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Effect of Plant Sweeteners with Date Syrup on Physicochemical and Sensory Quality Properties of Cow's Milk

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ABSTRACT

This research study the effect of addition date syrup as sweetness in milk. Date syrup extracted from local dates as a source of sugar in producing flavored milk drinks, dates can be used as a natural sweetener with various health and nutritional advantages for customer acceptability. Dates syrup added to cow's milk with adequate amounts in (5, 7.5, 10, and 12.5% date syrup / total weight of flavored milk). Results of sensory evaluation indicated that the ratio of% exhibited the highest acceptability in compared with the other Results of physical, chemical, and sensory properties of the selected milk samples, found that water activity and pH content was high ($p<0.05$), and moisture content and percentage of soluble sugars were low ($p<0.05$). This results medicated that dairy products could be fortified with dates syrup with to produce drinks of high nutritional value without adding artificial additives, refined sweeteners and preservatives, and are accepted by consumers.

Keywords: Date syrup, milk, physicochemical, sensory, syrup.

INTRODUCTION

Dates palm (*Phoenix dactylifera L.*) is a versatile plant with great tolerance to climate changes. It is now widely cultivated and used all over the world on a harvested area of 118 thousand hectares. Kingdom Saudi Arabia, the second largest producer of dates in the world,

Fresh dates are consumed raw, but they may also be produced in a variety of commodities, such as powder, syrup, juice, jam, pickles, vinegar, and alcohol (Vijayanand and Kulkarni 2012). One of the most popular manufactured date products is date syrup (syrup), which Saudi Arabia produces from its surplus supplies of dates. Date fruit contains antioxidant and anti-disintegration properties and significant levels of glucose and fructose, in addition to potassium, calcium, salt, magnesium, citric, acetic, malic and oxalic (Bouhlali *et al.* 2020). As a result, the use of date syrup in food products as a flavoring element and a sweetener is critical from a nutritional and health perspective.

Milk is an exceptional source of vital nutrition for human diet. It mostly consists of biologically available calcium, phosphorous, fats, protein and many essential minerals and vitamins in a balanced proportion from other food stuff (Hossain and Dev 2013). Milk is converted from different mammals, by humans, into various nutritionally enhanced dairy products.

Dates and their derivatives can be used in the manufacture of a number of products, including: milk flavored with date syrup that has not been previously commercially produced, which helps in the expansion and prosperity of the manufacture of dates with a new nutritional and healthy drink for consumers, especially school children (Hassan, 2008). The importance of this research lies in the exploitation of concentrated dates-extracted syrup as a sweetener for cow's milk, where the new mixture shall be a natural drink with high nutritional value. It may be a competitor of, or perhaps a substitute for, milk flavors, such as chocolate, vanilla, coffee, caramel, banana and strawberry, all with added sugar, as available in school canteens, fast-food restaurants and catering services provider. This study aims to determine the physicochemical properties and sensory evaluation of cow's milk flavored with date syrup, extracted from dates.

MATERIALS AND METHODS

Materials

All experiments were carried out in the Food Processing Laboratory, Department of Food Science, College of Health Sciences, Public Authority for Applied Education and Training, State of Kuwait. Sugary date, which is commonly produced in Kingdom of Saudi Arabia, has been selected, where it has been purchased from local markets, along with pasteurized full-cream cow's milk. They were kept at 5°C in refrigerated containers until experiments thereon were carried out.

Preparing Date Syrup Milk Drink:

The syrup was prepared by mixing milk samples and different densities of date syrup at the ratio of 5.0, 7.5, 10.0 and 12.5% date syrup/100 g total weight of milk. The mixture was heated at a temperature of 75 Degrees Celsius for 5 minutes to inhibit the enzymatic activity (Dalim, *et al.* 2012). Heater device (Kenwood, KM070 Series, United Kingdom) was used, where heating temperatures in the container were distributed inside the mixture, upon which the device stopped automatically and the mixture was ready to be transferred to water bath and cooled using pieces of ice melted therein, so as to accelerate the process of reducing the mixture temperature to 5°C. Then the product was kept cool at 5°C in

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a special blender (Cofrimell + Coldream 2 M, Italy) and thus became ready for the sensory evaluation test.

Color Analysis:

Color characteristics of cow milk drink with added date syrup were determined using a color estimator (Color Flex, Model No.45/0, Hunter Associates Laboratory. Inc., VA, USA) (Alhamdan et al. 2018).

Basic color factors (L*, a*, b*) for milk drink with date syrup were estimated using a color estimator (Color Flex, Model No.45/0, Hunter Associates Laboratory. Inc., VA, USA) where color value (L*) expresses the extent of whiteness, color value (a*) denotes redness/greenness, which value varies between -100 for greenness and 100 for redness, and color value (b*) denotes yellowness/blueness, where its value varies between -100 for blue and 100 for yellow. (L*, a*, b*) also express at time zero. Color may also be expressed by coefficients derived from basic color values, which are the total color (AE) difference, the Hue angle, the color brightness and chroma and the Browning index (BI).

Estimation of total dissolved solids and water activity:

Measuring the soluble solids of milk drink with date syrup, using a refractory device at a laboratory temperature of (25°C) (ABBA 5 (code 44-501), Refractometer, Bellingham+ Stanley ltd (BS). Jena, Germany)

Also, Pullman Inc. Device, Derices Decagon, Series3 Model, Aqualab (A.S.U., 99163 Washington (ISO 18,787) is used to measure water activity at room temperature, 25°C (Iso, 2017).

Determination of pH:

Measuring the pH of milk drink with date syrup, using a device with a measuring accuracy of + 0.01. (Jenway, Model 3510, pH Meter, Designed and Manufactured in the U.K.).

Determination of Density:

Date syrup milk drink has been measured at different temperatures (from 5 to 80°C), using an advanced liquid density meter (ANTON PAAR, Density Meter, DMA4100M, Anton Paar Gmbh, Graz, Austria).

Determination of Moisture:

The standard method for measuring the moisture content of milk drink with date syrup, according to the Society of Official Analytical Chemists (AOAC, 2005) has been adopted, using a vacuum drying oven (Heraeus VT 6025, I, 6025, Instruments Vacutherm, Germany), at a temperature of 70 and a vacuum pressure of 200 mbar, for 48 hours (Association of Official Analytical Chemists – International [AOAC], 2005).

Sensory Evaluation:

Three training sessions were conducted for 30 participants (males and females whose ages ranged between 18 and 60 years old) from the staff of the College of Health Sciences, the Public Authority for Applied Education and Training in the State of Kuwait; including professors, staff members and students. Sensory evaluation was conducted on samples of full-cream pasteurized milk, of different densities (5%, 7.5%, 10%, 12.5%) of sugary date syrup variety, using Hedonic structured point-9 method (Larmond, 1977).

Sensory tests included (taste, smell, thickness, color and general acceptance of the product), on an admiration scale from Degree (9) (I like it the most), which is the highest degree of sensory evaluation, to Degree (1) (I hate it the most), which is the lowest degree of sensory evaluation.

Members of the committee were chosen based on their interest in and expertise in sensory evaluation, and they received training to become specialists in assessing the color, taste, consistency, flavor, and sweetness of samples of milk drinks sweetened with date syrup. They are sensory boundaries and the measuring range for sensory parameters. This was accomplished through individual assessments and group discussions. Also, sensory evaluations were correctly carried out on each sample in the food science lab at a temperature of 20 degrees Celsius. The samples were given to the committee members at random after being coded with three-digit numbers. For every sample and session, average scores were computed and examined.

Statistical Analysis:

Statistical analysis of the obtained data was carried out, using descriptive analysis method, by measuring the arithmetic means and standard deviations and the two-way ANOVA method, in order to analyze the laboratory experiments' data subject to randomization, where experimental units are identical based on the least square difference (LSD) test and level of significance at ($p<0.05$).

RESULTS AND DISCUSSION

Physicochemical composition of raw materials (date syrup and milk):

Before making the date flavored milk drink, the primary raw materials (date syrup and cow's milk) were examined; results are presented in Table 1 and Table 2. Date syrup is a rich source of energy, minerals (such as calcium, salt, and magnesium), carbohydrates (mostly glucose and fructose) and sugars. Additionally, milk is rich in minerals, including calcium, potassium, sodium, and magnesium. Milk has more levels of moisture, water activity, protein, fat and lightness, compared to the syrup, while the latter has higher levels of ash, acidity, pH, and redness. Results pertaining to physicochemical composition of milk are somewhat similar to those published for several forms of milk produced conventionally or commercially in different states (Musaiger et al. 1998; Roger et al. 2013; Ortiz-Rivera et al. 2017; Sani et al. 2019).

Differences between the physical and chemical compositions of date syrup and milk can be attributed to a number of variables; impact of type and age of cows, lactation season, time, stage, type and composition of feed, type of starter culture, incubation period and ambient conditions on milk chemical composition (Ashraf and Hamidi-Esfahani 2011). Physicochemical composition of the syrup is also impacted by factors including date palm variety, age, agricultural techniques, maturity stage, harvest time, seasons, environmental conditions and processing conditions. Development of products using date syrup and milk may result in a final product with improved physicochemical properties.

Sensory analysis of milk drink fortified with different ratios of date syrup:

Sensory evaluation was conducted for taste, smell, thickness, color and general acceptance of milk samples flavored with different percentages of syrup additions (5%, 7.5%, 10% and 12.5%).

Results are indicated in Table 3, showed that sensory evaluation results indicate that preferred with samples where the percentage of added date syrup is 7.5%, compared to other milk samples, whether in terms of taste, smell, thickness, color and general acceptance.

Table 1. Physicochemical properties of milk

Milk	± SD
Protein (g/100g)	3.12 ± 0.01
Casein (g/100g)	2.85 ± 0.01
Fat (g/100g)	3.20 ± 0.02
Ash (g/100g)	0.79 ± 0.01
Acidity (% expressed as lactic acid)	0.69 ± 0.00
Total Dissolved Solids (g/100g)	13.98 ± 0.02
Calcium (mg/L)	726.00 ± 0.75
Magnesium (mg/L)	80.24 ± 0.75
Sodium (mg/L)	305.40 ± 0.75
Potassium (mg/L)	933.00 ± 20.0
pH	.77 ± 0.026
Pix	7.11 ± 0.01
Moisture (%)	87.12 ± 0.13
water activity	0.995 ± 0.01
L*	95.82 ± 1.12
a*	−2.45 ± 0.45
B*	10.57 ± 1.11

Table 2. Physicochemical properties of Date syruo

Date Syrup	± SD
Moisture (g/100g)	24.89 ± 0.59
Protein (g/100g)	0.88 ± 0.01
Fat (g/100g)	0.10 ± 0.00
Fiber (g/100g)	0.10 ± 0.00
Ash (g/100g)	1.49 ± 0.02
Total sugars (g/100g)	53.05 ± 0.95
Glucose (g/100g)	26.51 ± 0.10
Fructose (g/100g)	26.54 ± 0.01
Sucrose (g/100g)	0.10 ± 0.00
Maltose (g/100g)	0.10 ± 0.01
Calcium (mg/L)	424.00 ± 2.00
Sodium (mg/L)	164.00 ± 1.00
Potassium (mg/L)	0.54 ± 0.01
Magnesium (mg/L)	420.0 ± 1.96
Vitamin A (U/100 g)	1.00 ± 0.02
Vitamin D (U/100 g)	10.00 ± 0.30
pH	5.12 ± 0.13
water activity	0.71 ± 0.05
Acidity (mg lactic acid/liter)	1.00 ± 0.01
dissolved solids (°Bx)	71.11 ± 0.11
L*	6.89 ± 0.05
a*	2.23 ± 0.11
B*	7.59 ± 0.08
Energy (Kcal/100 g)	216.62 ± 2.00

Table 3. Sensory analysis of milk properties with added dates syrup.

Milk sample with added syrup	Taste	Smell	Thickness	Color	General Acceptance
5	6.100 ± 1.185	6.100 ± 1.213	6.900 ± 1.213	7.400 ± 1.211	6.333 ± 1.213
7.5	7.433 ± 0.935	7.233 ± 1.073	7.600 ± 0.770	7.600 ± 0.814	7.433 ± 0.858
10	7.133 ± 1.008	7.000 ± 0.974	7.333 ± 0.711	6.900 ± 0.96	7.033 ± 0.928
12,5	6.667 ± 1.516	7.483 ± 1.153	7.200 ± 1.126	7.600 ± 1.368	6.767 ± 1.305

Dissimilar letters in each column indicate that the average characteristic is significantly different based on the least square difference (LSD) test and the level of significance (P<0.05).

Chemical composition of different milk samples with added date syrup:

Chemical changes of milk flavored with date syrup at different densities (5.0%, 7.5%, 10.0% and 12.5%) included moisture content, water activity, soluble sugars, and pH density. Results for four samples with different densities of date syrup milk drink are included in Table 4 as average values, standard deviation, and density ANOVA between the four samples. The results in Table 4 show that the drink containing milk flavored with date syrup (5%) was higher compared to the other three samples, while water activity of milk flavored with date syrup (10%) was the highest compared to the other three samples. There are significant differences in the percentage of soluble sugars for the four samples of milk drink with date syrup, which were 15.95, 12.61, 16.09, 12.62 (Brix), respectively, at room temperature of 25 Degrees Celsius (Isanga Zhang 2009; Werry, 1984; Ramirez-Sucre and Velez-Ruiz 2011).

Average values of moisture content and water activity for the four samples, with different densities of milk with date syrup, showed significant differences, as well as significant differences in average pH values.

Table 4. Chemical composition for milk samples with added date syrup

Milk samples	Moisture Content %	Water Activity (aw)	Brix	pH
12.5	77.134 +0.173	0.977 +0,004	15.95 +0.030	6.533 +0.009
10	80.215 +0.265	0.982 +0.002	12.61 +0.017	6.663 +0.052
7,5	77.810 +0.054	0.963 +0.003	16.09 +0.010	6.353 +0.005
5	80.831 +0.222	0.977 +0.010	12.62 +0.000	6.353 +0.008

Dissimilar letters in each column indicate that the mean characteristic is significantly different based on the least square difference (LSD) test and the level of significance (P<0.05).

Density of milk with date syrup:

Density values of milk with date syrup samples were obtained in different densities (5.0, 7.5, 10.0 and 12.5%), within temperatures from 5 to 80°C. Average experimental values, standard deviation and density ANOVA results are indicated in Table 5 in terms of temperature. Density values of the four samples of milk with syrup decreased with the increase in temperature. Within the experimental temperatures of 5 to 80°C, these values varied from 1.77 to 1.041, from 1.063 to 1.030, from 1.079 to 1.041 and from 1.068 to 1.032 (g/cm3), respectively. The aforementioned Table indicates significant differences in all average values of density of the four samples of the milk with syrup, at all temperatures. Experimental results were marched with a linear equation to predict the property of the four preferred samples in terms of temperature. Table 5 indicates the relationship of density values changing with the four samples' temperatures (Souza *et al.* 2009). Density value decrease with temperature increase is due to the drink's expansion upon heating, which also increases its volume. Density is also impacted by intermolecular forces; when these forces are strong, it means that there is a strong interconnection between the molecules, which created high density, and vice versa. Temperature increase causes weak forces, thus leading to spacing the molecules and low density (Greenwood and Earnshaw, 1997; Shell *et al.* 2002; Perlman, 2016; Zumdahl and Zumdahl, 2013; Loerting *et al.* 2001).

Table 5. Average values, standard deviation, and density ANOVA (g/cm3) within the range from 5m to 80m for milk with date syrup

Temperature (C)	Sweetened Cow's Milk (15%)	Pure Cow's Milk (10%)	Sweetened Cow's Milk (15%)	Pure Cow's Milk (10%)
10	C 1.077 4- 10×4.472±	A 1.063 4- 10×5.958±	D 1.079 4- 10×7.950±	B 1.068 5- 10×9.094±
25	C 1.076 10×5.477±	A 1.062 10×5.477±	D 1.078 5- 0.000±	B 1.068 5- 0.000±
40	C 10123 10111±	A 10174 10111±	D 10157 5- 11×40472±	B 10171 10111±
60	C 10152 10111±	A 10127 5- 11×40472±	D 10151 4- 11×20511±	B 10124 10111±
80	C 10142 4- 11×10314±	A 10157 10111±	D 10141 5- 11×40472±	B 10154 10111±

Dissimilar letters in each column indicate that the mean characteristic is significantly different based on the least square difference (LSD) test and the level of significance (P<0.05).

Coun.Table 5. Constants values and correlation coefficient of density prediction equation in terms of temperature (T) within the range from 5°C to 80°C for milk flavored with date syrup

Added Syrup %	P=a T + b		Correlation Coefficient
	b	A	
12.5	1.81	0.0005-	0.988
10	1,067	0.0004-	0.985
7.5	1,084	0.0005-	0.970
5	1,072	0.0005-	0.975

Change of color in milk samples with added date syrup:

Table 6 indicates the average values, standard deviation, and analysis of variance of the results obtained for the derived base color values (chroma, hue angle and blackening index) at room temperature 25°C for the four samples (*b*, a*, L)

Results of variance analysis, comparing the results of basic color values of the four preferred milk with syrup samples, indicated asignificant differences in the basic color values. Derived color coefficients included chroma, hue angle and blackening index (BI).

Results of variance analysis, comparing derived color values of color chroma, hue angle and the blackening index of the four milk with syrup samples, indicated significant differences, as it was noted that blackening index values were higher for milk samples with densities of 5% and 7.5%, compared to blackening index values for samples with densities of 10% and 12.5%.

Table 6. Average values, standard deviation, and density ANOVA of derived color values of milk with syrup

Milk samples with added date syrup	Basic Color Values			Derivative Color Coefficients		
	b*	a*	L*	Chroma	Hue Angle	Blackening Index (BI)
12.5	13.331 C 0.422±	1.131 C 0.040±	12.121 C 0.462±	13.331 C 0.422±	57.474 A 0.042±	17.342 C 0.204±
10	13.313 D 0.412±	D 1.175- 0,006±	11.227 A 0.141±	13.313 D 0.412±	57.422- D 0.000±	15.315 D 0.102±
7.5	15.222 A 0.014±	1.373 B 0,002±	15.133 D 0.042±	15.227 A 0.014±	57.114 B 0.002±	13.231 A 0.040±
5	14.444 B 0.050±	1.411 A 0.006±	17.173 B 0.042±	14.451 B 0.050±	57.134 C 0.006±	17.135 B 0.006±

Dissimilar letters in each column indicate that the mean characteristic is significantly different based on the least square difference (LSD) test and the level of significance (P<0.05).

CONCLUSION

This study's major goal is to use dates as a natural sweetener to make a drink that is sweet, healthy, and incredibly nutrient-dense. The developed drink's qualities were assessed in terms of nutrition, chemistry, and sensory appeal. Results showed that a 10% date syrup addition to milk enhanced its quality. By combining date syrup and milk, a product's nutritional value could be regulated, and its sensory quality could be enhanced by enhancing the resulting product's flavor and widespread acceptance. Because it doesn't contain artificial additives, refined sweeteners, or preservatives, this unique, flavorful product may have significant nutritional and health benefits and appeal to consumers.

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تأثير محليات النباتية بدبس التمر على خصائص الجودة الفيزوكيميائية والحسية للحليب البقري

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الملخص

يدرس هذا البحث الي استخدام دبس التمر المستخلص من التمور المحلية كمادة تحلية وكمصدر للسكر في صنع حليب مطعم ومنكهة, والاستفادة من التمر كمادة تحلية طبيعية بحيث يتمكن المستهلك من الحصول علي العديد من الفوائد الصحية والغذائية من استهلاكه. وتضمنت الدراسة الصفات الحسية لنوع الحليب البقري المنكه بدبس التمر وقد تمت إضافة شراب التمر للحليب البقري بنسب محددة (5 ، 7.5 ، 10 ، 12.5 ٪ شراب التمر / الوزن الإجمالي للحليب المكنه) وتم اختيار نسبة مناسبة (7.5%) علي أساس الحالة الحسية وتفضيل أعضاء اللجنة , وبعد دراسة الخصائص الفيزيائية والكيميائية والحسية للعينات المفضلة من الحليب المنكة بدبس التمر تبين ان محتوى النشاط المائي والرقم الهيدروجيني في ارتفاع (p <0.05) والمحتوي الرطوبي ونسبة السكريات الذائبة في انخفاض (p <0.05) ستساعد نتائج هذا البحث في تقوية منتجات الألبان بالتمر لصنع مشروبات عالية القيمة الغذائية دون إضافة إضافات صناعية ومحليات مكررة ومواد حافظة ، والتي في نفس الوقت يقبلها المستهلكون .

كلمات دالة : الفيزيوكيميائية , حسية , شراب , حليب , دبس التمر.