yoghurt made with dates syrup was significantly lower than that of plain yoghurt ($p<0.05$) at different storage periods. Inversely, the redness colour was higher in yoghurt made with all dates syrup compared with the plain yoghurt, however, the redness was more pronounced in $T_2$ ($p<0.05$). Dates syrup had no significant effect on the yellow degree except in $T_1$ which had highest yellow degree. A similar trend was observed by Keshtkaran and Mohammadifar[42] in date milk beverage. Storage period had no significant effect on all colour attributes in all yoghurt treatments.

**Starter activity:** The change of starter activity in the yoghurt made with dates syrup during storage at 4±2°C for 14 days is presented in Fig. 1. A total count of starter culture in the $T_2$ was significantly higher ($p<0.05$) than that in the plain yoghurt during all storage period. However, slight increase in total count was observed in $T_1$ and $T_3$ until day 10 compared with plain yoghurt, then was lower thereafter ($p<0.05$). The same trend was observed in yoghurt made with all dates syrups for *L. bulgaricus* and *S. thermophilus* viability. Over storage, counts of *Lb. bulgaricus* and *S. thermophilus* increased until day 3 in all yoghurt treatments ($p>0.05$), then decline thereafter. However, the viability of starter strains was more stable in $T_2$, the decrease in starter strains being significant only at day 15 ($p<0.05$). Therefore, using date syrup in yoghurt manufacture had no adverse effect but may enhance the viability of starter culture.

**Sensory evaluation:** Sensory attributes (body, texture and flavour) of yoghurt made with dates syrup compared with plain yoghurt during storage at 4±2°C for 14 days are given in Table 10. In general, yoghurt made with date syrup was more softness, smoothness and more sweetness compared with plain yoghurt. Also, $T_2$ was more acceptable compared with other treatments. The same result was found by Ardali *et al.*[43] in milk drink with 10% date syrup. However, statistical analysis showed that, there was no significant difference in body and texture and flavour scores among all yoghurt samples.

Table 10: Sensory evaluation of yoghurt made with dates syrup during storage at 4±2°C for 14 days

| | | Yoghurt treatments | | | | |
|---|---|---|---|---|---|---|
| Colour attributes | Storage period | Cont | $T_1$ | $T_2$ | $T_3$ | LSD at 0.05 |
| Body and texture | 1 | 8.00 | 8.06 | 8.25 | 8.12 | 0.83 |
| | 7 | 8.25 | 8.25 | 8.15 | 8.36 | |
| | 14 | 8.12 | 8.15 | 8.18 | 8.14 | |
| Flavour | 1 | 7.88 | 8.12 | 8.50 | 8.18 | 0.76 |
| | 7 | 8.00 | 8.06 | 8.37 | 8.25 | |
| | 14 | 7.89 | 8.00 | 8.50 | 8.36 | |

## CONCLUSION

Fresh date varieties in Egypt (Salma, Magdy and Khalas), are characterized by high content of vitamin C, iron, phosphorus, zinc, fructose and glucose as well as antioxidant properties. The syrup of these varieties can be used in the manufacturing of flavored and healthy yoghurt rich in vitamins, carbohydrate, dietary fiber, minerals, fat and proteins as well as antioxidant components. These combinations can be helpful in reducing the coronary heart disease, cancer and diabetes as well as reducing the malnutrition diseases.

## SIGNIFICANCE STATEMENTS

This study discovers the fortification of fermented milk with date syrup that can be beneficial for the production of flavored and healthy dairy foods rich in some minor and major components. Such foods can be helpful in protecting children from malnutrition as well as reducing osteoporosis and atherosclerosis in adults.

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