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Nutritional Value of Dehydrated Sheets (Tamr El-Dein) Produced from Barhi Date as a Functional Food

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Abstract: The Barhi date cultivar is a high-quality which fruits (dates) are packed and eaten in the Khalal maturity stage due to their sweetness, crispiness and yellow skin color. After harvesting, Khalal Barhi fruits rapidly matured to the Rutab stage, where their tissues become soft and their skin color browner. This leading to decrease in their market value and customer demand, with the need to utilize dates in a more efficient way is a must. In this study, a new product was developed using Barhi date, due to its unique qualities, with mix of sweet potato, is considered date sheet produced to be highly nutritional, therapeutic and energy source. Form of end product (Barhi sheets) we called it Tamer El-Dein. the Proximate analysis proved that products are nutritious and can contribute especially to the daily allowance in macro-elements. Rheological properties of Barhi date sheet produced belongs to the same family of products such as dried Qamer El-dein in terms of the attributes. Products were aged up to twelve weeks, with remaining stable throughout the storage period. The present work is a part of scientific project about the valorization of the common dates grown in Egypt, is Barhi dates. The principal aim was to with the view to produce food sheet, which can easily take the place of many synthetics ingredients (healthily beverages by reconstitute and in pastry and pies), or in many food preparations. Hence, Barhi dates sheets (slabs) with sweet potatoes, are effective, safe and cheap supplements for improving hemoglobin and restoring iron stores to correct iron deficiency, could appropriate to participate in the Egyptian school meal programs. In addition, leading to a greater diversity of products, therefore have economic benefits to producers. Likewise, will enhance use of date sheet in many sectors such as functional foods or as ingredients in nutraceuticals. Furthermore, maintaining the physical, microbial and nutritional quality features of Barhi dates sheet during extended storing. We need to further studies to possible development trends such as of using microwave drying in Barhi date products processing application were put forward and testing another raw material with Barhi date to valorization of products. Finally, it could be concluded through this study, that it is economic, practicable and successful, it produce dehydrated sheets from Barhi date with sweet potato as new untraditional product .That aforementioned product possessed high nutritional value, aver and above, high palatability.

Key words: Barhi date · Tamer El-Dein sheet · Physicochemical analysis · Microbiological analysis · Rheological properties · HMF · Sensory attributes

INTRODUCTION

Among the agricultural commodities of commercial importance in Egypt. In recent years, a huge interest in the abundant health promoting properties of date fruits has led to the need to develop new food products using dates as a source of nutrients, as it is a blessed tree mentioned in Holy Quran [1].

The top 10 date-producing countries are illustrated in Figure 1. Saudi Arabia was the second largest date producer from 2018–2019, with a total production of 1, 483, 631 tons after Egypt first date producer 1, 583.73 t [2]. Dates are an indispensable source of dietary metals and free amino acids and have been used to treat chronic illnesses and diseases since ancient times [3].

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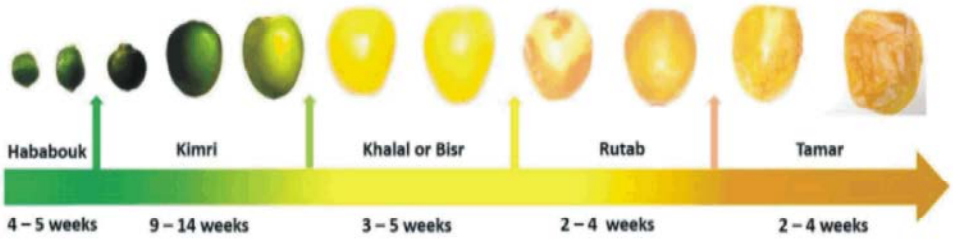

Fig. 1: Different growth and maturity stages of Barhi date fruit (post-anthesis weeks)

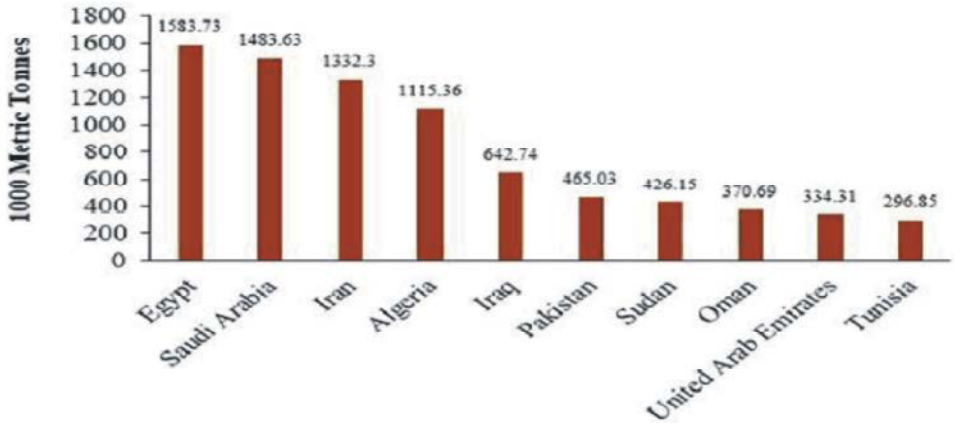

Fig. 2: Top 10 date-producing countries according to FAOSTAT, [2]

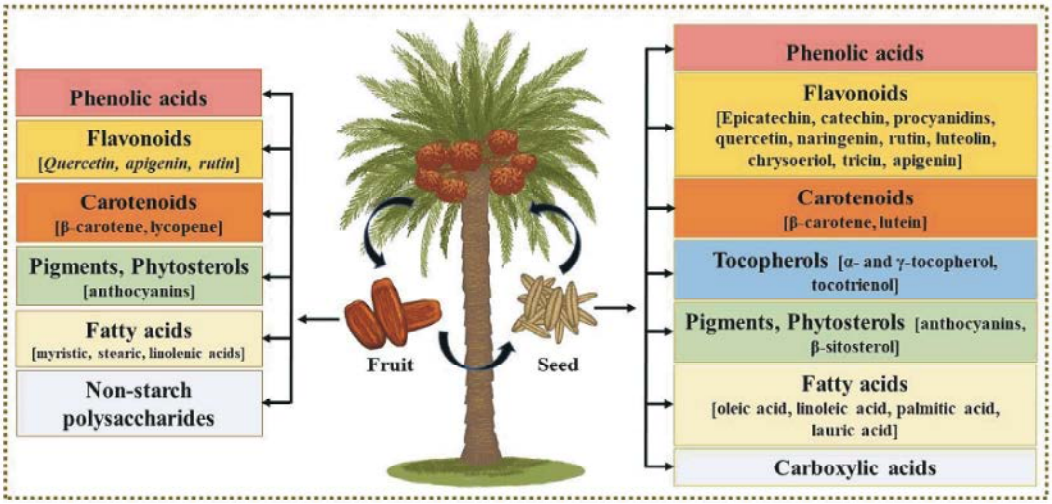

Fig. 3: Bioactive constituents from date palm and seed [12]

The Barhi date is a high-quality date cultivar which fruits (dates) are packed and eaten fresh when they reach the Khalal maturity stage due to their sweetness, crispiness and yellow skin color. After harvesting, Khalal Barhi fruits rapidly matured to the Rutab stage (Fig. 1), where their tissues become soft and their skin color browner. This results in a decrease in their market value and customer demands.

Generally, dates are well known for their nutritional value comprising sugars, dietary fiber, protein, polyphenolic compounds and ash, for example, Barhee consists of Glucose 34.6 %, Fructose 39.3%, 4.2 % g/100 g of fruit flesh [4, 5].

Figure 3 show bioactive constituents from date palm and seed, where as previous research findings on their nutraceuticals and pharmaceutical benefits revealed that

consumption of date fruits and seeds could help to prevent oxidative stress and enhance the anti-inflammatory activities of the body. The development of value-added products and can prevent neurodegenerative, metabolic, or skin disorders.

Besides, Anemia's means deficiency of hemoglobin in the blood, which could be caused by either too few red blood cells or too little hemoglobin in the cells. Which in turn decrease energy formation, as energy need oxygen supply plus nutrients like carbohydrates and fat, leading to energy production by the mitochondria [6].

Iron deficiency anemia results from decreasing blood formation of cells and iron deficiency in tissues which occurs depending on the balance between iron intake and iron requirement. The development rate of iron deficiency in tissues and cells depends on the turnover rate of iron-containing proteins. Iron is also associated with several metabolism substances including mitochondria and neurotransmitters [7, 8].

On the other hand, anemia means deficiency of hemoglobin in the blood, there are many factors that contribute to the wide distribution of anemia, mainly decreased physical activity and unhealthy dietary together with mineral deficiency specially, iron, copper and selenium [9, 10].

Researchers reported the importance of supplements in enhancing fitness and performance in sport and help athletes to retard the state of fatigue. The most important supplements are those which are natural in origin such as date that contain vitamins, minerals and trace elements such as iron. It is very essential in oxygen transportation and energy production and the main product to prevent anemia, especially among girls and women [11].

A variety of date cultivars have shown to be effective inhibitors of tyrosinase and α-glucosidase. Therefore, it is important understand the mechanism of bioactive constituents and purified compounds that may embody these effects. Chemists and biologists have recognized dates and date seed waste as valuable sources for developing drugs and nutraceuticals because they show many benefits to humans.

They have also been found to reduce high blood pressure and oxidative stress and have been used to treat diabetes, cancer and atherosclerosis and to stimulate immunity [13].

Besides, they have a higher antioxidant activity than culinary fruits, contain several bioactive compounds, such as coumaric acids, ferulic acid, cinnamic acid, flavonoids, procyanidins, phenolic compounds and water-soluble vitamins [14, 15]. These compounds can strengthen bones, promote uterine contractions in pregnant women during childbirth and prevent anemia [16]. Additionally, Ajwa and other date varieties can be a factor in preventing cancer, cardiac arrest and neuron damage and can also increase fertility [17, 18].

On the other hand, sweet potato is very popular in Egypt where it is grown as a summer and autumn crop and consumed locally. Sweet potatoes are an economical and healthy food crop containing high carbohydrate contents, -carotene, substantial amounts of ascorbic acid and minerals as mentioned before. Globally, the sweet potato is an important food which is used for industrial applications such as dietary fiber, pureed infant food, spray-dried powders and thickeners [19, 20]. Studies on the rheological properties are important for process design and development, to evaluate the sensory properties and to widen the applications of sweet potato-based material [21]. Over and above, instrumental TPA is helpful in quality control and developing products with appropriate rheological characteristics and to measure the instrumental TPA attributes of date sheets as a function of moisture content by two-cycles compression.

From these points of view the aims of this study were to produce delicate and nutritive dehydrated sheets from Barhi date pulp. Through the years, there is no published work on sheets or rolls of dates as a new product and unique, until now.

In other words, formulating a novel and nutritious date confectionery (Rolls or sheets) using dates Barhi plus sweet potato (5, 10%). study the chemical composition and bacteriology assay of the product was evaluated and discussed in connection to its rheological and physicochemical properties, a relationship between the instrumentally derived textural characteristics and the sensory profile obtained using a trained taste panel, of what it know the Tamr El-dein.

MATERIALS AND METHODS

Materials: Dates of Barhi cultivar were obtained from the (El-Bostan zone, El-Beheira Governorate, Egypt) at the harvesting season (2020 / 2021). Fresh dates (in Tamer stage) were packed in polyethylene bags and stored at-20°C. Before each experiment, dates were taken out from the freezer and, after stabilization at ambient temperature (25± 5°C), they were pitted manually and ground with a meat grinder to prepare date paste.

Fig. 4: Date sheets from Barhi date plus sweet potato as end product

Freshly harvested sweet potato tubers of the "Giza 69" varieties were obtained from the local market, The samples were washed and peeled, then boiled by steam, added by 5 and 10 % to Barhi date pulp, blended, mix and put on tray. Paraffin wax was purchased from ADWIC (El-Nasr Pharmaceutical Chemicals Company).

Methods

Making of Tamer El-Dein Sheet (TDS): The paste was mixed and placed uniformly in Pyrex plates (10 cm in diameter) was greased with paraffin wax on the surface. The samples were spread on the plates by a ruler and accurately adjusted to the thicknesses of 0.5 cm. and then held in a cabinet dryer (WT-binder, Type F115, Germany) at 60°C for 24 hours. During the drying process, the samples were taken out and weighed using a digital electronic balance. Moisture content of the samples was determined and drying was continued until three consecutive measurements showed constant weights in sheet or roll form, naming-Tamr el-Dein. Three replicates for each of the experiments were done. At the end of each experiment, the moisture ratio was determined. The obtained dried date sheets (Tamr El-Dein) were rolled in a polyethylene bags and kept in a refrigerator till analysis. Likewise, sensory evaluation of produced Tamr El-Dein sheets was carried out for taste, aroma, color, texture and overall acceptability.

Chemical Analysis

Chemical Composition of Date Sheet: Proximate composition was determined including moisture content, crude protein, crude fat, total sugars (reducing and non-reducing), ash, crude fiber, total carbohydrates calculated by difference, glucose and fructose contents and minerals (K, Ca, Na, Mg, Fe, Mn, P and Zn), in addition, phytochemical composition (total phenolic content (TPC), total anthocyanin content (TAC) and titratable acidity as % citric acid according to AOAC [22]. Besides, pH value was measured at 25 °C by a pH-meter.

HydroxymethylFurfural(HMF): HydroxymethylFurfural Was Determined as Described by Ranganna [23].

Amino Acid Composition of Date Sheet: Amino acids were analyzed by the method of Laury, [24], with vapour HCl hydrolysis of samples and standards at 110°C for 19-20 h. After hydrolysis, samples on polyvinylidene difluoride were extracted three times with 100 L of 40% acetonitrile and 0.5% trifluoroacetic acid and the extracts were dried completely in a Speed Vac before resuspension in sample buffer. Samples and standards were then analyzed in a Beckman 6300 system.

Vitamins C and Carotenoids of Date Sheets: Vitamins C, the 2, 6 dichloro-phenol indophenol titration method was used to estimate ascorbic acid as described by the A.O.A.C., [25]. While, total carotenoids content was determined at the wavelengths of 470, 646 and 663 nm according to the method described by [26].

Physical Parameters

Color Attributes: Color attributes ; lightness (*L*),* redness *(a*)* and yellowness (*b*)* were evaluated by a Minolta Color Reader CR-10, Minolta Co. Ltd., Japan, color index at 420 nm was determined as described by Ranganna [23].

Rheological Properties (TPA): For the two-cycle compression, a texture analyzer (Texture Pro CT V1.6 Build, Brookfield) were carried out by TPA Lab, Department of Bread and Pasta, FTRI, ARC, Giza) was used to measure the TPA of date sheets. Each prepared sheet of the barhi date sheets 5 % and 10 % sweet potato were made into a square disc (10*10 cm) of 200 g weight and 14 mm height.

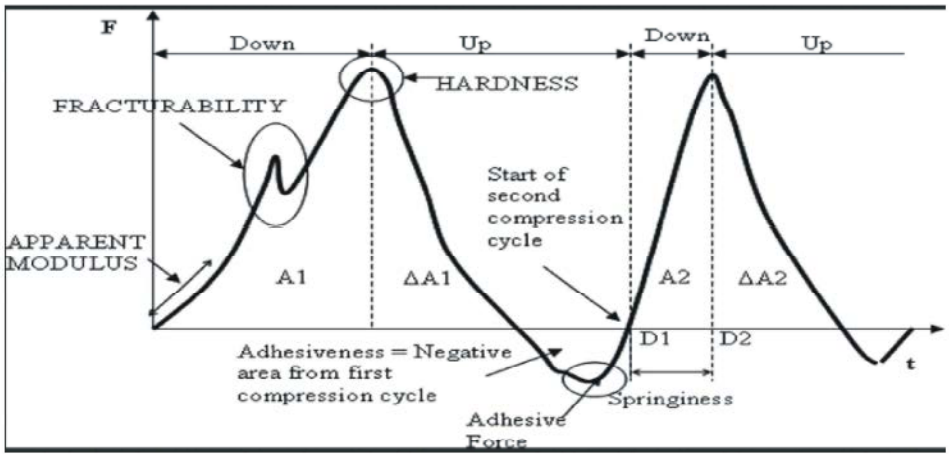

Fig. 5: Generalized instrumental texture profile curve obtained with the General Foods Texturometer [65]

All measurements were carried out in a controlled room temperature. The cross-head was allowed to penetrate with a cylindrical probe (25 mm diameter) at the rate of 30 mm/min to a total deformation 20 mm and back to the original position followed by a second down and up cycle on the same sample. Three replicates were conducted for each date sheets sample and all operations were automatically controlled by the Texture Analyzer. The following parameters were extracted from the generalized instrumental texture profile curve (Fig. 5): hardness cycle 1, gumminess, chewiness, adhesiveness, springiness, cohesiveness, adhesive force, hardness cycle 2, area cycle 1 and area cycle 2. Hardness is defined as the force necessary to attain a given deformation or a penetration in a product [27]. Area cycle 1 (A_1 in Fig. 5) is the total energy required for the first compression and area cycle 2 (A_2 in Fig. 5) is the total energy required for the second compression. Cohesiveness (shown as A_2/A_1 in Fig. 5) is the extent to which a material can be deformed before it ruptures. Springiness (or elasticity) is the rate at which a deformed material goes back to its un-deformed condition after the deforming force is removed. Adhesiveness is the work necessary to overcome the attractive forces between the surface of the food and the surface of the other materials with which the food comes in contact. Chewiness is the energy required to masticate a solid food to a state ready for swallowing, or a product of hardness, cohesiveness and springiness. Gumminess is the energy required to disintegrate a semi-solid food to a state ready for swallowing, or a product of a low degree of hardness and a high degree of cohesiveness [28, 29]. Besides, date sheets were placed in airtight plastic containers and stored at room temperature for a period of three month thus allowing us to record textural variations during storage.

Food Energy Value: The energy value of date sheets was calculated based on Atwater factor system as indicated by Leung *et al.* [30].

Microbial Analysis of Barhi Date Sheets

Microbiological Analysis: Ten gms from date sheet 5 % and 10 % sweet potato were weighed and homogenized with 90 ml sterile normal saline (0.85% NaCl; Active Fine Chemicals Ltd., Sigma) in sterile stomacher bag. Following serial dilution technique, decimal dilutions were prepared and 0.1 ml of sample from appropriate dilution was added on different nonselective and selective culture media, followed by microbiological analysis by surface plate method. Nutrient Agar, Potato Dextrose Agar and MacConkey Agar (Oxoid, England) were the culture media of choice for aerobic plate count (APC), yeasts and molds count (YMC), total coliform count (TCC) and E. coli count [22]. After incubation at 35?C for 1 to 2 days, the colonies in each plate were counted and results were expressed as log CFU/g sample.

Sensory Evaluation for Sheets: Staff members and semi-trained panelists judged the date sheets for taste (10), aroma (10), color (10) and texture (10) besides, total acceptability (10) were determined from the total scores of tested attributes according to the method described by Penfield and Campbell [31].

Statistical Analysis: The statistical analysis was performed out using SPSS statistical software for sensory evaluation of date sheet .Data were analyzed by one-way analysis of variance (ANOVA). The results were expressed as mean ± SE. The differences between means were tested for significance using LSD test at ($P < 0.05$) by SPSS [32].

RESULTS AND DISCUSSION

Chemical Composition of Date Sheets (Tamer El-Dein): To develop a new food product, identification of its composition and nutritional value is necessary. This can be related to structural/textural characteristics (rheological properties) thus allowing improvement of acceptability and mouth feel (To develop a new food product, identification of its composition and nutritional value is a must. This can be related to structural/textural characteristics (rheological properties) thus allowing improvement of palatability and mouth feel (this has a dense, tightly woven mouth feel, with complex, chewy and velvety tannins) according to consumer requirements. In the current study, the relevant information for Barhi date sheet was obtained and compared to studies literaturaly that of the similar commercial product (Qamer E-lDein) and according to CXS [33] and UNECE [34].

Table (1) shows the average chemical composition of date sheets from the Barhi (*P. dactylifera* L.) cultivar. The moisture content of date sheets were 15.84 ± 0.04 % and 17.22± 0.05 % on basis dry, according to the Egyptian Standards, [35] for apricot sheets, the moisture content of date sheets was within the limits of this standard (<18%), also these results are in agreement with those reported by El-Nakhal *et al.* [36] . While, the protein content was 03.50 ± 0.20 and 03.71 ± 0.41 g/100 g dry matter in the date sheet, indicating relatively little protein; it has been reported previously that dates, generally are not a good source of protein, which includes essential amino acids required for human metabolic function. Some of which are not found in common fruits.

Furthermore, the date sheets had a high carbohydrate content (76.00 ± 0.32 and 77.43 ± 0.28 %). It is well known that dates are important source for sugar. In contrast, reducing sugars was 55.34 ± 0.81and 55.65 ± 0.91 %, this increment may be due to the hydrolysis of the non-reducing sugars and polysaccharides during dehydration. The fiber content 2.55 ± 0.15 and 2.68 ± 0.21 %, while ash contents ranged from 2.45 ± 0.31 and 2.54 ± 0.32 % of date sheets. Additionally, available carbohydrate were ranged from 73.32 ± 0.30 and 74.85 ± 0.40 %, it has been defined as the sum of free sugars (glucose, fructose, galactose, sucrose, maltose, lactose and oligosaccharides) and complex carbohydrates (dextrin's, starch and glycogen). These are carbohydrates that are digested and absorbed and are glucogenic in humans, Anon, [37] and McCleary *et al*.[38], such values allow the estimation of the glycemic index value of a food and with obligate to involves labeling of available carbohydrates in the nutrition facts panel of products. Date sheets have a low-fat content, about 0.50 ± 0.11: 0.53 ± 0.32 g per 100 g. Lipids are mostly concentrated in the skin and are more important for protecting the fruit than for contributing to the date's nutritional value.

Vitamins composition of date sheets where as ascorbic acid 13.10 ±2.0 and 13.33±3.1 mg/100g) of date sheets. While, carotenoids were 0.395 ±1.4 and 0.452 ±1.3 (mg/100g) of date sheets.

On the other hand, hydroxymethyl furfural (HMF) content reflects the effect of sweet potato in retarding non-enzymatic browning. It significantly decreased from 80.4±3.2 and 84.4±2.1 mg /100 g-1 for date sheets, this ratio palatable, besides this reflects the effect of phenolic compounds in retarding non-enzymatic browning. At the preclinical level, no toxic effects have been observed at daily doses ranging from 80 to 100 mg/kg body weight [39].

HMF is a cyclic aldehyde produced by sugar degradation through the Maillard reaction (a non-enzymatic browning reaction) during food processing or long storage, Markowicz *et al*. [40] the presence of simple sugars (glucose and fructose) and many acids, as well as minerals, lead further enhance the production of this substance [41].

Hence, higher HMF concentration is indicative of poor storage conditions and/or excess heating of product [42].

Therefore, the Codex Alimentarius Standard commission has set the maximum limit for HMF in honey at 85 mg/ kg to ensure that the product has not undergone extensive heating during processing and is safe for consumption [43].

Therefore, HMF is considered one of the main quality indexes of different commercial whey proteins, molasses and many other products [44].

In most previous studies, HMF has been reported to have negative effects on human health, such as cytotoxicity toward mucous membranes, the skin and the upper respiratory tract; mutagenicity; chromosomal aberrations; and carcinogenicity toward humans and animals [45]. However, in more recent extensive studies, HMF has been proved to have a wide range of positive effects, such as antioxidative, anti-allergic, anti-inflammatory, anti-hypoxic, anti-sickling, anti-hyperuricemic effects [46].

Table 1: Chemical composition and caloric value of date sheets (mg/100 g dry weight)

	Date sheet on dry basis		
	Date sheet (Control)	Date sheet plus 5% sweet potatoes	Date sheet plus 10 % sweet potatoes
Moisture	15.11 ± 0.02	15.22 ± 0.04	16.10 ± 0.05
Protein	03.50 ± 0.20	03.70 ± 0.30	03.71 ± 0.41
Fat	0.50 ± 0.11	0.52± 0.22	0.53 ± 0.32
Ash	2.45 ± 0.31	2.51 ± 0.39	2.54 ± 0.32
Fibers	2.55 ± 0.15	2.66 ± 0.19	2.68 ± 0.21
Total carbohydrates	77.40 ± 0.21	77.43 ± 0.28	76.00 ± 0.32
Available carbohydrates	74.85 ± 0.40	74.77± 0.40	73.32 ± 0.30
Reducing sugars	55.34 ± 0.81	55.44 ± 0.88	55.65 ± 0.91
Non-reducing sugars	25.32 ± 0.21	25.82 ± 0.27	25.95 ± 0.29
Glucose	25.41 ± 1.21	25.48 ± 1.26	25.55 ± 1.56
Fructose	32.10 ± 0.50	32.20 ± 0.52	32.90 ± 0.55
pH value	5.41±1.5	5.42±1.4	5.52±1.5
Acidity (%, as citric acid)	0.61±3.2	0.63±3.4	0.65±2.3
Total phenolic content (TPC) %	0.87 ±2.1	0.89±2.2	0.92±1.4
Total anthocyanin (TAC) (mg/100g)	0.955 ±2.1	0.977±2.3	0.842±2.1
Vit. C (mg/100g)	13.10 ±2.0	13.12±2.1	13.33±3.1
Total carotenoids (mg/100g)	0.395 ±1.4	0.399±1.5	0.452±1.3
HMF* (mg 100 g^{-1})	84.2 ±2.2	84.4±2.1	80.4±3.2
Caloric value K. cal / 100 g	317.88 ± 1.81	317.88 ± 1.81	312.12 ± 2.84

(%, n = 3 ± SD), Values are mean of three replicates ± standard deviation (SD), HMF * = Hydroxymethyl furfural

Table 2: Chemical composition of mineral of date sheets (mg/100 g on dry weight)

		On dry weight basis
Minerals		Date sheet with 10 % sweet potato
Macro-elements	Potassium (K)	184.39
	Calcium (Ca)	129.75
	Sodium (Na)	012.97
	Magnesium (Mg)	003.21
Micro-elements	Iron (Fe)	006.06
	Manganese (Mn)	001.16
	Phosphorus (P)	002.21
	Zinc (Zn)	001.27

On the other hand, phytochemical composition such as total phenolic content (TPC), total anthocyanin content (TAC) and total carotenoids (TC) of Tamr El-Dein Sheets (TDS) were shown in Table (1). From Table (1), there wasn't a great difference in total phenolic content (TPC) for all samples of Tamr El-Dein Sheets, where as it ranged from 0.89±2.2 to 0.92±1.4 mg/kg.

Bioactive compounds, such as phenolic and flavonoid compounds, are found in ample quantities in date fruits and these compounds are known for their nutritional and health potentials as antioxidant, antimicrobial, antihyperlipidemia, antidiabetic and anticancer components [47].

Values presented in Table (1) indicate that date sheet has a high pH value and low acidity (in citric acid), which make it very suitable media for microorganisms. Sheets has attractive colors and good contents of sugars, dietary fibers, vitamin C and a high sugar/acid ratio [48].

On the other hand, date sheet (Table 2) contained significant amounts of minerals. The potassium concentration was the highest (184.39± 0.12 mg/100 g dry matter), followed in descending order by calcium (129.75± 0.10mg/100 g), Iron (Fe) 006.06 ± 0.04, magnesium (003.21 ± 0.00 mg/100 g), phosphorus (002.21± 0.03mg/100 g), furthermore, sodium (012.97± 0.10mg/100 g) and Zinc 001.27± 0.00 with date sheet with 5% sweet potato.

Our results are in close agreement with those reported by many other studies, which show that dates fresh generally, contain suitable concentrations of calcium, potassium and phosphorus, these elements are important for metabolism in human cells according to Abo-Hassan and Bacha [49], besides, magnesium and calcium are essential for healthy bone development and for energy metabolism and iron is essential for red blood cell production.

Table 3: Amino acid content of date sheet 10 % sweet potato (mg/100 g dry weight)

Amino acid (mg/100 g)		Date sheet 10 % sweet potato
Non essential amino acids (NEAAs)	Alanine (Ala)	84
	Arginine (Arg)	95
	Aspartic (Asp)	188
	cysteine (Cys)	–
	Glutamic (Glu)	207
	Glycine (Gly)	86
	Tyrosine (Tyr)	–
	Proline (Pro)	88
	Serine (Ser)	60
Essential amino Acids (EAAs)*	Histidine (His)*	28
	Isoleucine (Iso)*	48
	Leucine(Leu)*	59
	Lysine(Lys)*	76
	Methionine (Met)*	29
	Phenylalanine (Phe)*	49
	Threonine (Thr)*	59
	Tryptophan (Try)*	47
	Valine (Va)*	67

Value are mean of two replicates, * = essential amino acid

Elleuch, *et al*. [50] stated that, the high potassium and low sodium contents in date fruits were found to be useful for people suffering from hypertension.

Additionally, in unique study by Nadir *et al*. [11] the students suffering from anemia disorders took 10 gm date sheet twice daily before breakfast and before dinner this lead to a rise of iron to 83.6± 6.669 after ingestion, while before was 33.242± 2.57, plus ferritin raised to 21.68± 3.983 after ingestion date sheet, while before was 8.372± 1.263. This showed iron enhancement may prompt a beneficial outcome on weak subjects. Additionally, fundamental or practical iron is significant for the digestion of the body and is the dynamic component for development of the heme of hemoglobin, myoglobin and that of the catalase catalyst [51, 52].

Likewise, Shashley and Green [53] and Weight [54] demonstrated that date sheet actuated an improvement in all parameters tried over iron (hemoglobin, O2, beat rate and ferritin).

The superseding impact of date sheet over conventional iron salts, might be because of the added substances found in the event of date sheet contrasted with customary iron salts, which are iron, vit C, Zinc, Phytochemical synthesis, as shown in Table (1) in the current study, they all are considered as cancer prevention agents, that all together increment the ingestion of iron from date sheet in the stomach-related framework, which thus have a fast impact in relieving weakness, through the quick development of hemoglobin and increment iron fixation and ferretin. These factors also help in improvement of O2 transport to dynamic muscles, prompting higher wellness and physical execution.

On the other hand, the recommended daily intake of both Iron and zinc are 8 mg/day plus manganese 2 mg /day for men and women; thus, our date sheet (Tamer El-Dein) with approximately 100 g per day can be considered as a good source of these elements and cover 90 % from our daily requirements (Recommended Dietary Allowances, RDA) according to WHO [55].

Date sheets contain essential amino acids as shown in Table (3), which the body cannot make and must be provided in the diet [56]. Analysis of the amino acid composition by high-performance liquid chromatography revealed the presence of 16 amino acids. Mainly, date sheet extracts contained high concentrations of glutamic, aspartic acid were 207 and 188 mg /100, respectively as acidic amino acids, it followed by arginine as basic amino acid, proline, glycine and alanine as aliphatic amino acids, the results also demonstrated that the concentrations of methionine, histidine, tryptophan and isoleucine were relatively small, furthermore a no detect concentration of tyrosine and cysteine. Although the amount of protein was too small for date sheet to be considered an important nutritional source, date sheet contain essential amino acids.

The essential amino acids (EAAs) were 40 % from total amino acids (about 481 mg / 100 gm, such as histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine as shown in Table (3). On the other hand, a disappearance of cysteine of date sheets might return be attributed to destruction during the drying by temperature, as reported by Alshowiman and Ba Osman [57].

Table 4: Texture profile analysis (TPA) of Barhi date sheets

Texture parameters	Date sheet (Control)	Date sheet with 5% S.P.	Date sheet with 10% S.P.
Hardness cycle 1 (g)	210.74 ± 6.50[a]	211.84 ± 8.51[a]	232.16 ± 24.31[a]
Adhesive force (g)	-100.33 ± 10.19[b]	-102.83 ± 12.29[b]	-127.16 ± 16.98[a]
Gumminess (g)	151.51 ± 8.19[a]	159.61 ± 9.29[a]	173.23 ± 14.33[a]
Adhesiveness (g.s)	-2, 115.03 ± 510.41[b]	-3, 145.06 ± 515.61[b]	-3, 870.25 ± 449.41[a]
Cohesiveness	0.56 ± 0.03[a]	0.76 ± 0.06[a]	0.75 ± 0.08[a]
Chewiness (g.mm)	2, 666.63± 341.21[b]	2, 843.64 ± 344.27[b]	2, 888.76 ± 307.23[a]
Springiness (mm)	15.60 ± 1.42[a]	18.80 ± 1.52[a]	17.69 ± 0.78[a]
Area cycle 1 (g.s)	6, 901.33 ± 345.15[a]	7, 101.35 ± 355.16[a]	6, 792.29 ± 583.24[a]
Area cycle 2 (g.s)	4, 661.23 ± 341.41[a]	4, 691.27 ± 351.51[a]	4, 212.56 ± 368.13[b]
Hardness cycle 2 (g)	203.21± 8.88[a]	205.31± 9.88[a]	217.18 ± 17.72[a]

S.P.= sweet potatoes, Values followed ± are the standard deviation, each data is the average of 3 replicates, the same upper letters are not significant at $P < 0.05$

There are three EAAs which have special characteristics (leucine, isoleucine and valine) and are called branched chain amino acids (BCAAs). The EAA and BCAA must be provided in the diet. There are different studies on the benefit of these amino acids in sports performance and in different sports such as stimulation of muscle protein synthesis, prevention of muscle protein breakdown and reduction of markers of exercise-induced muscle damage plus reduction of feelings of fatigue, furthermore, the main observed effect of AAs and BCAAs in sports is related to the anabolic response in muscle recovery or post exercise nutritional recovery.

These data are tabulated in Table 3, there were significant differences among the date sheets.

Besides, the content of Fe in 100 g of the date sheets covered 11.07% of FAO/WHO daily allowance. Also, the prepared date sheet was rich in vitamins A and C, their contents in 100 g of meal covered FAO/WHO [58] daily requirements. Therefore, results indicated that the prepared date sheet contained a complementary amino acid profiles, minerals, vitamins (C and A) and 15% of total calories.

For instance, the recommended dietary allowances for children (7-9 year) were 700 mg calcium, 6.9-11.9 mg iron, 6 mg zinc/day. While, the recommended vitamin allowances were 500 µg vitamin A, 35 mg vitamin C and protein intake 0.75 g/kg of body weight [59, 60]. Hence, date sheet could appropriate to participating in the Egyptian school meal programs.

Texture Profile Analysis of Barhi Date Sheets: The TPA of date sheets is shown in Table 4. Hardness cycles 1 and 2, gumminess, cohesiveness, springiness and area cycle 1 were not significant between date sheets samples analyzed in this study. Among analyzed parameters adhesiveness, chewiness, area cycle 2 at $p < 0.05$ and adhesive force at $p < 0.01$ were significant. Cohesiveness, springiness and area cycles 1 and 2 were higher for date sheets 5 % S.P. than date sheet 10% S.P compared with control. While, the adhesive force and adhesiveness obtained lower. Rahman and Al-Farsi [61] reported a significant different value for date flesh. However, cohesiveness and springiness values obtained here were very close to those evaluated by Ahmed and Ramaswamy [62]; Yao *et al*. [63, 64] for date sheets gumminess, cohesiveness, springiness, adhesiveness, chewiness.

As conclusion, these parameters are very important for determining the overall quality and consumer palatability of products. These parameters would help the process industries to design new food products, machineries and quality control. According to the cohesiveness, springiness, area cycles 1 and 2 and total positive area were higher for sweet potato 5 % date sheet than sweet potato 10 % and control date sheet, while adhesive force, adhesiveness, gumminess, chewiness, hardness cycle 2 and mean load were observed low.

Overall, triplicate results of force-deformation spectra upon compression analysis were very similar at each sheet.

On the other hand, the quality attributes measured were hardness (H), cohesiveness (CO), adhesiveness (A), springiness (S), resilience (R) and chewiness (CH). Hardness, chewiness and resilience increased exponentially with the decrease of moisture content, whereas adhesiveness, cohesiveness and springiness increased exponentially with the decrease of moisture content and showed a maximum value at critical moisture content 15.11 %.

By other concept, two factors: elastic nature (hardness, adhesiveness and chewiness) and plastic nature (cohesiveness, resilience and springiness) can explain the instrumental TPA attributes of dried sheets and as a function of moisture content.

For these causes, the trends or curvature above and below the peaks are different for cohesiveness, adhesiveness and springiness.

Hence, the rheological properties are considered to be important for process design and development, to evaluate the sensory properties, as an analytical tools to provide fundamental insights into the structural organization of food and they play an important role in heat transfer. This is important in the food industry, to formulate and develop high quality products whose quality can be maintained throughout processing, distribution and storage [66].

Besides, texture profile analysis suggests that the Barhi date of sheet (Tamr El-Dein) belongs to the same family of products with the apricot sheet (Qamer el-Dein) in terms of the attributes of hardness, firmness and adhesiveness. Products were aged up to thirteen weeks, with results demonstrating that the textural quality remains stable throughout the storage period.

In addition, correlation of chemical characteristics and composition of the fabricated products with textural results was shown to be extremely encouraging of Barhi date sheet as shown in Fig. (1). These promising developments will encouraged us futuring to fully develop an inexpensive and more nutritious sheet by mix with another materials, to wide of the applications of date sheet.

The plasticity and adhesiveness of Barhi date sheet were fully investigated via a trained sensory panelists that allowed handshaking of the consumer's perception to instrumental textural attributes.

One of the objectives of this work was to reproduce the textural properties of a good quality sheet using as raw material (sweet potato plus Barhi date).

The parameters of firmness, hardness, brittleness and adhesiveness were identified as indicative of textural quality. This is a particular relevant temperature since it reflects the storage conditions of the product in the market.

Addition of sweet potato reinforced the structure of the material at room temperature.

The stress-strain curve is reminiscent of a thick viscous foodstuff rather than a plastic dispersion [67]. The final product remains relatively soft.

The soft, consistency of our sheets contrasts dramatically with the results obtained for the commercial product. The excessive yield stress of the commercial material reflects upon its adhesiveness, which is virtually zero. On the other hand, our formulations exhibited considerable adhesiveness at ambient temperature (e.g., 140.2 N mm).

Clearly, the overall structural relaxation was maintained at ambient temperature. Furthermore, no significant difference was noticed between the sheets in terms of these quality criteria.

TPA properties of date sheets are considerable interest in the development of date sheet products for technological and marketing reasons - as powerful tool into understanding molecular structure changes [68, 69].

They provide the information necessary for the optimum design of unit processes; contribute to the quality control in both manufacturing processes and final product; limits of the acceptability and the field of application of a new product.

There were a variations between the rheological properties of the date sheet with 5 and 10 % potatoes as a plotted in Table (4), this may be due to the changes occurred for some components during dehydration process which consequently changed the hydrocollidal system.

Some foods, especially starches and proteins, undergo changes/modifications during processing, resulting in a viscous dispersion, solutions or gel, depending on the temperature and concentration [70, 71].

In addition, the dynamic shear rheological properties revealed dominance of the elastic properties over the viscous properties and the dispersions became more elastic with increasing concentration.

The elastic properties could be attributed to the intermolecular association of amylase chains leaching out from the granules. Based on the dynamic data, 5-10% dispersions of sweet potato displayed weak gel like behavior that could be explained by the association of ordered chain segments, giving rise to a weak three-dimensional network.

Color Attributes: Color attributes were 27.77, 2.65 and 1.77 of *L*, a*, b** for Barhi date sheet 5 % sweet potatoes, while were 27.86, 2.84 and 1.85 of *L*, a*, b** for Barhi date sheet 10 % sweet potatoes compared with control sheet (low values). Furthermore, color index (O.D. at 420 nm) were 0.974 and 0.981 for Barhi date sheet 5 and 10 % sweet potatoes, respectively; compared with control sheet (low value).

Sensory Evaluation of Barhi Date Sheets (Tamr El-Dein): Organoleptic testing of Barhi date sheets was carried out for taste, odor, color, texture and overall palatability. Results in Table (6) show that, Organoleptic attributes the Barhi date sheets (Tamr el-Dein) had the highest scores for color, taste, odor, color, texture and overall palatability, compared with commercial product of

Table 5: Physical characteristics of Barhi date sheets:

	Characteristics			
	Color attributes			
Sample	*L**	*a**	*b**	Color index (O.D. at 420 nm)
Control Barhi date sheet	26.66±3.1[a]	2.55±2.2[a]	1.57±2.0[a]	0.964
Barhi date sheet 5 % sweet potatoes.	27.77±2.1[a]	2.65±2.4[a]	1.77±2.1[a]	0.974
Barhi date sheet 10% sweet potatoes.	27.86±2.2[a]	2.84±2.3[a]	1.85±2.3[a]	0.981

Value = mean ± SD. Value in the same column with different superscript letter differ significantly at 5% probability level

Table 6: Sensory attributes of Barhi date sheets (Tamr El-Dein)

	Properties					
Treatment	Taste (10)	Aroma (10)	Color (10)	Texture (10)	Overallpalatability (10)	Average
Control Barhi date sheet	8.8[a]	8.1[a]	6.42[c]	8.10[a]	7.82[a]	7.848
Sheet plus 5% sweet potato	9.[a]	8.4[a]	6.45[c]	8.21[a]	8.31[a]	8.074
Sheet plus 10 % sweet potato	9.2[a]	8.6[a]	7.44[b]	8.55[a]	8.42[a]	8.442

Means having the same letter within each property are not significantly different at $p \leq 0.05$

Table 7: Microbial analysis of Barhi date sheets:

	Microbiological parameters (log CFU/gm)			
Name of sample	TABC	TCC	*E. coli*	Yeast & Molds
Control sheet	<1.0*	<1.0	<1.0	3.0
Date sheet plus 5% sweet potato	<1.0*	<1.0	<1.0	3.0
Date sheet plus 10 % sweet potato	3.0	<1.0	<1.0	<1.0

* <1.0: below detection limit; lowest detection limit 1.0 Log CFU/gm, TABC = total aerobic bacterial count, TCC = Total Coliform Count

Qamer el-Dein (trade mark- Al ahlam Qamer Al-Dein dried apricot sheets 400g). Where, it had the highest overall palatability (around 8.00) scores.

On the other hand, sheets Qamr el-Dein had the lowest overall palatability scores (7.7) scores and the tested sensory attributes of Tamr El-Dein (Barhi date sheets) were with according to the Egyptian standards, [35] for apricot sheets, the moisture content of date sheets was within the limits of this standard (<18%), also these results are in agreement with those reported by El-Nakhal *et al.* [36].

Date sheets prepared with 5 and 10% sweet potatoes had moisture contents 15.84 ± 0.04 and 17.22± 0.05 respectively.

Moreover, results presented in Table (6) revealed that sheets containing 10% sweet potato had the highest scores of color and total acceptability compared with sheet 5% sweet potato and there were no significant differences ($p \leq 0.05$) between the sheets containing 5 and 10 % potatoes in aroma and texture.

The plasticity and adhesiveness of Barhi date sheets were fully investigated via a trained sensory panelists that allowed handshaking of the consumer's perception to instrumental textural attributes.

In general, we can say that date sheets or slob could be produced with added sweet potato up to 10% with good sensory characteristics, finally, average was 8.074 and 8.442 for 5 and 10% sweet potato, respectively.

Furthermore, Tamer Al-dein is traditionally served thick and cold, all of which are crucial after a long day of fasting(Ramadan month). It is especially fortifying and a good source of energy, electrolytes and hydration.

Microbial Analysis of Barhi Date and Sheet Shelf Life: The low TVC of Barhi dates is likely due to the no pollution with flaw sheet during making date sheet and lowering moisture, high of TSS, in addition positive effect of phenolic compounds content of end product thereby increasing the disruption rate of microbial cells and then causing the inactivation of microbes [72].

Results of Table (7) revealed that samples of Barhi date sheets from 5, 10 % sweet potato and control sheet were after microbiological quality analysis were satisfactory level (<1.0 log CFU/ gm and 3.0 log CFU/ gm) of aerobic bacteria and, yeasts and molds, E.coli and TCC according to the guidelines provided by WQAS [73].

This is return to high sugar content and antimicrobial components like tannins (around 2.5%), which is inhibitory to a certain load of both bacteria and fungi, these levels of microbial contamination (Table 7) are clearly indicating good hygiene and handling practices during processing of the date sheet [74, 75].

Conclusion and Future Directions: In the current study, assessment the chemical, nutritional value, rheological properties and microbiological characteristics of product along with their health benefits and the potential use of dates sheet or roll. We also demonstrated that the addition of dates to energy nutrition bars resulted in a positive effect on consumer acceptability and liking as well as good sensory attribute ratings and high nutritional value.

The dates sheets contain high natural sugars, fiber and minerals content with a deliciously sweet taste, in addition to other nutrients needed by athletes, young, liver disease and as functional food for Anemia disease. Besides, potassium and low concentration of sodium render the date sheet to be valuable in production of special juices and drinks for people who suffering from hypertension.

Moreover, due to their abundance of natural sugars, dates are an essential ingredient in the preparation of energy nutrition rolls in order to provide the needed energy for physically active individuals (natural energy beverage), especially for Muslimism as a drink delicious, nutritious, healthy, besides, prepare easily it as during in Ramadan month for all ages.

Date sheet could thus be used as an alternative to traditional nutrition bars and snacks that are currently available in the market. Newly developed sheet or rolls has the potential to be marketed as a nutritional fruit rolls, ready-to-eat snack, or dessert and this would also help food manufacturers and customers to think about nutrition ingredients from a different perspective.

In future, further work is reward to optimize and standardize the processing steps in order to ensure consistency with Egyptian standardization characteristics. Additionally, work is also needed in order to determine consumer acceptability of different flavors with a wider range of addition material choices. Plus, the shelf-life stability of this new product in order to ensure safety and the highest quality.

All sheets were microbiologically stable during storage for three months. Likewise, date sheets quality can be development using new processing techniques and additives. To our knowledge, this is the first time to extensively report on Barhi date sheets and to the different properties, plus sensory evaluation of end product.

Finally, it could be concluded through this study, that it is economic, practicable and successful, it produce dehydrated sheets from Barhi date with sweet potato as new untraditional product .That aforementioned product possessed high nutritional value, aver and above, high palatability.

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