RESEARCH ARTICLE OPEN ACCESS

NEW VALLEY JOURNAL OF AGRICULTURAL SCIENCE

Published by Faculty of Agriculture, New Valley University, Egypt

Print ISSN 2805-2420 **Online ISSN** 2805-2439

10.21608/NVJAS.2023.232896.1244

Effect of Adding Nano Date Press Cake Particles on Physiochemical, Microbiology Analysis and Sensory Indices of Soft Carbonated Date Bio-beverage

Ferweez, H.[1], Samy. I. Elsyiad[2], Ali. A. Othman[3] and Yassmin M. S. Salh[1]

[1]Food Sci. and Tech. Dept., Faculty of Agric., New Valley Univ., Egypt
[2]Food Sci. and Tech. Dept., Faculty of Agric., Assiut Univ., Egypt
[3]Physic Dept., Faculty of Sci.., Assiut Univ., Egypt

*** Corresponding author**
Ferweez, H.

Received: 30/08/2023
Revised: 04/09/2023
Accepted: 24/09/2023
Published: 01/10/2023

ABSTRACT

The data of this work concluded that soft carbonated date bio-beverage with fortified Nano date press cake particles can be produced from date fruit extracts. In addition, date press cake (a main waste produced from date juice extraction from dates) contains valuable nutrients and is viable as food ingredient for the maintenance of a sustainable environment and economy. Therefore, this study intended to evaluate the effects of nanoparticles of date press cake and total soluble solids concentrations on physiochemical properties, microbiological quality, and sensory indices of soft carbonated date bio-beverage. The obtained results clarified that the total soluble solids ratio of soft carbonated date bio-beverage had a significant effect on physiochemical properties, i.e. moisture content, total sugars, reducing sugars, non-reducing sugars, glucose, fructose, ash%, color(IU), pH value, mineral composition (Ca, K, Na, Mg, P, and Fe mg/100g), probiotic bacteria, microbiological analysis, sensory indices, i.e. appearance, sweetness, flavor, acidity and overall acceptability. While fortification of soft carbonated date bio-beverage with nano date press cake particles had a significant effect on glucose, fructose, color (IU), probiotic bacteria, appearance, and overall acceptability. Generally, it can be concluded that a non-alcoholic beverage with 18% total soluble solids of date bio-beverage and 200.00 mg Nano date press cake particles is preferable in terms of physicochemical, microbiological, and sensory attributes and acceptability.

Keywords: Bio-beverage, by-products, Nano fiber, probiotic bacteria.

Introduction

The fruits of Date Palm (*Phoenix dactylifera*) are a rich source of carbohydrates and vitamins and are considered as a complete traditional medicinal diet. Dates products are widely consumed in Islamic countries due to their history of more than 1400 years. Additionally, it contains amounts of macro- and micronutrients that play an important role in many biological functions in the body. The nutritive value of dates not only is due to their sugars and dietary fiber but also it supplies macro- and micronutrients that play an important role in many biological functions in the body (Siddiqui, 2009; Baliga, et al. 2011 and El-Far, et al. 2016 and 2019).

Low-quality dates are poor in size and taste, unsuitable for consumption, and usually sold as animal feed at reduced prices. The presence of high sugar content in these dates makes them suitable for industrial use, and thus a wide range of products can be produced from these dates. Many products are being made of date juice including carbonated and non-carbonated beverages, jam, and jelly as a sugar substitute. Press cake is the by-product of the process in which date juice is extracted. Since press cake forms 30% of date weight), and easily deteriorates, it causes a disposal problem. The date press cake is a rich source of dietary fiber and contains the highest levels of phenolic compounds and antioxidant activity. Date press cake (DPC) as one of the agro-manufacture residues contributes to a large loss of raw agricultural materials and causes disposal issues and environmental problems due to containing their high fibers and bulky nature (Al-Farsi and Lee,2007& 2008; Ashraf and Hamidi-Esfahani,2011). Heidarinejad et al., (2018) concluded that sugar extraction of low-quality dates resulted in nearly 17- 28% date press cake, which is used in either animal feed or dumped into drains or open soils. This action leads to great environmental and economic problems. The lack of available information on the chemical composition of date press cake, as well as its benefits for food, and health is the cause of the underutilization of its and other food applications.

Beverage consumption has become an important part of human lifestyle around the world and it is determined more by social rather than nutritional factors. Beverages are liquids other than water which are usually taken to quench thirst. Some are, however, consumed as a substitute to fill nutritional deficits as well as for their stimulating effects (Ukwo, et al. 2019).

Nanomaterials can successfully improve food safety by enhancing nutritional value as additives without changing the taste and physical characteristics of food products (He & Hwang, 2016). They revealed that the primary deficiency in soft beverages is a lack of dietary fiber. The review emphasizes the addition of dietary fiber in beverages to boost its health benefits.

Soft carbonated beverages are preferred by consumers for their thirst-quenching and refreshing characteristics. A soft carbonated beverage is a non-alcoholic, sweet, light, flavored, water-based drink that has carbon dioxide added to it to make it bubbly or fizzy. Soft carbonated beverages became a widely consumed beverage readily available for the masses. Today there are hundreds of variants of flavored carbonated soft drinks in the market (Greenfield& Southgate (2003); Cheng, et al.2009, Hildebrandt, et al.2013; Eweis, et al.2017 and Grumezescu, & Holban (2019).

According to the WHO, probiotics are defined as live microorganisms able to give, when administered in adequate amounts, many health benefits to the host. It is generally considered that a minimum of 106 cells per daily dose is required for probiotics to be effective. Moreover, microorganisms make oligosaccharides and exopolysaccharides (EPSs) usable as emulsifiers or stabilizer compounds. The consumption of beverages and foods that contain probiotic microorganisms is an increasing trend worldwide. Prebiotics were defined as no digestible food ingredients (dietary fibers) that beneficially affect the host by selectively stimulating the growth or activity

of healthy bacteria such as bifidobacteria and lactobacilli in the gut and increase resistance to invading pathogens. The 'symbiotic products are a combination of prebiotics and probiotics and the new challenge for functional beverages. Soft carbonated beverages are a subsector of the functional important food industry and the fastest-growing sector of the functional food market due to their perceived health benefits (Franke et al., 2005 and Pojer et al., 2013).

Fruit juice is also a good source of nutraceuticals (Shahidi & Naczk, 2003). Due to the high nutritional and healthy benefits of date press cake and little information about using date press cake and establishing new food bio-beverages that increase the nutritional value and health benefits of the probiotic-fortified date beverage. Therefore, this study aimed to evaluate the effects of nanoparticles of date press cake and total soluble solids concentrations on physiochemical properties, microbiological quality, and sensory indices of soft carbonated date bio-beverage.

Materials and Methods

This investigation was conducted in the Department of Food Science and Technology, Faculty of Agriculture, New Valley University to evaluate the physical properties, chemical composition, microbiological quality and sensory of soft carbonated date bio-beverage. Additionally, properties of soft carbonated date bio-beverage fortified with 0.00, 100.00 and 200.00 mg of Nano date press particles/100 mL were investigated.

1. Material source

1.1. Low quality dates

Low-quality dates (Phoenix dactylifera L.) or Hashf (hard texture) at full maturity "Tamr stage" of the abundant cultivar, Saidy cultivar (semi-dry variety)., were obtained from the dates factories of El.Gharga Oasis, New Valley Governorate, Egypt. Ten kilograms of dates were directly divided into bags of 500 g and stored at −20 ◦C until use.

1.2. Probiotic bacteria

Bifidobacterium animalis subsp animalis was acquired from the Faculty of Agriculture, Ain Shams University's Microbiological Resources Center (Cairo MIRCEN). The starter was regularly kept alive in sterilized skim milk at a temperature of 5-7 °C.

1.3. Date press cake

Date press cake was obtained after extraction of the juice from low-quality dates of fruits (Saidy cultivar) to prepare soft carbonated date bio-beverage during the 2022 season.

1.4. Commercial chemicals

EL-Gomhouria Trading Chemicals and Drugs Co. in Assiut, Egypt, supplied the chemicals used in this work to estimate the physiochemical analysis of the studied products.

2. Preparation of raw materials

2.1. Preparation of date fruit extract:

The tamer date fruits (Saidy cultivar) of low–quality dates were washed, drained, and pitted manually according to the method described by Khalil et al. (2002), and Ashraf & Hamidi-Esfahani, (2011). The weight of the pulp and seeds was recorded. The traditional extraction was carried out as follows: dates (400 g) obtained from the Saidy variety were mixed with 1200 mL of mineral water. The sample was placed in a thermostatically controlled water bath at 100 ◦C for 15 min. The produced juice was filtered by a filtering cloth and then centrifuged at 2907 × g for 15 min to remove fibrous materials. Date juice is made by dissolving and diluting total soluble solids (TSS) of date in water and removing insoluble solids. Date juices or beverages at the desired concentration, 14.00, 16.00, and 18% of TSS (total soluble solids) were obtained by properly diluting the concentrates with deionized water.

2.2. Preparation of nano date press cake particles (Nano DPC)

Date press cake was washed thoroughly with warm water and dried at room temperature for 2 d. After drying, it was kept in boiling water for 2 hr. to inactivate any microbial contamination as well as undesirable substances. Date press cake was then dried in the oven at 60°C for 6 hr. Further, the dried ES was milled using mortar grinding Fritsch

Pulversitte 2, for one hour. The X-ray diffraction (XRD) of the milled powder was recorded using a PW1700 X-ray diffractometer in the 2θ range from 20 °C to 50 °C. The mean crystallite size D of the obtained NPES was calculated by using the Scherrer Equation (1):

$$D = 0.89\lambda/\beta \mathrm{Sin}\theta$$

Where λ is the CuKα x- rays (1.54056 A°), β is the full width at half maximum of the diffraction peak, Θ is the different angle. The mean crystallite size D was found to be 27 ± 1.7 nm as described in the publications of Merkus, (2009) and Verleysen, et al. (2021).

2.3. Preparation of probiotic culture.

Probiotic culture (Bifidobacterium animalis subsp animalis) was inoculated in MRS media with 0.1 g Land 1% (v/v) respectively then incubated at 37 °C for 48 h. The probiotics were activated after three transfers for the preparation of cultures for soft date bio-beverage making (Crittenden et al., 2005).

2.4. Preparation of soft date beverage fortified with nano DPCP.

Nano date press cake particles (Nano DPCP) were added to soft date beverage (SDB), in the proportion of 0.00 (control), 100.00 and 200.00 mg/100 mL respectively. The soft date beverages were gently stirred and left for 1 min. at room temperature to attain equilibrium. Soft date beverage from the different treatments was heated at 85°C/10 min and then cooled to 40°C, transferred to 250 mL sterile plastic bottles.

2.5. Preparation of soft date bio-beverage (SDBB)

All soft date beverage samples (five hundred) at the studied different concentrations (14.00, 16.00, and 18.00% TSS) fortified with Nano DPCP by 0.00, 100.00, and 200.00 mg/100 mL were prepared by heating standardized to 85 °C and holding it for 30 minutes at this temperature. After letting it cool to 37 °C, were packaged in sterile plastic containers and incubated anaerobically with 1% Bifidobacterium animalis subsp animalis at 37 °C for 18 hours to achieve 108 to 109 CFU/mL and then stored at 4 °C.

2.6. Preparation of soft carbonated date bio-beverage (SCDBB)

All soft date bio-beverage samples fortified with Nano DPCP, packaged in sterilized plastic containers and refrigerated were carbonated with a carbonator. (Carbonator CF121, OMVE, The Netherlands). After preliminary tests, CO_2 concentration in all beverages was adjusted to 5 g/L to simulate commercial beverages. soft date bio-beverage samples were filled in 250 mL PET bottles at the pressure range of 100 psi by using carbonation unit. After carbonation the bottles were sealed tightly by using capping machine and it was stored at cool and ambient temperature for further studies. Three replicates were prepared and analyzed from the different treatments.

Soft carbonated date bio-beverages (SCDBB) fortified with nano date press cake particles were prepared by blending the used ingredients for each treatment as shown in Table 1.

Table1. Soft carbonated date bio-beverages formulations fortified with Nano date press cake particles*

Treatments	Soft carbonated date bio-beverages fortified with NDPCP
T1	Soft date beverage 14%TSS + 0.0 mg NDPCP/100 ml+1%probiotic+ 5 g CO_2/L
T2	Soft date beverage 14%TSS + 100.0 mg NDPCP/100 ml+1%probiotic+ 5 g CO_2/L
T3	Soft date beverage 14%TSS + 200.0 mg NDPCP/100 ml+1%probiotic+ 5 g CO_2/L
T4	Soft date beverage 16%TSS + 0.0 mg NDPCP/100 ml+1%probiotic+ 5 g CO_2/L
T5	Soft date beverage 16%TSS + 100.0 mg NDPCP/100 ml+1%probiotic+ 5 g CO_2/L
T6	Soft date beverage 16%TSS + 200.0 mg NDPCP/100 ml+1%probiotic+ 5 g CO_2/L
T7	Soft date beverage 18%TSS + 0.0 mg NDPCP/100 ml+1%probiotic+ 5 g CO_2/L
T8	Soft date beverage 18%TSS + 100.0 mg NDPCP/100 ml+1%probiotic+ 5 g CO_2/L
T9	Soft date beverage 18%TSS + 200.0 mg NDPCP/100 ml+1%probiotic+ 5 g CO_2/L

NDPCP *= nano date press cake particles

3. Analytical methods

3.1. Physiochemical properties

According to **Wojtczak (2003)**, the total soluble solids (TSS) of the raw materials and soft carbonated date bio-beverages supplemented with NDPCP were measured using an Abbe Refract meter at 20°C, and the pH value was calculated using a Beckman pH meter. Color (IU) or browning of all samples was assessed at an absorbance of 420 nm, and the value was reported in **ICUMSA units (IU).**

Using techniques outlined in **Wojtczak (2003),** the approximate chemical composition of the raw materials and soft carbonated date bio-beverages supplemented with NDPCP was ascertained. This included moisture content, total sugars, reducing sugars, non-reducing sugar, protein, ash, crude fat, and fiber. Using a flame photometer, the sodium and potassium contents of each sample were determined. Iron, calcium, magnesium and phosphorus were measured using the Perkin Elmer Atomic Absorption Spectrophotometer (model 80, England).

3.2. Microbiological quality

The viable cell count of *Bifidobacterium animalis subsp animalis* was determined by the standard plate method and expressed as CFU/g of food. Ten grams of each probiotic beverage sample was homogenized in a saline solution (0.9% NaCl) on a Stomacher. A series of ten-fold dilutions (10^{-5} to 10^{-10}) was prepared and a given amount of each dilution (100 µl) was spread on MRS agar (de Man, Rogosa, and Sharpe) with the addition of vancomycin (12 mg/l) (**Verdenelli *et al*., 2011**). Bacterial counts were made after 72 h of aerobic incubation at 37 °C.

Both 6.3 g of potato dextrose agar and 5.3 g of melted Mac-Monkey agar in 100 mL of distilled water were sterilized at 121 °C for 15 minutes and 15 psi, respectively, to measure the total fungal count and the total coliform count. After serially diluting the beverage samples with distilled water, 1 milliliter was inoculated at room temperature in various medium. For TBC and coliform, Petri plates were incubated at 37 °C for 23 t0 48 hours, and for mold and yeast colonies, the incubation period was 4-5 days. A colony counter was used for counting and the outcome was reported as log10cfu/ml, or colony-forming units per milliliter **(O' Dell, *et al*. 1998).**

3.3. Sensory evaluations

Forty panelists who were not qualified in the food science department at New Valley University assessed appearance, sweetness, flavor, acidity, and overall acceptability. For this reason, a 0–10 point Hedonic scale was used (0–2 = detest significantly, 3–4 = dislike mildly, 5 = fair, 6–8 = like moderately, and 9–10 = outstanding). In glass 50 mL cups, a soft carbonated date bio-beverage enhanced with NDPCP samples was served at room temperature with no cold storage interval **(Ali, 2018**).

RESULTS AND DISCUTION

Physiochemical parameters and minerals contents

Physiochemical parameters and minerals contents of low-quality dates (LQD), soft carbonated date bio-beverage (SCDBB), at 14, 16 and 18% total soluble solids (TSS), and date press cake (DPC) were analyzed and compared (Tables 2&3). It could be noted from data in Table 2 that there were significant differences in physiochemical parameters and minerals contents i.e. moisture, protein, lipids, total sugars, reducing sugars, non-reducing sugars, glucose, fructose, total dietary fiber, ash contents, color, pH value, Ca, K, Na, Mg, P and Fe of the studied soft carbonated date bio-beverages at different concentrations of total soluble solids. DPC had the highest values (2.07, 0.85, 55.25%, 3368.12 IU, and 7.42) of crude protein, lipids, total dietary fiber content, color, pH value and the lowest values (13.35, 24.16, 28.60, 0.79, 18.61, 4.90 and 1.78%) of moisture, total sugars, reducing sugar (RS), non-reducing sugar(NRS), glucose, fructose and ash contents, respectively. However, SCDBB contained the highest values (85.45,91.35, 86.18, 45.31, and 36.71%) of moisture, total sugars, reducing sugars

(RS), glucose and fructose contents, also the lowest values (0.15, 0.09,0.06 % and 606.16 IU) of crude protein, lipids, total dietary fiber contents, and color, respectively. The chemical composition, especially the mineral content of the date fruit can vary depending on the cultivar, soil conditions, agro-economic practices, ripening stage, as well as harvest and post-harvest treatments (**Al-Hooti *et al*, 1997**). These results were found to be in good agreement with those secured by **Chillo *et al*., (2009) and Sozer, (2009).** They revealed that the date press cake had interesting characteristics from a nutritional and functional standpoint, as it is a source of fiber and a substitute for flour in the processing of GF food. They added that date palm juice contains 9-14% sugar, a tiny amount of organic acid, and some trace elements. In this respect, **Ashraf & Hamidi-Esfahani, (2011) and Baliga, *et al*. (2011)** demonstrated that the majority of protein exists in date press cake and is a rich source of dietary fiber. They indicated that many products are being made of date juice, including carbonated and non-carbonated beverages, as a sugar substitute. As well as **Chandrasekaran, & Bahkali, (2013)** indicated that the date juice was rich in reducing sugars (16.1%) and total sugars (18.3%). In addition, **El-Far, *et al*. (2016 & 2019)** studied that dates have a consortium of nutrients that are police with high carbohydrate content mainly in the form of sugars and, a rich source of dietary.

Table 2. Physiochemical parameters of LQD, SCDBB and DPC composition (DWB) used in soft carbonated date bio-beverage preparation.

Components	LQD	SCDBB at 14%TSS	SCDBB at 16%TSS	SCDBB at 18%TSS	DPC	Mean	F value	LSD at 5%
Moisture%	16.26	85.45	83.62	81.75	13.35	56.09	**	0.57
Crude protein%	2.02	0.15	0.19	0.20	2.07	0.93	**	0.16
Crude lipids%	0.82	0.09	0.11	0.11	0.85	0.42	**	0.09
Total sugars%	53.78	91.35	90.87	89.39	24.16	69.91	**	0.32
RS %	53.28	86.18	84.37	83.22	28.60	67.13	**	0.71
NRS %	0.85	4.92	6.18	5.86	0.79	3.72	**	0.10
Glucose%	28.51	45.31	44.78	43.87	18.61	36.22	**	0.18
Fructose%	21.37	36.71	33.83	31.43	4.90	25.65	**	0.23
Total Fiber%	4.21	0.06	0.07	0.08	55.25	11.93	**	0.44
Ash%	3.19	1.86	2.15	2.45	1.78	2.29	**	0.06
Color **	2241.05	606.16	818.21	1109.85	3368.12	1628.68	**	86.54
pH value	5.91	4.94	4.88	4.71	7.42	5.57	**	0.05

DWB=Dry weight basis, SCDBB= Soft carbonated Date bio-beverage, DPC= Date press cake and TSS= Total soluble solids, LQD=Low quality dates, RS%= Reducing sugars%, NRS%= non-reducing sugars%, color**= Color (IU unit) = International unit

Table 3. Minerals (mg/100 g) of raw materials composition*(DWB) used in soft carbonated date bio-beverage preparation

Components	Raw materials					Mean	F value	LSD at 5%
	LQD	SCDBB at 14%TSS	SCDBB at 16%TSS	SCDBB at 18%TSS	DPC			
Calcium (Ca)	38.65	11.09	13.18	15.73	45.60	21.40	**	1.30
Potassium (K)	268.23	124.77	129.61	135.22	3.35	98.24	**	1.69
Sodium (Na)	52.41	4.36	5.78	7.26	0.28	4.42	**	0.31
Magnesium (Mg)	79.67	7.55	8.36	9.18	64.42	22.38	**	6.75
Phosphorus (P)	82.32	8.45	9.78	10.69	58.16	21.77	**	4.20
Iron (Fe)	4.58	2.05	2.18	2.69	3.88	2.70	**	0.29

DWB*=Dry weight basis, SCDBB= Soft carbonated Date bio-beverage, DPC= Date press cake and TSS= Total soluble solids, LQD=Low quality dates.

Effect of fortification with NDPCP on physiochemical parameters of soft carbonated date bio-beverage at different concentration

It is argued that soft carbonated date bio-beverages are deficient in fiber and micronutrients. The total soluble solids% of the softly carbonated date bio-beverage (SCDBB) significantly affected the physiochemical parameters, including moisture, protein, lipids, total sugars, reducing sugars, non-reducing sugars, glucose, fructose, total dietary fiber, ash contents, color, and pH value at the studied different concentrations of Nano date press cake particles.

Table 4: Effect of adding Nano date press cake particles on physiochemical parameters (DWB %) of soft carbonated date bio-beverage at different TSS*%.

Parameter	TSS% of SCDBB (A)	Nano Date Fiber particles content mg/100 ml (B)			Mean	F value	LSD at 5%
		0.00	100.00	200.00			
Moisture%	14%	85.45	83.62	81.75	85.31	A=**	0.03
	16%	85.29	83.51	81.67	83.51	B=Ns	-
	18%	85.19	83.41	81.58	81.67	AB=Ns	-
Mean		83.61	83.49	83.39	83.50		
Total sugars%	14%	91.35	91.27	91.21	91.28	A=**	0.21
	16%	90.87	90.84	90.82	90.84	B=Ns	-
	18%	89.39	89.36	89.35	89.36	AB=Ns	-
Mean		90.54	90.49	90.46	90.50		
Non-reducing sugars%	14%	4.92	4.86	4.87	4.88	A=**	0.09
	16%	5.86	5.89	5.89	5.88	B=Ns	-
	18%	6.18	6.17	6.18	6.18	AB=Ns	-
Mean		5.65	5.65	5.64	5.65		
Reducing sugars%	14%	86.18	84.37	83.22	86.14	A=**	0.09
	16%	86.15	84.34	83.16	84.34	B=Ns	-
	18%	86.09	84.32	83.14	83.17	AB=Ns	-
Mean		84.59	84.55	84.52	84.55		
Glucose%	14%	45.31	45.22	45.19	45.24	A=**	0.10
	16%	44.78	44.75	44.72	44.75	B=**	0.02
	18%	43.87	43.84	43.81	43.84	AB=*	0.03
Mean		44.65	44.60	44.57	44.61		
Fructose%	14%	36.71	36.68	36.64	36.67	A=**	0.11
	16%	33.83	33.77	33.71	33.77	B=**	0.02
	18%	31.43	31.42	31.37	31.41	AB=Ns	-
Mean		33.99	33.96	33.90	33.95		
Ash %	14%	1.86	1.86	1.83	1.85	A=**	0.03
	16%	2.15	2.15	2.14	2.15	B= Ns	-
	18%	2.45	2.46	2.45	2.45	AB=Ns	-
Mean		2.16	2.16	2.14	2.15		
pH value	14%	4.94	4.94	4.89	4.92	A=**	0.02
	16%	4.87	4.84	4.83	4.85	B= Ns	-
	18%	4.71	4.66	4.63	4.67	AB=Ns	-
Mean		4.84	4.81	4.79	4.81		
Color (IU*)	14%	606.16	611.99	617.79	611.98	A=**	1.68
	16%	818.21	825.74	837.94	827.30	B= **	1.74
	18%	1109.85	1122.10	1129.10	1120.35	AB=**	3.02
Mean		844.74	853.28	861.61	853.21		

Notes: Values in the same row or Colum with different superscripts are statistically significant from each other ($p < 0.05$). The values in Table were mean of three replicates. TSS*%= Total soluble solids%, SCDBB= Soft carbonated Date bio-beverage, Ns**= non-significant. IU= International unit. NDPCP= Nano date press cake particles.

The soft carbonated date bio-beverage with 14% TSS had the highest values (85.31, 91.28, 86.14, 45.24, 36.67%, and 4.92) of moisture, total sugars, reducing sugars, glucose, and fructose contents, as well as pH value (Table 4). The lowest values (4.88, 1.85%, and 611.98 IU) of non-reducing sugars, ash, and color were observed in this bio-beverage. On the other hand, the greatest values were found in the soft carbonated date bio-beverage with the highest TSS (18%, 2.45%). Soft date beverages' high dietary fiber content may add to their nutritional value by promoting fullness, having a laxative impact due to increased stool weight, and providing therapeutic advantages. Al-Farsi et al. (2005) reported on this topic and found that date fruit is a good source of fiber in addition to being high in carbohydrates (sucrose, glucose, and fructose).

As indicated in Table 4, the relationship between the total soluble solids percentage of SCDBB and fortification with NDPCP had a substantial impact on the percentage of glucose and color value of SCDBB. While NDPCP, which was prepared from 18%TSS beverage and fortified with 200.00 mg NDPCP/100ml, had the lowest value (43.81%) of glucose% and the highest value (1129.10 IU) of color, SCDBB, which was prepared from 14%TSS beverage, had the highest value (45.31%) of glucose% and the lowest value (606.16 IU) of color. SCDBB's color is slightly darker and its glucose content is slightly lower when NDPCP fortification levels are increased. These findings are consistent with those of **Yildiz & Ozcan (2019),** who showed that fortification with dietary fiber does not change the structural organization. Fiber addition enhances the structure and firmness of food.

Effect of fortification with NDPCP on minerals composition of soft carbonated date bio-beverage at different concentrations

A date beverage is a good source of minerals. Table 5 shows the changes in the minerals composition of SCDBB at different total soluble solids concentrations fortified with NDPCP at different levels. The results indicate that the total soluble solids% of soft carbonated date bio-beverage (SCDBB) had a significant effect on all the minerals, i.e., Ca, K, Na, Mg, P, and Fe of SCDBB at the studied different levels of NDPCP. There was a significant increase in calcium content by 16.61 and 40.22%, potassium content by 4.30 and 8.37%, sodium content by 32.80 and 69.27%, magnesium content by 11.48 and 23.50%, phosphorus content by 15.23 and 25.15%, and iron content by 5.83 and 24.76% of SCDBB with increasing total soluble solids concentration from 14 (control) to 16 and 18% of the control value, respectively. Potassium was the most abundant mineral in the formulated beverage. Potassium is important not only as a cation in the intra-cellular fluids but also essential in the nervous system, maintenance of the correct rhythm of heartbeat, and clothing of blood (**Shahidi, 2004**).

The inclusion of date fruit extract enhanced the quantities of minerals, particularly potassium. For those with hypertension, the beverages' high potassium and low sodium concentrations are advantageous (Babalola, 2001). Without any of the negative symptoms that iron pill supplements may cause, including nausea, headaches, or anorexia, date fruit has been utilized as a useful supplement for iron insufficiency **(Al-Farsi *et al*., 2005).** However, **Al-Hooti *et al*. (1997)** pointed out that the date fruit's chemical makeup, particularly its mineral content, can differ based on the cultivar, soil characteristics, agro-economic methods, ripening stage, harvesting methods, and post-harvest procedures. To meet an adult's recommended daily allowance **(Allowances, R. D. 2009)** for magnesium and potassium, about 100g of the beverage may be consumed. **Besbes & Associates (2008)** stated that in addition to causing a significant loss of raw materials, date press cakes as waste pose major environmental issues.

Table 5: Effect of adding Nano date press cake particles on minerals composition (DWB %) of soft carbonated date bio-beverage at different TSS*%.

Element (Mg/100 g DWB %)	TSS% of SCDBB (A)	Nano Date Fiber particles content mg/100 ml (B)			Mean	F value	LSD at 5%
		0.00	100.00	200.00			
Calcium (Ca)	14%	11.09	11.23	11.09	11.14	A=**	0.87
	16%	13.18	12.91	12.87	12.99	B=Ns	-
	18%	15.73	15.62	15.50	15.62	AB=Ns	-
Mean		13.33	13.25	13.16	13.33		
Potassium (K)	14%	124.77	124.46	123.79	124.34	A=**	2.31
	16%	129.61	129.53	129.90	129.68	B=Ns	-
	18%	135.22	135.29	134.75	134.75	AB=Ns	-
Mean		129.87	129.48	129.42	129.59		
Sodium (Na)	14%	4.36	4.33	4.40	4.36	A=**	0.25
	16%	5.78	5.76	5.82	5.79	B=Ns	-
	18%	7.26	7.48	7.40	7.38	AB=Ns	-
Mean		5.87	5.86	5.80	5.84		
Magnesium (Mg)	14%	7.55	7.47	7.45	7.49	A=**	0.22
	16%	8.36	8.33	8.38	8.35	B=Ns	-
	18%	9.18	9.27	9.30	9.25	AB=Ns	-
Mean		8.36	8.36	8.38	8.37		
Phosphorus (P)	14%	8.45	8.45	8.53	8.47	A=**	0.25
	16%	9.78	9.75	9.75	9.76	B=Ns	-
	18%	10.69	10.62	10.48	10.60	AB=Ns	-
Mean		9.64	9.60	9.59	9.61		
Iron (Fe)	14%	2.05	2.05	2.08	2.06	A=**	0.13
	16%	2.18	2.18	2.19	2.18	B= Ns	-
	18%	2.69	2.41	2.61	2.57	AB=Ns	-
Mean		2.31	2.29	2.22	2.27		

Notes: Values in the same row or Colum with different superscripts are statistically significant from each other ($p < 0.05$). The values in Table were mean of three replicates. TSS*%= Total soluble solids%, CDBB= Carbonated Date bio-beverage, Ns**= non-significant.

At the various NDPCP contents under evaluation, the fortification of SCDBB with NDPCP did not appreciably alter the mineral composition, measured in mg/100g of Ca, K, Na, Mg, P, and Fe. Given how little of the NDPCP was reinforced, this finding is predictable.

Effect of fortification with NDPCP on probiotic count of soft carbonated date bio-beverage at different concentrations

The results displayed in Table 6 demonstrated that the total soluble solids% of SCDBB had a substantial impact on the probiotic bacteria count, *Bifidobacterium animalis subsp anomalis*, of SCDBB that was supplemented with the different amounts of NDPCP. As the total soluble solids content of SCDBB rose from 14 (control) to 16 and 18%, respectively, or 12.23 and 20.38% of the control value, the number of probiotic bacteria increased dramatically. The conclusions of **Knorr (1998) and Fooks *et al.* (1999)**, who discovered that the term "probiotic" originates from two Greek words meaning "for life," align with our findings. They discovered that the majority of probiotic products on the market contain species of *Lactobacillus* and *Bifidobacterium*, the two main genera of Gram-positive bacteria that are currently being described.

Probiotic microorganism-containing meals and beverages are becoming more and more popular worldwide. In this regard, **Shah (2007) and Prado *et al.* (2008)** clarified that in order

to offset the potential decrease in the number of probiotic microorganisms during the passage through the gut, these bacteria should be present in food to a minimum level of 106 CFU/g or the daily intake should be about 108 CFU/g. Their findings showed that *Bifidobacterium* species have been shown to improve the nutritional value of food and introduce microbes into the stomach, where they can produce vitamins including thiamine, riboflavin, folate, and coalmine.

Table 6: Effect of adding Nano date fiber particles on probiotic count CFU/ml of carbonated date bio-beverage at different TSS%**

TSS% of SCDBB (A)	Nano Date Fiber particles content mg/100 ml (B)			Mean
	0.00 (Control)	100.00	200.00	
14%	0.75 x 10 ^{9}	5.54 x 10 ^{9}	6.24 x 10 ^{9}	4.17 x 10 ^{9}
16%	1.63 x 10 ^{9}	5.78 x 10 ^{9}	6.63 x 10 ^{9}	4.68 x 10 ^{9}
18%	1.83 x 10 ^{9}	6.13 x 10 ^{9}	7.11 x 10 ^{9}	5.02 x 10 ^{9}
Mean	1.40 x 10 ^{9}	5.82 x 10 ^{9}	6.66 x 10 ^{9}	4.61 x 10 ^{9}
F value	A	B	AB	
	**	**	*	
LSD at 5%	0.13	0.14	0.25	

Notes: Values in the same row or Colum with different superscripts are statistically significant from each other ($p < 0.05$). The values in Table were mean of three replicates. TSS*%= Total soluble solids%, SCDBB= Soft carbonated Date bio-beverage, Ns**= Non-significant, Probiotic bacteria**= *Bifidobacterium animalis subsp anomalis*, CFU= Colony for unit.

Table 6 data demonstrated that, at varying TSS concentrations, the probiotic bacteria count, *Bifidobacterium animalis subsp anomalis*, was significantly impacted by the fortification of SCDBB with varying NDPCP levels. Probiotic bacteria count increased by 315.71 and 375.71% of the control value, respectively, when NDPCP fortification of SCDBB was increased from 0.00 (control) to 100.00 and 200.00 mg/100 ml. Prebiotics are defined as "food ingredients that promote the growth or activity of a limited number of bacterial species for the benefit of host health **(Douglas & Sanders 2008)** and are present in date press cake particles. These results are consistent with those obtained by **Yildiz & Ozcan (2019)**, who found that dietary fiber fortification increases the capacity of viable cells and metabolic activity of *Bifidobacterium*. Prebiotics were defined as no digestible food ingredients (dietary fibers) that positively impact the host by selectively promoting the growth or activity of beneficial bacteria, such as *lactobacilli* and *bifidobacteria*, in the gut and enhancing resistance to invasive pathogens. Additionally, they discovered that microorganisms are responsible for the conversion of oligosaccharides and exopolysaccharides (EPSs) into compounds that can be used as emulsifiers or stabilizers.

The probiotic bacteria count of SCDBB was significantly influenced by the interaction between total soluble solids of SCDBB and fortification with NDPCP as shown in Table 6. The highest value (7.11 X 109) of probiotic bacteria count, *Bifidobacterium animalis subsp anomalis*, was recorded in SCDBB prepared from 18%TSS beverage and fortified with 2000.00 mg NDPCP/100ml, while the lowest value (0.75X109) of was found in NDPCP prepared from 14%TSS beverage and fortified with 0.00 mg NDPCP/100ml. Increasing levels of fortification by NDPCP and total soluble solids of beverage resulted in an increase in probiotic bacteria count of SCDBB, especially fortification by NDPCP. According to **Correa *et al.* (2008)**, probiotic coconut flans had a tendency towards higher scores when compared to the control product, indicating its significant potential as a functional meal with excellent sensory acceptability.

The current findings in this experiment are consistent with those of Douglas & Sanders (2008), who demonstrated that date press cake

did not adversely affect the growth of Bifidobacterium in MRS. The "symbiotic" products are a "combination of prebiotics and probiotics," as demonstrated by **Hildebrandt *et al.* (2013), Eweis *et al.* (2017), and Grumezescu & Holban (2019)** in this area. This presents a new challenge for functional beverages. These Prebiotics are used to boost the gut's beneficial microbiota and increase the survivability of probiotic bacteria without negatively altering their physicochemical makeup. It is widely believed, again, without much pertinent research, that probiotic products should contain at least >1 x 106 CFU/ml or gram at the time of consumption and that, in order to have therapeutic benefits, a total of 108 to 109 probiotic microorganisms should be consumed daily.

Effect of fortification with NDPCP on microbiological quality of soft carbonated date bio-beverage at different concentrations

Microbial analysis revealed no coliform and fungal growth after production. **Lazareva *et al.* (2007)** showed that the consumption of juices and other drinks is on the rise both in Egypt and throughout the world. There is a growing interest in drinks that not only quench thirst but also have a positive effect on various systems of the body and human health in general. The results presented in Table 7 made this clear. Total soluble solids of SCDBB fortified with the different contents of NDPCP had no significant effect on coliform count, mold & yeast.

Ukwo, *et al.* (2019) observed a similar pattern and reported that carbon dioxide also has a preservation impact by inhibiting the growth of microbes such as mold, yeast, and lactic acid bacteria. Additionally, it prevents shape deformation by applying internal pressure to the cans. They suggested that the high acidity of the beverage, the thermal processing, the method used, and the adoption of excellent sanitary practices throughout manufacturing could all be responsible for the non-alcoholic beverage's stability and safety with respect to microbiological load.

Table 7: Effect of adding nano date fiber particles on microbial quality CFU/ml of carbonated date bio-beverage at different TSS%

Microbial type	TSS% of SCDBB (A)	Nano Date Fiber particles content mg/100 ml (B)			Mean	F value	LSD at 5%
		0.00	100.00	200.00			
Coliform count	14%	Nd	Nd	Nd	Nd	A= Ns	-
	16%	Nd	Nd	Nd	Nd	B=Ns	-
	18%	Nd	Nd	Nd	Nd	AB=Ns	-
Mean		Nd	Nd	Nd	Nd		
Mold& yeast count	14%	Nd	Nd	Nd	Nd	A= Ns	-
	16%	Nd	Nd	Nd	Nd	B=Ns	-
	18%	Nd	Nd	Nd	Nd	AB=Ns	-
Mean		Nd	Nd	Nd	Nd		

Notes: Values in the same row or Colum with different superscripts are statistically significant from each other ($p < 0.05$). The values in Table were mean of three replicates. TSS*%= Total soluble solids%, SCDBB= Soft carbonated Date bio-beverage, Ns**= Non-significant, CFU= Colony for unit. Nd = Not detected

The information in Table 7 demonstrated that the addition of various NDPCP contents to SCDBB did not significantly affect the coliform count, mold, or yeast. According to **Dueck *et al.* (2020)**, dietary fiber (DF) has been shown to be a significant component of health foods because of the demonstrated correlation between increased dietary fiber consumption and a lower incidence of specific non-communicable/metabolic disorders.

Effect of fortification with NDPCP on sensory indices of soft carbonated date bio-beverage at different concentrations

The findings displayed in Table 8 made it evident that the total soluble solids of (SCDBB) significantly impacted the sensory indices, i.e. that is, appearance, sweetness, flavor, acidity, and general acceptability fortified with varying amounts of NDPCP. The appearance property increased gradually by 9.67 and 17.71%, the sweetness property by 8.33 and 15.44%, the flavor property by 8.76 and 14.19%, and the overall acceptability property by 9.50 and 29.85%. However, the acidity property decreased as the total soluble solids concentration of SCDBB increased from 14 (control) to 16 and 18%, respectively. Date juice is used as a flavoring and sweetener in this investigation. **Lazareva *et al*. (2007)** show how many Egyptian producers now consider "drinks for health" to be essential.

By promoting the growth of probiotic bacteria, nano date press cake particles are often touted as a novel and valuable addition to soft carbonated date bio-beverages. Under the study conditions, a non-alcoholic beverage containing 200.00 mg of nano date press cake particles and 18% total soluble solids of date bio-beverage is preferred in terms of its physicochemical, microbiological, and sensory qualities.

Table 8: Effect of adding nano date fiber on sensory evaluation of carbonated date bio-beverage at different TSS*%.

Property	TSS% of SCDBB (A)	Nano Date Fiber particles content mg/100 ml (B)			Mean	F value	LSD at 5%
		0.00	100.00	200.00			
Appearance	14%	7.10	7.35	7.55	7.34	A=**	0.10
	16%	7.92	8.09	8.14	8.05	B=**	0.06
	18%	8.37	8.70	8.85	8.64	AB=**	0.10
Mean		7.80	8.05	8.18	8.01		
Sweetness	14%	8.16	8.15	8.16	8.16	A=**	0.10
	16%	8.82	8.80	8.90	8.84	B=Ns	-
	18%	9.36	9.44	9.47	9.42	AB=Ns	-
Mean		8.78	8.80	8.84	8.81		
Flavor	14%	7.19	7.16	7.22	7.19	A=**	0.08
	16%	7.82	7.78	7.85	7.82	B=Ns	-
	18%	8.17	8.19	8.27	8.21	AB=Ns	-
Mean		7.73	7.71	7.78	7.74		
Acidity	14%	8.05	8.08	8.09	8.07	A=**	0.60
	16%	7.86	7.79	7.90	7.85	B=Ns	-
	18%	7.33	7.48	7.43	7.41	AB=Ns	-
Mean		7.75	7.79	7.81	7.78		
Overall acceptable	14%	7.42	7.45	7.53	7.47	A=**	0.06
	16%	8.12	8.19	8.24	8.18	B=**	0.05
	18%	9.53	9.69	9.87	9.70	AB=**	0.09
Mean		8.36	8.44	8.54	8.45		

Notes: Values in the same row or Colum with different superscripts are statistically significant from each other ($p < 0.05$). The values in Table were mean of three replicates. TSS*%= Total soluble solids%, CDBB= Carbonated Date bio-beverage, Ns**= non-significant.

The findings shown in Table 8 demonstrated that at varying concentrations of total soluble solids, the appearance and general acceptability qualities of SCDBB fortified with varying amounts of NDPCP were significantly impacted. As SCDBB was fortified with NDPCP, the appearance property increased gradually from 0.00 (control) to 100.00 and 200.00 mg/100 ml, respectively, and the overall acceptability property increased by 0.96 and 2.15%. The reason for this could be because the date press cake had the highest color value (Table, 2). The results reported above were in agreement with those of **Salmeron *et al*. (1997), Liu, *et al*. 2002 and Anderson, *et al*., (2009).** They clarified that dietary fiber insufficiency is the main shortcoming in soft drinks. The health benefits of beverages are

enhanced when dietary fiber is included. In addition to these disorders, dietary fiber has been shown to have a preventive role in the world's widely spreading diseases like obesity and diabetes.

Appearance and overall acceptance properties of SCDBB were significantly influenced by the interaction between total soluble solids% of SCDBB and fortification with NDPCP as shown in Table 8. The highest value (8.18 and 9.87) of appearance and overall acceptance properties were recorded in SCDBB prepared from 18%TSS beverage and fortified with 2000.00 mg NDPCP/100ml, while the lowest values (7.10 and 7.42) were found in NDPCP prepared from 14%TSS beverage and fortified with 0.00 mg NDPCP/100ml. Increasing levels of fortification by NDPCP and total soluble solids of beverage resulted in an increased appearance and overall acceptance properties of SCDBB. Douglas & Sanders (2008) concluded that all probiotic-fortified date beverage was not rated significantly different from the control, except for appearance. A similar line was obtained by **Ukwo, *et al*. (2019)**.

Conclusion

The results of this study showed that date fruit extracts might be used to create a soft carbonated date bio-beverage with enhanced Nano date press cake particles. This study also demonstrated the date press cake's feasibility as a food processing ingredient and its abundance of important nutrients. Such organic by-products are typically thrown away as garbage, thus valuing them is a resource recovery tactic that helps to keep the economy and environment sustainable. The quality of Nano date press cake particles improves noticeably with an increase in the amount or percentage of soft carbonated date bio-beverage. Potassium was the most prevalent mineral in the non-alcoholic beverage formulation, followed by magnesium, phosphorus, and calcium. These minerals gradually increased as the Total soluble solids of date fruit extract increased in the beverage.

Generally, Nano date press cake particles is promised new and valuable component in soft carbonated date bio-beverage by enhancing the growth of probiotic bacteria. Under the study conditions, a non-alcoholic beverage containing 200.00 mg of nano date press cake particles and 18% total soluble solids of date bio-beverage is preferred in terms of its physicochemical, microbiological, and sensory qualities.

List of Abbreviations

SCDBB	Soft carbonated date bio-beverage
SCDBB	Soft carbonated date bio-beverage
SDB	Soft date beverage
SDBB	Soft date bio-beverage
NDPCP	Nano date press cake particles
TSS	Total soluble solids
RS	Reducing sugars
NRS	Non-reducing sugars
LQD	Low-quality dates
ICUMSA	(International Commission for Uniform Methods of Sugar Analysis)
Co.	Company
Ns	Non-significant
Nd	Not detected
DWB	Dry weight basis
DPC	Date press cake
IU	International unit
h	Hour
g	gram
MRS	de Man, Rogosa, Sharpe
CFU	Colony for unit

REFERENCES

Abbès, F., Bouaziz, M. A., Blecker, C., Masmoudi, M., Attia, H., & Besbes, S. (2011). Date syrup: effect of hydrolytic enzymes (pectinase/cellulase) on physico-chemical characteristics, sensory and functional properties. *LWT-Food science and Technology*, *44*(8), 1827-1834.

Al-Farsi, M., Alasalvar, C., Morris, A., Baron, M., & Shahidi, F. (2005). Compositional and sensory characteristics of three native sun-dried date (Phoenix dactylifera L.) varieties grown in Oman. *Journal of agricultural and food chemistry*, *53*(19), 7586-7591.

Al-Farsi, M., Alasalvar, C., Al-Abid, M., Al-Shoaily, K., Al-Amry, M., & Al-Rawahy, F. (2007). Compositional and functional characteristics of dates, syrups, and their by-products. *Food chemistry*, *104*(3), 943-947.

Al-Hooti, S., Sidhu, J. S., & Qabazard, H. (1997). Physicochemical characteristics of five date fruit cultivars grown in the United Arab Emirates. *Plant Foods for Human Nutrition*, *50*, 101-113.

Ali, M. R. (2018). Consumer acceptance of orange juice mixed with water mint leave extract. *Recent patents on food, nutrition & agriculture*, *9*(1), 50-54.

Allen, L. (2006). Guidelines on food fortification with micronutrients. *(No Title)*.

El Arem, A., Saafi, E. B., Slama, R. B., Zayen, N., Hammami, M., & Achour, L. (2013). Phytochemical composition, antibacterial and antioxidant activities of common date palm (Phoenix dactylifera L.) fruit during three maturation stages. *Tunisian Journal of Medicinal Plants and Natural Products*, *10*(2), 33-48.

Anderson, J. W., Baird, P., Davis Jr, R. H., Ferreri, S., Knudtson, M., Koraym, A. & Williams, C. L. (2009). Health benefits of dietary fiber. *Nutrition reviews*, *67*(4), 188-205.

Aragon-Alegro, L. C., Alegro, J. H. A., Cardarelli, H. R., Chiu, M. C., & Saad, S. M. I. (2007). Potentially probiotic and synbiotic chocolate mousse. *LWT-Food Science and technology*, *40*(4), 669-675.

Ashraf, Z., & Hamidi-Esfahani, Z. (2011). Date and date processing: a review. *Food reviews international*, *27*(2), 101-133.

Babalola, S. O., Babalola, A. O., & Aworh, O. C. (2001). Compositional attributes of the calyces of roselle (Hibiscus sabdariffa L.).

Baliga, M. S., Baliga, B. R. V., Kandathil, S. M., Bhat, H. P., & Vayalil, P. K. (2011). A review of the chemistry and pharmacology of the date fruits (Phoenix dactylifera L.). *Food research international*, *44*(7), 1812-1822.

Besbes, S., Drira, L., Blecker, C., Deroanne, C., & Attia, H. (2009). Adding value to hard date (Phoenix dactylifera L.): Compositional, functional and sensory characteristics of date jam. *Food chemistry*, *112*(2), 406-411.

Cheng, R., Yang, H., Shao, M. Y., Hu, T., & Zhou, X. D. (2009). Dental erosion and severe tooth decay related to soft drinks: a case report and literature review. *Journal of Zhejiang University Science B*, *10*, 395-399.

Chillo, S., Civica, V., Iannetti, M., Suriano, N., Mastromatteo, M., &

Del Nobile, M. A. (2009). Properties of quinoa and oat spaghetti loaded with carboxymethylcellulose sodium salt and pregelatinized starch as structuring agents. *Carbohydrate Polymers*, *78*(4), 932-937.

Chniti, S., Jemni, M., Bentahar, I., Shariati, M. A., Djelal, H., Amrane, A., & Hassouna, M. (2017). By-products of dates: optimization of the extraction of juice using response surface methodology and ethanol production. *Journal of Microbiology, Biotechnology and Food Sciences*, *7*(2), 204-208.

Crittenden, R., Bird, A. R., Gopal, P., Henriksson, A., Lee, Y. K., & Playne, M. J. (2005). Probiotic research in Australia, New Zealand and the Asia-Pacific region. *Current Pharmaceutical Design*, *11*(1), 37-53.

Douglas, L. C., & Sanders, M. E. (2008). Probiotics and prebiotics in dietetics practice. *Journal of the American dietetic association*, *108*(3), 510-521.

Dueck, C., Cenkowski, S., & Izydorczyk, M. S. (2020). Effects of drying methods (hot air, microwave, and superheated steam) on physicochemical and nutritional properties of bulgur prepared from high-amylose and waxy hull-less barley. *Cereal Chemistry*, *97*(2), 483-495.

El-Far, A. H., Ahmed, H. A., & Shaheen, H. M. (2016). Dietary supplementation of Phoenix dactylifera seeds enhances performance, immune response, and antioxidant status in broilers. *Oxidative medicine and cellular longevity*, *2016*.

El-Far, A. H., Oyinloye, B. E., Sepehrimanesh, M., Allah, M. A. G., Abu-Reidah, I., Shaheen, H. M. & Mousa, S. A. (2019). Date palm (Phoenix dactylifera): novel findings and future directions for food and drug discovery. *Current drug discovery technologies*, *16*(1), 2-10.

Eweis, D. S., Abed, F., & Stiban, J. (2017). Carbon dioxide in carbonated beverages induces ghrelin release and increased food consumption in male rats: implications on the onset of obesity. *Obesity research & clinical practice*, *11*(5), 534-543.

Fooks, L. J., Fuller, R., & Gibson, G. R. (1999). Prebiotics, probiotics and human gut microbiology. *International dairy journal*, *9*(1), 53-61.

Franke, A. A., Cooney, R. V., Henning, S. M., & Custer, L. J. (2005). Bioavailability and antioxidant effects of orange juice components in humans. *Journal of agricultural and food chemistry*, *53*(13), 5170-5178.

Greenfield, H., & Southgate, D. A. (2003). *Food composition data: production, management, and use*. Food & Agriculture Org.

Grumezescu, A., & Holban, A. M. (Eds.). (2019). *Functional and Medicinal Beverages: Volume 11: The Science of Beverages*. Academic Press.

Guarner, F., & Schaafsma, G. J. (1998). Probiotics. *International journal of food microbiology*, *39*(3), 237-238.

He, X., & Hwang, H. M. (2016). Nanotechnology in food science: Functionality, applicability, and safety assessment. *Journal of food and drug analysis*, *24*(4), 671-681.

Heidarinejad, Z., Rahmanian, O., Fazlzadeh, M., & Heidari, M. (2018). Enhancement of methylene blue adsorption onto activated carbon prepared from Date Press Cake by low frequency ultrasound. *Journal of Molecular Liquids*, *264*, 591-599.

Hekmat, S., & Reid, G. (2006). Sensory properties of probiotic yogurt is comparable to standard yogurt. *Nutrition research*, *26*(4), 163-166.

Hildebrandt, G. H., Tantbirojn, D., Augustson, D. G., & Guo, H. (2013). Effect of caffeinated soft drinks on salivary flow. *Journal of caffeine research*, *3*(3), 138-142.

Wojtczak, M. (2003). ICUMSA-International commission for uniform methods of sugar analysis. *Gazeta Cukrownicza*, *111*(06), 191-192.

Karaaslan, M., Ozden, M., Vardin, H., & Turkoglu, H. (2011). Phenolic fortification of yogurt using grape and callus extracts. *LWT-Food Science and Technology*, *44*(4), 1065-1072.

Khalil, K. E., Hafez, N. E., & Ahmed, E. Y. (2002). Production, evaluation and utilization of date syrup concentrate, Dibis. *Egyptian Journal of Food Science (Egypt)*.

Knorr, D. (1998). Technology aspects related to microorganisms in functional foods. *Trends in Food Science & Technology*, *9*(8-9), 295-306.

Lazareva, O. N., Vysokogorsky, V. E., & Voronova, T. V. (2007). Influence of water extracts from vegetable raw material on oxidation properties of milk produce. *Polythematic online scientific journal of Kuban State Agrarian University*, *31*, 105-115.

Lees, R. (1975). *Food analysis: analytical and quality control methods for the food manufacturer and buyer*. Leonard Hill Books.

Liu, S., Buring, J. E., Sesso, H. D., Rimm, E. B., Willett, W. C., & Manson, J. E. (2002). A prospective study of dietary fiber intake and risk of cardiovascular disease among women. *Journal of the American College of Cardiology*, *39*(1), 49-56.

Labuda, J., Barek, J., Gajdosechova, Z., Goenaga-Infante, H., Johnston, L. J., Mester, Z., & Shtykov, S. (2023). Analytical chemistry of engineered nanomaterials: Part 1. Scope, regulation, legislation, and metrology (IUPAC Technical Report). *Pure and Applied Chemistry*, *95*(2), 133-163.

Merkus, H. G. (2009). *Particle size measurements: fundamentals, practice, quality* (Vol. 17). Springer Science & Business Media.

Merrill, A. L., & Watt, B. K. (1955). *Energy value of foods: basis and derivation* (No. 74). Human Nutrition Research Branch, Agricultural Research Service, US Department of Agriculture.

Montgomery, D. C. (2017). *Design and analysis of experiments*. John wiley & sons.

Morales-de la Peña, M., Welti-Chanes, J., & Martín-Belloso, O. (2016). Application of novel processing methods for greater retention of functional compounds in fruit-based beverages. *Beverages*, *2*(2), 14.

O'Dell, W. D., Roberts, C. E., & Nester, M. T. (1998). *Student Study Guide to Accompany Microbiology a Human Perspective*. WCB/McGraw-Hill.

Pojer, E., Mattivi, F., Johnson, D., & Stockley, C. S. (2013). The case for

anthocyanin consumption to promote human health: a review. *Comprehensive reviews in food science and food safety*, *12*(5), 483-508.

Prado, F. C., Parada, J. L., Pandey, A., & Soccol, C. R. (2008). Trends in non-dairy probiotic beverages. *Food Research International*, *41*(2), 111-123.

Allowances, R. D. (2009). Nutrient requirements and recommended dietary allowances for Indians. *ICMR-National Institute of Nutrition: Hyderabad, India*.

Corrêa, S. B., Castro, I. A., & Saad, S. M. (2008). Probiotic potential and sensory properties of coconut flan supplemented with Lactobacillus paracasei and Bifidobacterium lactis. *International journal of food science & technology*, *43*(9), 1560-1568.

Salmerón, J., Ascherio, A., Rimm, E. B., Colditz, G. A., Spiegelman, D., Jenkins, D. J., ... & Willett, W. C. (1997). Dietary fiber, glycemic load, and risk of NIDDM in men. *Diabetes care*, *20*(4), 545-550.

Shah, N. P. (2007). Functional cultures and health benefits. *International dairy journal*, *17*(11), 1262-1277.

Shahidi, F., & Naczk, M. (2003). *Phenolics in food and nutraceuticals*. CRC press.

Siddiqui, A. (2009). Sahih Muslim, Book 23: The Book of Drinks, Chapter 25: Excellence of the dates of Medina. *Translator: Abd-al-Hamid Siddiqui*.

El-Sohaimy, S. A., & Hafez, E. E. (2010). Biochemical and nutritional characterizations of date palm fruits (Phoenix dactylifera L.). *J Appl Sci Res*, *6*(6), 1060-7.

Sozer, N. (2009). Rheological properties of rice pasta dough supplemented with proteins and gums. *Food Hydrocolloids*, *23*(3), 849-855.

Ukwo, S. P., Edima-Nyah, A. P., & Udo, I. I. (2019). Production of non-alcoholic beverage from roselle calyce (Hibiscus sabdariffa L.): Effects of date fruit extract incorporation on quality parameters and consumer acceptability. *Environment*, *5*(2), 855-863.

Mohamadshahi, M., Veissi, M., Haidari, F., Javid, A. Z., Mohammadi, F., & Shirbeigi, E. (2014). Effects of probiotic yogurt consumption on lipid profile in type 2 diabetic patients: A randomized controlled clinical trial. *Journal of research in medical sciences: the official journal of Isfahan University of Medical Sciences*, *19*(6), 531.

Verdenelli, M. C., Silvi, S., Cecchini, C., Orpianesi, C., & Cresci, A. (2011). Influence of a combination of two potential probiotic strains, Lactobacillus rhamnosus IMC 501® and Lactobacillus paracasei IMC 502® on bowel habits of healthy adults. *Letters in applied microbiology*, *52*(6), 596-602.

Yildiz, E., & Ozcan, T. (2019). Functional and textural properties of vegetable-fibre enriched yoghurt. *International Journal of Dairy Technology*, *72*(2), 199-207.