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## Evaluation of the Nutritional Value of Functional Yogurt Resulting from Combination of Date Palm Syrup and Skim Milk

A.S. Gad, A.M. Kholif and A.F. Sayed

National Research Center, Department of Dairy Science, Dokki, Giza, Egypt

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**Abstract:** The objective of this study was to use date palm syrup as a part of water (v/v) used in reconstituting skim milk powder in processing yogurt with 14% total solids. Physical properties such as sensory characteristics and apparent viscosity were evaluated. To evaluate the nutritional value of yogurt, antioxidant values were monitored during storage and the sample which recorded the highest values would determine its chemical composition. In addition, some micronutrients (HCl-soluble minerals) and (folate and C vitamins) compared to plain yogurt. Results showed that yogurt enriched with 10% date syrup had a significant sweetness, recorded the highest antioxidant values, higher in HCl-soluble minerals and folate concentration compared to plain yogurt. It could be concluded that numerous health benefits beyond its nutritional value have been associated with consuming yogurt enriched with 10% date palm syrup.

**Key words:** Yogurt, date palm, minerals, folate, antioxidant activity

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### INTRODUCTION

The date palm (*Phoenix dactylifera* L.) is one of the major fruit trees in Egypt (El-Assar *et al.*, 2005). Its production and consumption is growing continuously due to its therapeutic properties beside its high nutritive value (Karagul *et al.*, 2004). Date fruit consumption is an important source of supplying mineral and vitamin elements in a balanced nutrition regime (Al-Shahib and Marshall, 2003). Research proves that when dates are eaten alone or in mixed meals with plain yogurt have low glycaemic indexes (Yousif *et al.*, 1996; Miller *et al.*, 2003). The good news is that consumption of dates may also benefit in glycaemic and lipid control of diabetic patients (Miller *et al.*, 2002, 2003). Lately, several therapeutic virtues are assigned to the date palm and its derivatives. Date fruit has anti-tumor activity (Ishurd and Kennedy, 2005), antioxidant and anti-mutagenic properties (Vayalil, 2002; Mansouri *et al.*, 2005). The fruit has been recommended in folk remedies for the treatment of various infectious diseases and cancers (Duke, 1992). Dry date fruits are used in Indian traditional medicine after child birth as immunostimulants (Puri *et al.*, 2000). Extracts of the dates provided to the women after childbirth stimulate their immune system (Puri *et al.*, 2000). Aqueous date extract was also found to inhibit significant the lipid peroxidation and protein oxidation in a dose-dependent manner (Al-Laith, 2007). Furthermore, Al-Shahib and Marshall (2003) concluded that, in many ways, dates may be considered as an almost ideal food, providing a wide range of essential nutrients and potential health benefits. On the other hand, a polysaccharide isolated from dates presented an antitumor activity (Ishurd and Kennedy, 2005). Extracts of the pits date decrease quickly and meaningfully the women's

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**Corresponding Author:** A.M. Kholif, Department of Dairy Science, National Research Center, Dokki, Giza, Egypt

wrinkles (Bauza *et al.*, 2002). Yogurt is most often flavored with fruit preserves or other ingredients (Potter and Hotchkiss, 1995). Flavored yogurts are made by adding fruit concentrates or flavored syrups to cultured milk before or after incubation (Keating and White, 1990). The aim of this study was using the date extract as a part of aqueous phase used in reconstitute skim milk powder, processed yogurt and evaluate the nutritional values of the new product.

## **MATERIALS AND METHODS**

This study was conducted from July 2008 to June 2009 in Dairy Science Department laboratories, National Research Centre, Dokki Giza Governorate, Egypt. Skim milk powder (low heat, origin USA) was reconstituted in distilled water and left overnight at 4°C to allow full hydration. Dried date fruits from local market. Folin-Ciocalteu reagent and 2,4,6-Tris [2-pyridyl]-s-triazine (TPTZ) were obtained from Fluka Chem. Co (Buchs, Switzerland), 2,2-Diphenyl-1-picrylhydrazyl (DPPH) radical and the reagents, (S)-(-)-6-Hydroxy -2,5,7,8-tetramethylchroman -2-carboxylic acid (TROLOX) from (Sigma, St. Louis, Mo. USA) and gallic acid from (MP Biomedicals. Inc. (Eschwege, Germany). Starter: freeze dried culture of *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus salivarius* subsp. *thermophilus* (1:1) were obtained from Chr. Hansens laboratories, Denmark.

### **Preparation of Date Palm Syrup (Aqueous Extract of Date Fruit/Date Juice)**

Dried date fruits (500 g) were grinded with a mechanical set (to increase surface area), infused in 1000 mL hot water then stirred for 2 h and allowed to stand in a refrigerator overnight to fully extract. The raw date palm syrup was extracted by squeezing the mixture through cheese cloths. The date fruit extract was collected and used with different concentrates as a part of water (2.0, 4.0, 6.0, 8.0 and 10% v/v) in reconstituted skim milk powder that prepared of processing yogurt (Vayalil, 2002).

### **Determination Total Soluble Solids (TSS) of Prepared Date Palm Syrup (Brix°)**

Total soluble solids in the raw date palm syrup were measured using an Abbe Mark II digital refractometer (Leica Inc., Buffalo, NY) by placing 0.5 g syrup on the lens and reading the sample for temperature corrected Brix.

### **Yogurt Manufacture**

Skim milk powder was reconstituted in distilled water including date palm syrup to give 14% total solids. Reconstitute milk was heat treated at 90°C for 10 min, then cooled to 43°C, starter was added at the rate of 3% and incubated at 43°C for 4 h until coagulation occur and samples reached to pH 4.3. Yogurt then refrigerated at 5°C for 12 day and subsequent analysis. Plain yogurt was produced by the same procedure. Samples were duplicated.

### **Physical Properties of the Yogurt**

#### **Sensory Evaluation**

Yogurt samples were served in plastic plates labeled with three-digit codes from a random number table. The quality properties that were evaluated were color, firmness, smoothness, taste, sweetness, sourness, flavor and overall acceptance. The sensory scores of produced types of yogurt was done on a 9-point hedonic scale with 1 = dislike extremely and 9 = like extremely.

### **Apparent Viscosity of Yogurt (cP.s)**

Apparent viscosity was based on measuring resistance to a rotating spindle (Brookfield Model DV III, Programmable rheometer) depends on time of shearing and test samples were subjected to shear rate a spindle speed of 50 rpm and spindle rotating velocities, at constant temperature (25°C) for 5 min. The instrument was equipped with an 18 measuring head. Samples were allowed to relax (more than 10 min) prior to measuring their viscosity. All apparent viscosity measurements were expressed in centipoise seconds (cP.s), performed in duplicate.

### **Monitor the Antioxidant Activity in Yogurt (14% TS) During Storage (0, 3, 6, 9 and 12 Days)**

#### **Determination of Total Phenols Content**

The method of Zheng and Wang (2001) was followed in determining the total phenol compounds in yogurt using Folin Ciocalteu Reagent (FCR) and gallic acid as a standard solution. Aliquots (20 µL) of the diluted extracts were mixed with 100 µL of Folin-Ciocalteu phenol reagent and 300 µL of 20% Na<sub>2</sub>CO<sub>3</sub>. The absorbance was read with a SP-2000UV UV/V is spectrophotometer at 765 nm. The total phenol contents were calculated from a standard curve of diluted gallic acid solution and expressed as gallic acid equivalent in (GAE) mg/100 mL extract.

#### **Measurement of DPPH Radical Scavenging Activity**

The DPPH free radical scavenging activity of yogurt was assessed according to the method mentioned at (Larrauri *et al.*, 1998) with some modifications. Briefly, 40 µL of the different blends of yogurt samples were mixed with 2.9 mL of 0.1 mM DPPH solution in methanol and the absorbance was measured at 517 nm. A standard curve was prepared for the reaction between 40 µL of Trolox solutions (0.5 mM) and DPPH the same as the samples. The scavenging activity of the different samples were measured from the prepared standard curve and expressed as µmoles Trolox Equivalents/100 mL sample (TE).

#### **Measurement of the Ferric Reducing Antioxidant Power (FRAP)**

The method of Benzie and Strain (1996) was followed in determining the FRAP. Aliquots of 100 µL of blended yogurt samples were mixed with 3 mL FRAP reagent and the absorbance of reaction mixture was measured at 593 nm after incubation at 37°C for 10 min. FRAP values were obtained from a standard curve prepared ferrous sulphate (FeSO<sub>4</sub>.7H<sub>2</sub>O) solutions (0.1-3.0 mmol L<sup>-1</sup>) and data was expressed as mg Fe<sup>2+</sup>/100 mL (FRAP value). Sample recorded the highest antioxidant values during storage, the nutritional value evaluated as chemical composition and some micronutrient (HCl-soluble minerals) and (folate and C vitamins) compared to plain yogurt.

#### **Chemical Composition of Yogurt**

The pH, acidity, moisture, protein, fat and total solids of yogurt containing date products were determined. The pH was measured using a Jonway 705 pH meter. Titrable acidity was determined as lactic acid by titrating with 0.1 N NaOH using phenolphthalein as an indicator. Total solids content was determined in a laboratory oven at 105°C for 24 h and total protein was assayed by Kjeldahl method (Ling, 1963).

#### **Liquid High-Performance Chromatographic Determination of Water-Soluble Vitamins (Vit. C and Folic Acid in Yogurt)**

A weight of 5 g of prepared yogurt sample was stirred well with 70 mL of 0.02% EDTA in 2 N H<sub>2</sub>SO<sub>4</sub>. The blend was transferred quantitatively to a 100 mL volumetric flask and the

volume made to mark with 0.02% EDTA solution. An aliquot of the blend was centrifuged at 7000x g for 5 min, then analyzed for vitamin C according to the HPLC method of Ilic and Ashoor (1988).

#### **Determination of HCl-Soluble Mineral (K, Ca, Mg, P, Fe and Z) Concentrations in Yogurt**

Minerals (K, Ca, Mg, P, Fe and Zn) content of the yogurt was determined by atomic absorption spectrophotometer (Varian spectra AA 220) (Tamimea *et al.*, 1999).

#### **Statistical Analysis**

Statistical analysis was performed by using the General Linear Model (GLM) procedure of Statistical Analysis System (SAS, 1988). The Least Significant Difference test (LSD) was used to test differences between means ( $p \leq 0.05$ ).

## **RESULTS**

### **Physical Properties of the Yogurt**

#### **Sensory Evaluation**

Yogurt has 10% date palm syrup recorded the highest sensory scores (Table 1) had 35.8° Brix level (SS).

#### **Apparent Viscosity of Yogurt (cP.s)**

The apparent viscosity of yogurt measured as function of shearing time showed greater reduction of apparent viscosity with time of shearing. In yogurt made from skim milk mixed with different concentrations of aqueous extract of date fruit dry dates (2.0, 4.0, 6.0, 8.0 and 10%) apparent viscosity at initial stress were 41, 37, 34, 33 and 30.0 cP.s whereas plain yogurt recorded 46.0 cP.s (Fig. 1). Apparent viscosity had a lower viscosity in increased date palm syrup concentration. The apparent viscosity with time of shearing, were decreased. There were significant differences between concentration at time 0.0, 0.5, 1, 1.5, 2 and 2.5 min. However, at 3 min no significant differences between the concentrations were observed.

### **Determination the Antioxidant Activities in Yogurt During Storage**

#### **Total Phenols Content**

Soluble phenolic content of yogurt made with skim milk-date palm syrup were increased significantly ( $p < 0.05$ ) with increasing the concentration of date palm syrup 2, 4, 6, 8 and 10% in yogurt produced whereas decreased by storage time (0, 3, 6, 9 and 12 days) in the fixed concentration. Plain yogurt had 248 mg GAE/100 mL sample at zero day storage was decreased to 210 mg GAE/100 mL sample at 12 days storage and yogurt -10% date syrup had 306 mg GAE/100 mL yogurt sample at zero day was also decreased to 260 mg GAE/100 mL yogurt sample at 12 days storage (Fig. 2).

Table 1: Average scores of sensory evaluation of yogurt enriched with different concentrations (0-10%) date palm syrup

Yogurt	Color	Firmness	Smoothness	Taste	Sweetness	Sourness	Flavor	Acceptability
Plain yogurt	8.2	7.5	8.6	7.6	5.5	7.8	6.5	6.6
Yogurt-2%	8.1	7.4	8.5	7.6	5.6	6.7	6.9	6.7
Yogurt-4%	8.0	7.4	8.4	7.9	5.6	6.6	7.0	7.5
Yogurt-6%	7.8	7.2	8.2	8.1	5.8	6.4	7.2	7.7
Yogurt-8%	7.6	7.0	7.8	8.3	6.2	6.4	7.7	7.9
Yogurt-10%	7.4	6.7	7.5	8.5	7.6	6.2	7.8	8.2

9-point hedonic scale was used with 1: Dislike extremely and 9: Like extremely. Means within a column not followed by a common letter are different ( $p \leq 0.05$ )

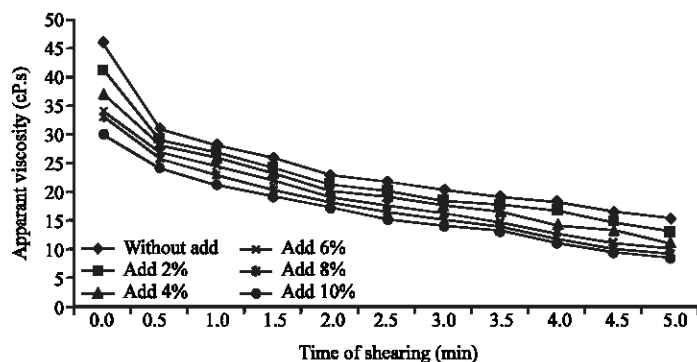


Fig. 1: The dependency of the apparent viscosity of yogurt (skim milk mixed with different concentration of dry dates 14%TS pH 4.5) with the time at a constant shearing for 25°C. Data were analyzed by SAS (t) test, one-way ANOVA followed by LSD test ( $p < 0.05$ )

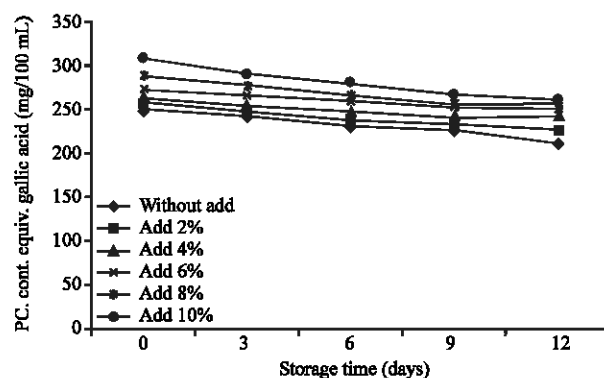


Fig. 2: Effect of storage time on phenolic compound content in milk with different conc. of dry dates additives. Data were analyzed by SAS (t) test, one-way ANOVA followed by LSD test ( $p < 0.05$ )

### DPPH Radical Scavenging Activity

Results showed that scavenging capacities of yogurt was significantly increased ( $p < 0.05$ ) with increasing the concentration of date palm syrup addition. Scavenging capacities of yogurt 10% date palm syrup was 103.3 TE mg/100 mL at zero day storage and values was decreased to 80.3 TE mg/100 mL at 12 days storage. Scavenging capacities of plain yogurt was 68.9 TE mg/100 mL at zero day storage and decreased to 40.0 TE mg/100 mL at 12 days storage (Fig. 3).

### The Ferric Reducing Antioxidant Power (FRAP)

This antioxidant power was significantly increased ( $p < 0.05$ ) with increasing the date palm syrup concentration in the yogurt and decreased with extent storage. The antioxidant power of in yogurt-has 10% date palm syrup was 43.3 mg  $Fe^{2+}$ /100 mL at zero day storage then decreased to 33.5 mg  $Fe^{2+}$ /100 mL after 12 days storage. The antioxidant power of plain yogurt was 35.4 mg  $Fe^{2+}$ /100 mL at zero day storage then reduced to 23.0 mg  $Fe^{2+}$ /100 mL after

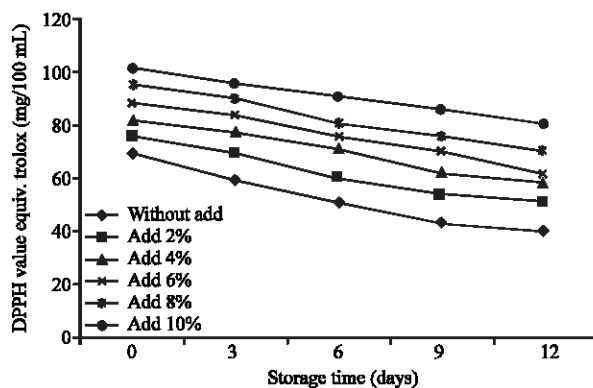


Fig. 3: Effect of storage time on antioxidant activity of using DPPH method in milk with different conc. of dry dates additives. Data were analyzed by SAS (t) test, one-way ANOVA followed by LSD test ( $p < 0.05$ )

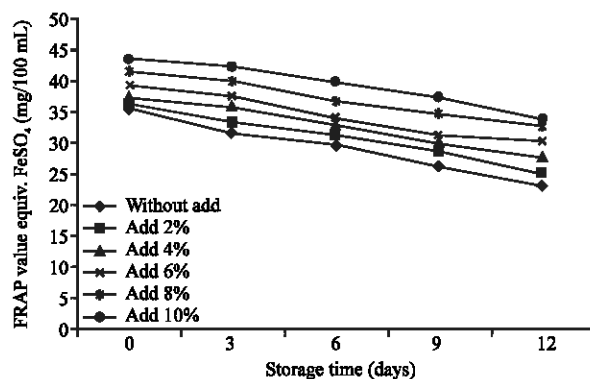


Fig. 4: Effect of storage time on antioxidant power (FRAP value) using FRAP method of milk with different conc. of dry dates additives. Data were analyzed by SAS (t) test, one-way ANOVA followed by LSD test ( $p < 0.05$ )

12 days storage (Fig. 4). From previous results yogurt-10% date palm syrup recorded the highest antioxidant values after 12 days storage, so it was chosen as a new product (functional yogurt) and evaluated its nutritional value comparing with plain yogurt.

**Evaluation the Nutritional Values of Yogurt-10% Date Juice Compared with Plain Yogurt  
Chemical Composition of the Chosen Yogurt-Date Sample Compared to Plain Yogurt**

Means for chemical composition (pH, acidity, moisture, protein, fat and total solids) of yogurt containing 10% date palm syrup and plain yogurt are presented in Table 2. Addition of date palm syrup had decreased protein content, acidity and moisture while increased total solids of the yogurt.

**Determination Some Micronutrients: Vitamins and Minerals**

A rapid, simple and reliable liquid chromatographic method had been developed for the simultaneous determination of water-soluble vitamins in yogurt. Results showed no

Table 2: Chemical composition of yogurt containing 10% date juice and plain yogurt

Yogurt	pH	Moisture	Protein	Total solids	Acidity
			(%)		
Plain yogurt	4.5	85.91	3.55	14.1	0.98
Yogurt-10% date juice	4.5	85.43	3.45	14.6	0.94

All data are insignificant ( $p > 0.05$ )

Table 3: Vitamins contents of yogurt

Yogurt	Vitamin C (mg)	Folic acid (mcg)
Plain yogurt	120.1 <sup>a</sup>	1.19 <sup>b</sup>
Yogurt-10% date juice	120.2 <sup>a</sup>	4.38 <sup>a</sup>

Folate (folic acid or folacin) is a water-soluble B9 vitamin. Dissimilar superscripts at the same column are significant ( $p < 0.05$ )

Table 4: HCl-soluble mineral content (K, Ca, P, Mg, Fe and Zn) (ppm) in yogurt

Yogurt	K	Ca	P	Mg	Fe	Zn
Plain yogurt	1978 <sup>b</sup>	1100 <sup>b</sup>	1002 <sup>b</sup>	155 <sup>b</sup>	3.1 <sup>b</sup>	5.2 <sup>b</sup>
Yogurt-10% date juice	3744 <sup>a</sup>	1700 <sup>a</sup>	1704 <sup>a</sup>	360 <sup>a</sup>	10.8 <sup>a</sup>	17.8 <sup>a</sup>

Dissimilar superscripts at the same column are significant ( $p < 0.05$ )

significant difference in vitamin C concentration in both yogurts whereas folate concentration had increased significantly ( $p < 0.05$ ) in yogurt-10% date juice compared to plain yogurt (Table 3). The HCl-soluble mineral content (potassium, calcium, phosphours, manganese, iron and zinc) in the plain yogurt sample were 1978, 1100, 1002, 155, 3.1 and 5.2 ppm whereas in yogurt-10% date juice were 3744, 1700, 1704, 360, 10.8 and 17.8 ppm, respectively with significant differences ( $p < 0.05$ ) as in Table 4.

## DISCUSSION

Participants found the sensory attributes of yogurt flavored with date palm syrup to be very acceptable. Previous studies were obvious that date fruit extracts significantly increased or decreased gastrointestinal transit (GIT) in mice (Al-Qarawi *et al.*, 2003) and that date fruit extract had strong antioxidant and antimutagenic properties (Vayalil, 2002). Data presented in this study demonstrated that yogurt containing 10% date palm syrup had significantly higher sensory evaluation, higher taste rating, higher sweetness rating compared to plain yogurt. The higher tasty and sweet was related to the date syrup that contain a high percentage of carbohydrate. Although, with increasing the extract of date fruit in yogurt caused leasing in the apparent viscosity, the yogurt with 10% date syrup gave acceptable consistency specially it was processed without stabilizer. The high levels of sugar bind moisture effectively thus preserving the fruit by preventing bacterial growth (Al-Shahib and Marshall, 2003).

Yogurt enriched with 10% date palm syrup had the highest total phenolics content, hydrogen-donating capacity and the ferric reducing antioxidant power compared to the other sample with all storage time. The antioxidant activity of date fruits have also been assessed and reported by other researchers using different methods. The predominant phenolics found in date fruits are very active as antioxidants and the antiradical activity in dates was highly correlated to the phenolic contents (Mansouri *et al.*, 2005). The antioxidant activity of the yogurt 10% date palm syrup was attributed to the presence of phenolic compounds (Ishurd and Kennedy, 2005; Al-Laith, 2007).

Vitamins and minerals are classified as micronutrients which the body's daily requirements. This concentrate of date palm syrup (10%) in yogurt was compared with plain yogurt in both some major minerals and vitamins as a required nutritional quality of the



product that providing a wide range of potential health benefits. The HCl-soluble mineral content of the yogurt-10% date juice was higher than the plain yogurts. The new product was also rich in calcium that helps strengthened bones and is particularly beneficial to young children to prevent rickets and brittle and weak bones in adults. Adequate intake of calcium and other nutrients from dairy has also been demonstrated to help reduce the risk of high blood pressure (Miller *et al.*, 2000). This yogurt was also rich with potassium which regulates the water balance in the body and provides the appropriate alkaloidal features for body fluids. In addition, to stimulating the kidneys to expel toxic bodily wastes (Lindinger, 1995). Potassium is not stored in the body and much is lost in perspiration, it must be continually replenished. Yogurt with date palm syrup has large amount of iron which controls the synthesis of hemoglobin in the red blood cells and ensures an appropriate level of red cells in the blood (MacPhail, 2007). Zinc in new yogurt was also more than in plain yogurt. Zinc believed to play a valuable role in the healing process, blood stability and mental functions and in keeping a proper alkaline balance in the body (Hamrick and Counts, 2008).

Yogurt enriched with 10% date palm syrup was exceedingly rich in folic acid. Folic acid, a B9 vitamin is of great importance to pregnant women. The need for folic acid thus rises significantly during pregnancy and the daily requirement doubles (Goh and Koren, 2008). Folic acid plays a particularly important role in cell division and in the formation of the genetic structure of the cell (Calvet and Chadwick, 1994). It has become clear that folate play important roles not only in the prevention of neural tube defects (Czeizel and Dudás, 1992), but possibly also in the etiology of cardiovascular diseases (Verhoef *et al.*, 1996) and cancer (Giovannucci *et al.*, 1993, 1998). Folate helps in the metabolism of several amino acids (Shimakawa *et al.*, 1997).

## CONCLUSION

Date palm syrup provides unique functionality when used with milk in processing yogurt including sweetening, flavoring and increasing nutritional quality. Yogurt enriched with 10% date palm syrup has a smooth texture, mildly sour and pleasant flavor besides the abundance of nutritional values that provides lots of health benefits. The main benefit of the new product yogurt is that it provides more content of HCl-soluble mineral that we need to stay healthy. Phosphorus works with calcium to help with bone strength and growth, potassium that helps to keep your muscles working correctly and Zinc is important for cell growth and repair. Yogurt enriched with 10% date palm syrup is also a good source of folate that is increasing the chances of achieving nutritional recommendation. Numerous health benefits beyond its nutritional value have been associated with consuming yogurt enriched with 10% date palm syrup.

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