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# Effect of Enzymatic Extraction Method on Quality Parameters and Sensory Acceptability of Date Dibs Produced from Second Grade Dates

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**Abstract**

This study was conducted to investigate the effect of enzyme extraction methods on quality parameters of dibs (date syrup) produced from the two varieties of second grade dates. Different concentrations of cellulase enzyme 0.5 and 1.0% were used. The efficiency of date dibs extraction prepared from siwi and sakkoty date (water : pulp) in proportions (2:1, 3:1 and 4:1) was done. The physicochemical and phytochemical characteristics of dibs were performed. The results showed non-significant differences between both variety from total and reducing sugars contents. Sakkoty date was characterized by significantly higher amount from crude fat, total carbohydrate, total flavonoids and antioxidants contents, while siwi date contained significantly higher amounts from moisture and total acidity contents. There were no significant differences between both date varieties in the content of total phenolic compounds. Enzyme extraction methods showed an increase in total sugar content and the total sugar percentage increased with the increasing in the enzyme percentage at the same extraction conditions. The sakkoty date dibs had the highest sugar content compared to the siwi date dibs in all treatments except for the date dibs prepared by (2:1). For the same cultivar, with an increase in the enzyme percentage, an increase in the contents of total phenols and total flavonoids occurred at the same extraction conditions. The sakkoty date dibs had the highest contents from total phenols and total flavonoids compared to the siwi date dibs for all treatments. The date dibs treated with cellulase enzyme also showed the highest scores of sensory evaluation in all treatments compared to the control date dibs except for the treatment (4:1).

***Keywords***: Siwi date, Sakkoty date, date dibs, physico-chemical, and phytochemical.

## Introduction

The date fruit (*Phoenix dactylifera*) is one of the oldest cultivated tree crops, as it has been cultivated for thousands of years (**Tang *et al*., 2013**). The date palm is cultivated in arid and semi-arid regions of the world, including the Arab Gulf states. The date palm played an important role in the economic and social life of the inhabitants of these regions (**Al-Farsi *et al*., 2007 and Al-Jasser, 2010**).

The stages of ripening dates include several stages until they reach full maturity, these stages include Habab Ouk, Kimri, Khalal or Besser, Rutab, and Tamer. The last stage of maturity is the Tamer stage, where the fruits are brown or black, and the fruit has relatively higher sugar content and lower moisture content (**Hussain *et al*., 2020**).

Global production has increased significantly during the past thirty years. The Arab countries alone produce about 74.5% of the total global production of dates. Egypt is the largest producer of dates in the world since 1974, where the average productivity is higher compared to other countries. Egypt considered as the first country of the top ten date producers in world (1, 617, 30/1000 tons), followed by Algeria (1, 086, 9/1000 tons) and Saudi Arabia (728, 2/1000 tons) (**FAO, 2018**).

In Egypt there are many varieties of dates, which differ greatly in their growth and productivity characteristics. These varieties are spread geographically in certain areas in the Nile Valley and the oases of the Eastern Desert. Soft varieties in Egypt represent 43.5%, semi-dry 19% and dry 2.5% and range the production quantity of a single palm tree ranges from 75 to 150 kg, which is the highest productivity among all Arab countries. (**Abd El-Baky, 2012**). The soft varieties (Zaghloul, Samany, Bint-Aicha, Hayany, Amhat, etc.) are grown in the maritime subtropical district (the Nile Delta and the part of Giza governorate). The semi-dry dates (Amry, Aglany Saidy "Siwy" and Alhijazy) are grown in the desert subtropical, in the Nile Valley and the desert oases. In the desert tropical region, Aswan, only the dry varieties (Garguda, Gondaila, Sakkoty, Malkabi, Bartamuda, Degna, etc.) are grown **(Al-Khayri *et al*., 2015)**. Date fruits have high antioxidant properties due to their high content of phytochemicals such as polyphenols and carotenoids, vitamins such as ascorbic acid and tocopherols (**Al-Farsi *et al*., 2018; Al-Shwyeh, 2019 and Hussain *et al*., 2020).**

Date has several utilizations in food production, date dibs one of those. Date dibs has been utilized as a substitute for sugar in some food products such as ice cream, caramel color, chocolate products, cookies, bread, pan bread, fruit juice, beverages,

cakes, muffins, biscuits, and pies (**Bedeir, 2014**).Also, it's used in the production of baker's yeast (*Saccharomyces cerevisiae*) and new drinks by using milk (**Al-Jasass *et al*., 2010 and Ardali *et al*., 2014).** Making date molasses from fruits is a way to preserve fruits and reduce transportation and storage costs, and it can open new areas for the use of date fruits. Giza Governorate produced about 76772 tons; most of them were produced from Baharia oasis region, where its production reached 35 thousand tons (**Agri. Res. Cen., 2016**).

Date dibs are produced in two different ways: 1- at domestic or village by extraction and boiling down of the date juice. 2- On a semi or full industries scale; the process consisting of extraction, clarification and concentration of the date juice (**Al-Farsi *et al.*, 2018**). In date's dibs industry, date fruits flesh is mixed with water and heated at over 70°C for one hour or more in the extraction process; resulting in destroying some nutritive and health-promoting components, and causing the darkness of the final product's color (**Ganbi, 2012**). Cellulolytic and pectinolytic enzymes are used for the fruit processing industry to increase the extraction yield, soluble dry matter reducing sugars, and titrable acidity of the products (**El-Sharnouby *et al.*, 2014**). In the literatures, only few works have been reported regarding the effect of hydrolytic enzymes in the quality of date dibs (**Al-Hooti *et al.*, 2002**). The low-quality dates are a rich source of carbohydrates (73.3-89.55 g/100 g dry matter) composed mainly of sugars and dietary fibers and is safe for human consumption (**Abbès *et al.*, 2011**). The production of high-quality date dibs using enzymatic treatment could give high value addition to the low-quality dates (with hard texture). (**Ramadan *et al.*, 2018**). The aim of the study was to produce date dibs from Siwi and Sakkoty date by enzyme extraction methods and studying their physico-chemical and phytochemical properties.

## 2. Materials and methods:

### 2.1. Materials:

Second grade of Siwi dates variety (semi-dry) at tamr stage and Sakkoty (*Phoenix dactylifera* L.) was purchased from local market in Benha city, Kalyobia Governorate. Cellubrix® L was obtained from Novozyme (Denmark) representative in Egypt and stored at 4°C. The used solvents, DPPH (2,2-diphenyl-1-picryhydrazyl), gallic acid and Folin-Ciocalteu were obtained from Sigma Company. The other used chemicals were purchased from El-Nasr pharmaceutical chemicals Co., Egypt.

### 2.2. Enzymatic juice extraction:

Date fruit were cleaned pitted and the flesh was cut into small pieces and kept refrigerated in sealed polyethylene bags for processing and analyses. The pitted date fruit was homogenized with water (pulp: water ratio of 1:2, 1:3 and 1:4 (wt./wt.) using a food blender (MJ-176 NR, National Co. Ltd., Japan) for 4-5 min until a homogeneous fruit pulp was obtained. The pH of pulp: water mixture was adjusted by 0.1 N hydrochloric acid or 0.1 N sodium hydroxide. Cellubrix® L was added alone and in combination. To the pulp at ratios of 0, 5 and 1.0 % for all treatments expect the control samples. The pulp and enzyme mixtures were incubated at 40°C for 24 hours. The incubation temperature was controlled using a water bath. At the end of incubation, the enzyme was inactivated by heating the mixture at 90°C for 3 min. The treated juices were centrifuged at 16000 ×g for 15 min and the supernatant was separated. According to the method of **Bahramian *et al.*,. (2011)**.

### 2.3. Production of date dibs (Dibs):

Samples were blended with water at water/date ratio of 2:1, 3:1 and 4:1 (*w/w*) then; known weights of the obtained extracts were concentrated as follows; (1) The obtained extract by heating in water bath at 80°C for 90 min, was bleached by using granular activated charcoal and concentrated under vacuum using rotary evaporator at 60°C until the total soluble solids about 72%. (2) The obtained extracts by using 0.5 and 1.0% Cellubrix® L was concentrated using the same power levels. The produced date dibs (dibs) was packed in sealed glass bottles and kept refrigerated for chemical analysis, microbiological evaluation and sensory evaluation.

### 2.4. Proximate analysis*:*

Moisture, total soluble solids, total acidity, crude protein, pH, lipid, total sugars and reducing sugars and ash contents were determined according to the **AOAC (2012)** while,, total carbohydrates were calculated by difference.

### 2.5. Determination of total phenolic compounds (TPC):

Total phenolic compounds (TPC) were determined by the Folin- Cicalteau method as described by **(Singleton *et al*., 1999),** with minor modifications. Gallic acid was used for calibration curve. Results were expressed as mg Gallic acid (GAE).

### 2.6. Determination of total flavonoids :

Total flavonoids content was determined by using aluminum chloride calorimetric method, as described by **(Chang *et al*., 2002).** The results were expressed as catechin equivalents (CE) in mg/100g of dried extract.

### 2.7. Determination of antioxidant activity:

The antioxidant activity of free and bound phenolic extracts was measured by using DPPH scavenging as previously described by (**Hung and Morita, 2009**). The extracted solution (0.1 ml) was mixed with 3.9 ml of 0.075 mM DPPH. The mixture was left in the dark at room temperature for exactly 30 min. The absorbance was then measured using a spectrophotometer (6405 UV/VIS –Jenway-England) at 525 nm. The blank was made by replacing the extracted solution by methanol (0.1 ml) and then measured at T = 0.

The DPPH scavenging was calculated according to the following equation:

**% DPPH scavenging= [Abs (To) - Abs (T30) ×100]/Abs (To)**

Where: Abs. (T= 0) is absorbance of DPPH radical and methanol at T = 0 and Abs. (T=30) is absorbance of DPPH radical and extracts at T= 30.

**2.8. Sensory evaluation:**

Date dibs was organoleptically evaluated for its taste, color, texture, flavor and overall palatability according to the method of **Faridi and Rubenthaler (1984)** by ten panelists using a numerical basis of one to ten (where, one = very bad and 10 = excellent).

**2.9. Statistical analysis:**

The statistical analysis was carried out using one-way analysis of variance (ANOVA) under significant level of 0.05 for the whole results using the statistical program CoStat (Ver. 6.400) according to **Steel *et al.*, (1997)**. To ascertain the significant among means of different samples, LSD test was applied.

## Results and discussion

**3.1. Physico-chemical prosperities of different varieties of date fruit:**

Chemical composition of different varieties of date fruit are presented in Table (1). The obtained results revealed that siwi date contained significant high moisture content and total acidity being 17.25 and 0.49%, while, sakkoty date had significantly lower moisture content and total acidity being 15.53 and 0.30%. Furthermore, the highest value of crude protein was recorded for sakkoty date followed by siwi date being 2.09 and 2.06%, respectively. On the other hand, sakkoty date had significantly the high lipid and total carbohydrate contents and pH values followed by siwi date being 1.90, 1.15% and 78.53, 77.31% and 5.82 and 5.34, respectively.

Statistical analysis did not appear any significant differences in ash and protein contents between two varieties of dates, which contained 1.74, 1.65 % and 0.49 %, ând 0.30% of siwi and sakkoty date, respectively. These results are in agreement with **Selim *et al.*, (2012)** who found that moisture content, protein, fat, and ash of siwi date were 18.74, 1.72, 1.21, and 2.05%, respectively and **Hashem *et al.*, (2017)** who found that, moisture content, crude protein, ash, total acidity and lipid of siwi date at tamr stage was 18.6, 2.76, 0.83, 0.16 and 1.08%, respectively. Differences in chemical composition of date among the varieties grown in the same country, or different regions, can probably be attributed to the differences in time of harvest, post-harvest treatments, and the use of fertilizers (**Habib and Ibrahim, 2009**).

Also, Table (1) shows that there are no significant differences between two variety from total and reducing sugars contents, meanwhile, non-reducing sugar determined as sucrose content of two variety and the obtained results revealed that siwi date contained significant high amount of total non-reducing sugar 15.1%, while, sakkoty date had contained significant lower content being 11.78%. Such data are in line with those obtained by **Bellaouchi *et al.* (2017)** who found that total and reducing sugars of some date variety ranged from 45.5-66.2 % and 45.3–65.8 % ,respectively**,**while, data are different with those obtained by **Hashem *et al.*, (2017)** found that, total sugars, reducing sugars, non-reducing sugars of siwi date at tamr stage were 91.41, 86.78 and 4.63%, respectively.

**Table 1.** Physico-chemical properties of different date fruit varietie (on wet weight basis).

| Components | Date variety | |
|---|---|---|
| | Siwi | Sakkoty |
| **Moisture (%)** | **17.25±0.74$^{A}$** | **15.53±0.20$^{B}$** |
| **Ash (%)** | **1.74±0.11$^{A}$** | **1.65±0.16$^{A}$** |
| **Crude protein (%)** | **2.06±0.15$^{A}$** | **2.09±0.14$^{A}$** |
| **Ether extract (%)** | **1.15±0.21$^{B}$** | **1.90±0.14$^{A}$** |
| **Total carbohydrate (%)** | **77.80±0.84$^{B}$** | **78.83±0.78$^{A}$** |
| **Total sugar (%)** | **69.82±1.15$^{A}$** | **69.62±1.75$^{A}$** |
| **Reducing sugar (%)** | **53.83±0.54$^{A}$** | **57.22±3.82$^{A}$** |
| **Non-reducing sugar (%)** | **15.19±0.69$^{A}$** | **11.78±2.06$^{A}$** |
| **Total acidity (%)** | **0.49±0.01$^{A}$** | **0.30±0.04$^{B}$** |
| **pH value** | **5.34±0.18$^{A}$** | **5.82±0.17$^{A}$** |

A & B: There is no significant difference (P>0.05) between any two means, within the same row have the same superscript letter.

**3.2. Phytochemical compounds and antioxidant activity of different varieties of date fruit:**

Data presented in Table (2) show the total phenolic compounds (TPC) and, total flavonoids contents, moreover the antioxidant activity of the two-variety date. The obtained results show that there were no significant differences between both date varieties in the content of total phenolic compounds. Siwi and sakkoty date recorded 9.2 and 9.5 (mg/g TPC), respectively. Moreover, sakkoty date contained significantly higher amount from total flavonoid content (TFC) 0.53, followed siwi date 0.27 mg/g. Also, the results showed that sakkoty date had significantly higher level of antioxidant activity 34.43%, followed siwi date 25.94%. These results are agreeing with those previously reported by **El Sohaimy *et al.*, (2016),** who reported that the tamer stage (dry date) contains a considerable level of

phenolic content, water extract had 14.80 mg GAE/g sample but methanol extract had 10.31 mg GAE/g sample. The same trend was appeared in the study of **Saleh *et al.*, (2011).** This refer to the date palm may contain water-soluble phenolic compounds. The differences between these results may be due to the methods, the type of extracting solvent, the type of phenolic compound, and these in good agreement with **(Goli *et al.*, 2004 and Guo *et al.*, 2012)** who mentioned that the technique of phenolic and flavonoids isolation from a plant material, including the methods and type of extracting solvent, depends generally on the type of phenolic compound and the solvents.

**Table 2.** Phytochemical compounds and antioxidant activity of different date varieties (on wet weight basis**).**

| Components | Date variety | |
|---|---|---|
| | Siwi | Sakkoty |
| **Antioxidant (%)** | **25.94±0.99$^{B}$** | **34.43±4.06$^{A}$** |
| **Total phenolic compounds (TPC) (mg/g)** | **9.20±0.11$^{A}$** | **9.50±0.10$^{A}$** |
| **Total Flavonoids (mg/g)** | **0.27±0.09$^{B}$** | **0.53±0.06$^{A}$** |

A & B: There is no significant difference (P>0.05) between any two means, within the same row have the same superscript letter.

### 3.3. Physico-chemical prosperities of siwi date dibs produced with enzyme extraction methods:

Data illustrated in Table (3) show the chemical composition of siwi date dibs produced with enzyme extraction method. The obtained results show that there were significant differences in all components of siwi date dibs treatments.

Moisture content ranged from 19.66 to 23.47%, which was significantly higher in T2:1 with 1% enzyme, while it was significantly lower in T4:1 (control) without enzyme. Statistical analysis did not appear any significant differences in moisture content between two treatments T2:1 without enzyme and T4:1 with 1% enzyme, which contained 23.47 and 21.17 respectively.

Ash content of Siwi date dibs ranged from 1.25 to 1.67%, which was significantly higher in T2:1 with 0.5% enzyme, which it was significantly lower in T3:1 with 1% enzyme. Statistical analysis did not appear any significant differences in ash content between most treatments.

With respect to crude protein content in siwi dibs, it could be noticed that T2:1 with 0.5% and 1.0% enzyme, T3:1 with 1.0% enzyme and T4:1 with 1.0% enzyme had significantly higher content from crude protein, which contained 1.56 and 1.50%, 1.52% and 1.50%, respectively Statistical analysis did not appear any significant differences in crud protein content between most treatments.

Total acidity in siwi dibs ranged from 0.25% to 0.46%, significantly higher in T3:1 with 0.5% enzyme , while it was significantly lower in T2:1 with 0.5% enzyme statistical analysis did not appear any significant difference in total acidity between all treatments of T2:1 and T4:1 .

pH value of siwi date dibs ranged from 4.27 to 4.88, which was significantly high in T2:1 with 1.0% Enzyme, while it was significantly lower in T4:1 (Control) without enzyme. Statistical analysis did not appear any significant difference in total acidity between all treatments of T2:1 and T4:1.

Enzyme extraction methods showed slightly increasing in chemical composition (protein and ash contents), these results may be due to the increasing of enzyme ratio which led to increase in chemical composition (protein and ash contents). These results are in agreement with those obtained by **Abbès *et al.*, (2011)** who found that protein, ash contents, acidity and pH of date dibs (3: 1) treated with cellulase enzyme ranged from 1.03-1.50, 1.88-2.42, 1.22-1.29% and 3.07-3.20%, respectively, and **Ramadan *et* ., (2018)** who found that, ash content, total acidity and pH date dibs (4: 1) treated with cellulase enzyme ranged from 1.50-2.40, 0.90-1.59% and 5.0-5.14, respectively. Differences in nutrient composition of date dibs among the different varieties may be due to the nutrient composition of date fruits and variance of processing conditions (**Abbès *et al.*, 2013 and Hashem *et al.*, 2017**).

**Table 3.** Physico-chemical prosperities of siwi date dibs produced with enzyme extraction methods**.**

| Blend | Components | Moisture (%) | Ash (%) | Crude protein (%) | Total acidity (%) | pH |
|---|---|---|---|---|---|---|
| | **Cont. Siwi dips** | **21.16±0.66$^{c}$** | **1.51±0.05$^{abc}$** | **1.38±0.06$^{ab}$** | **0.27±0.00$^{b}$** | **4.86±0.04$^{a}$** |
| **2:1** | **0.5% Siwi dips (W1a)** | **22.02±2.95$^{b}$** | **1.70±0.03$^{a}$** | **1.50±0.10$^{a}$** | **0.25±0.02$^{b}$** | **4.80±0.03$^{ab}$** |
| | **1% Siwi dips (W1b)** | **23.47±0.41$^{a}$** | **1.67±0.02$^{ab}$** | **1.56±0.12$^{a}$** | **0.33±0.00$^{ab}$** | **4.88±0.01$^{a}$** |
| | **Cont. Siwi dips** | **18.99±0.25$^{f}$** | **1.32±0.07$^{abc}$** | **1.22±0.06$^{ab}$** | **0.34±0.02$^{ab}$** | **4.61±0.05$^{c}$** |
| **3:1** | **0.5% Siwi dips (W2a)** | **19.99±1.44$^{de}$** | **1.44±0.50$^{abc}$** | **1.48±0.42$^{ab}$** | **0.46±0.29$^{a}$** | **4.65±0.09$^{c}$** |
| | **1% Siwi dips (W2b)** | **20.66±0.65$^{cd}$** | **1.25±0.07$^{c}$** | **1.52±0.38$^{a}$** | **0.28±0.01$^{b}$** | **4.71±0.03$^{bc}$** |
| | **Cont. Siwi dips** | **19.66±1.19$^{e}$** | **1.46±0.14$^{abc}$** | **1.15±0.06$^{b}$** | **0.36±0.02$^{ab}$** | **4.27±0.15$^{d}$** |
| **4:1** | **0.5% Siwi dips (W3a)** | **20.37±0.54$^{de}$** | **1.29±0.05$^{bc}$** | **1.42±0.30$^{ab}$** | **0.32±0.02$^{ab}$** | **4.63±0.15$^{c}$** |
| | **1% Siwi dips (W3b)** | **21.17±0.53$^{c}$** | **1.49±0.44$^{abc}$** | **1.50±0.33$^{a}$** | **0.30±0.03$^{ab}$** | **4.47±0.05$^{c}$** |

a, b, c, …: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.

### 3.5. Total, reducing and non-reducing sugar of siwi date dibs produced with enzyme extraction methods:

Table (5) shows the total, reducing and non-reducing sugar contents of siwi date dibs produced with enzyme extraction methods. The obtained results show that there were significant differences in siwi date treatments in total, reducing sugar values TSS contents. The obtained results indicated that the treatment (2:1) siwi dibs control without enzyme treatment and treatment 2:1 with 0.5% enzyme had significantly higher total, reducing sugar and Tss, Moreover, the treatment (3:1) siwi dibs treated with 1.0 % cellulase enzyme had higher non-reducing sugar. In the same context, the results show that (3:1) Siwi dibs treated with 0.5 % cellulase enzyme had significantly lower total, reducing, and TSS. Meanwhile, the treatment (2:1) siwi dibs treated with 0.5 % cellulase enzyme had significantly higher total sugar content compared with all siwi dibs treatments treated with cellulase enzyme. These results are in agreement with those obtained by **Ramadan *et al.*, (2018)** who found that total, reducing, non-reducing sugar and TSS % of date dibs treated with cellulase enzyme differ on control date dibs.

**Table 4.** Total, reducing and non-reducing sugar of siwi date dibs produced with enzyme extraction methods.

| Blend | Components | Total Sugar (%) | Reducing sugar (%) | Non-Reducing sugar (%) | TSS |
|---|---|---|---|---|---|
| | **Cont. Siwi dips** | **75.35±0.93$^{a}$** | **65.79±1.67$^{a}$** | **9.56±0.75$^{ab}$** | **78.33±1.53$^{a}$** |
| **2:1** | **0.5% Siwi dips** | **73.86±2.14$^{ab}$** | **65.28±5.52$^{a}$** | **8.59±2.67$^{ab}$** | **76.67±1.53$^{ab}$** |
| | **1% Siwi dips** | **71.91±1.43$^{bc}$** | **63.36±0.96$^{ab}$** | **8.55±1.13$^{b}$** | **74.67±1.15$^{c}$** |
| | **Cont. Siwi dips** | **71.12±1.99$^{bcd}$** | **60.26±1.79$^{bc}$** | **10.86±1.18$^{ab}$** | **74.67±0.58$^{c}$** |
| **3:1** | **0.5% Siwi dips** | **68.48±2.05$^{d}$** | **58.73±4.09$^{c}$** | **9.75±2.07$^{ab}$** | **71.27±1.10$^{d}$** |
| | **1% Siwi dips** | **72.42±0.21$^{ab}$** | **61.12±1.28$^{bc}$** | **11.29±1.28$^{a}$** | **75.67±0.58$^{bc}$** |
| | **Cont. Siwi dips** | **68.67±3.37$^{cd}$** | **58.00±1.37$^{c}$** | **10.67±2.11$^{ab}$** | **71.67±0.58$^{d}$** |
| **4:1** | **0.5% Siwi dips** | **71.39±1.74$^{bcd}$** | **60.25±2.14$^{bc}$** | **11.16±0.39$^{ab}$** | **74.33±0.58$^{c}$** |
| | **1% Siwi dips** | **71.95±1.52$^{b}$** | **61.89±2.10$^{abc}$** | **10.06±1.25$^{ab}$** | **74.83±0.29$^{c}$** |

**a, b, c, …: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.**

### 3.4. Physico-chemical prosperities of sakkoty date dibs produced with enzyme extraction methods:

Physical and chemical prosperities of sakkoty date dibs produced with enzyme extraction method were conducted and data in Table (5), show that there were significant differences in sakkoty date dibs treatments in all components. The obtained results indicated that the treatment (4:1) sakkoty dibs control without enzyme treatment had significantly higher ash content, and pH values, moreover, the treatment (4:1) sakkoty dibs treated with 0.5 % cellulase enzyme had significantly higher acidity content. In the same context, the results show that (3:1) sakkoty dibs treated with 0.5 % and 1% cellulase enzyme had significantly higher moisture and crude protein contents, respectively.

Meanwhile, the treatment (4:1) controls sakkoty dibs, and treated with 0.5 %, 1% cellulase enzyme had significantly lower moisture content crude protein, pH values, respectively. Also, the treatment (3:1) control sakkoty dibs and treated with 0.5% enzyme had significantly lower acidity and ash contents, respectively.

These obtained results may be due the ratio of enzyme extract, and these data are comparable with those obtained by **El-Sharnouby *et al.*, (2009)** who found that, moisture, protein and ash of date dibs (2:1) treated with cellulase enzyme were 15.50, 1.58 and 1.80%, respectively and **Ramadan *et al.*, (2018)** who found that, ash contents, total acidity and pH date dibs (4:1) treated with cellulase enzyme ranged from 1.50-2.40, 0.90-1.59% and 5.0-5.14, respectively.

**Table 5.** Physico-chemical prosperities of sakkoty date dibs produced with enzyme extraction methods.

| Blend | Components | Moisture (%) | Ash (%) | Crude protein (%) | Total Acidity (%) | pH |
|---|---|---|---|---|---|---|
| | **Cont. Sakkoty dibs** | **22.73±1.07$^{c}$** | **1.69±0.12$^{a}$** | **1.36±0.10$^{bcd}$** | **0.35±0.02$^{b}$** | **3.86±0.04$^{c}$** |
| **2:1** | **0.5% Sakkoty dips (S1a)** | **21.81±2.19$^{d}$** | **1.65±0.03$^{ab}$** | **1.42±0.14$^{bc}$** | **0.32±0.02$^{bc}$** | **3.53±0.09$^{d}$** |
| | **1% Sakkoty dips (S1b)** | **21.17±0.97$^{e}$** | **1.48±0.06$^{bcd}$** | **1.53±0.12$^{ab}$** | **0.32±0.02$^{bc}$** | **3.42±0.05$^{d}$** |
| | **Cont. Sakkoty dips** | **22.92±1.97$^{bc}$** | **1.70±0.02$^{a}$** | **1.24±0.14$^{cd}$** | **0.26±0.02$^{d}$** | **3.17±0.06$^{d}$** |
| **3:1** | **0.5% Sakkoty dips (S2a)** | **24.88±0.59$^{a}$** | **1.45±0.16$^{cd}$** | **1.60±0.13$^{ab}$** | **0.30±0.02$^{c}$** | **4.85±0.08$^{a}$** |
| | **1% Sakkoty dips (S2b)** | **23.19±2.61$^{b}$** | **1.43±0.06$^{d}$** | **1.72±0.12$^{a}$** | **0.29±0.03$^{cd}$** | **4.16±0.09$^{b}$** |
| | **Cont. Sakkoty dips** | **21.02±0.41$^{ef}$** | **1.76±0.11$^{a}$** | **1.19±0.12d** | **0.35±0.02$^{b}$** | **4.96±0.39$^{a}$** |
| **4:1** | **0.5% Sakkoty dips (S2a)** | **20.84±0.13$^{ef}$** | **1.62±0.13$^{abc}$** | **1.33±0.14$^{bcd}$** | **0.41±0.02$^{a}$** | **3.15±0.05$^{e}$** |
| | **1% Sakkoty dips (S3b)** | **20.74±2.08$^{f}$** | **1.73±0.11$^{a}$** | **1.42±0.15$^{bc}$** | **0.35±0.02$^{b}$** | **4.16±0.10$^{b}$** |

a, b, c, …: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.

### 3.6. Total, reducing and non-reducing sugar of sakkoty date dibs produced with enzyme extraction methods:

Data illustrated in Table (6) shows total, reducing, non-reducing sugar and TSS of sakkoty date dibs produced with enzyme extraction methods. The obtained results show that there were a significant differences in total, and reducing, non-reducing sugar and TSS contents in sakkoty date dibs treatments. From the results, it can be seen that the treatment (4:1) sakkoty dibs treated with 1.0 % cellulase enzyme had significantly higher total and reducing sugar contents.

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In the same context, the results show that (2:1) sakkoty dibs treated with 0.5 % cellulase enzyme had a significantly lower total sugar and TSS contents. Meanwhile, the treatment (2:1) sakkoty dibs treated with 1.0% cellulase enzyme had significantly lower non-reducing sugar and TSS contents. These results are in agreement with those obtained by **Sharnouby *et al.*, (2009) and Abbès *et al*. (2011),** they found that total, reducing, non-reducing sugar and TSS % of date dibs treated with cellulase enzyme differ on control date dibs

**Table 6**. Total, reducing and non-reducing sugar of sakkoty date dibs produced with enzyme extraction methods**.**

| Blend | Components | Total Sugar (%) | Reducing sugar (%) | Non-Reducing Sugar (%) | TSS |
|---|---|---|---|---|---|
| | **Cont. Sakkoty dips** | **70.40±2.96$^{b}$** | **60.54±2.66$^{ab}$** | **9.37±1.03$^{ab}$** | **73.33±1.53$^{de}$** |
| **2:1** | **0.5% Sakkoty dips** | **69.71±1.29$^{a}$** | **59.18±0.21$^{b}$** | **10.00±1.08$^{ab}$** | **71.67±1.53$^{e}$** |
| | **1% Sakkoty dips** | **70.35±1.74$^{b}$** | **60.94±3.41$^{ab}$** | **8.94±1.68$^{b}$** | **73.67±1.15$^{cd}$** |
| | **Cont. Sakkoty dips** | **74.29±3.96$^{a}$** | **64.15±3.65$^{a}$** | **9.63±0.88$^{ab}$** | **77.33±0.58$^{a}$** |
| **3:1** | **0.5% Sakkoty dips** | **72.92±2.06$^{ab}$** | **61.32±2.05$^{ab}$** | **11.02±0.25$^{ab}$** | **75.43±0.93$^{b}$** |
| | **1% Sakkoty dips** | **72.76±1.32$^{ab}$** | **61.73±1.06$^{ab}$** | **10.48±1.74$^{a}$** | **75.33±0.58$^{bc}$** |
| | **Cont. Sakkoty dips** | **73.52±1.53$^{ab}$** | **61.53±1.93$^{ab}$** | **11.39±0.90$^{a}$** | **76.67±0.58$^{ab}$** |
| **4:1** | **0.5% Sakkoty dips** | **73.51±0.80$^{ab}$** | **64.06±2.63$^{a}$** | **8.98±1.87$^{b}$** | **76.00±1.00$^{ab}$** |
| | **1% Sakkoty dips** | **74.74±0.98$^{a}$** | **64.44±1.58$^{a}$** | **9.79±1.50$^{ab}$** | **77.50±0.50$^{a}$** |

a, b, c, …: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.

### 3.7. Phytochemical compounds and antioxidant activity of siwi date dibs produced with enzyme extraction methods:

Total phenols, flavonoids and antioxidant activity of siwi date dibs produced with enzyme extraction methods are presented in Table (7). The obtained results show that there were significant differences in siwi date dibs treatments in total phenols, flavonoids and antioxidant activity values. From results, it can be concluded that, siwi dibs in all treatments treated with cellulase enzyme had significantly higher total phenolic content and antioxidant activity compared with water extraction methods (control) except treatment (2:1). The treatment (3:1) siwi dibs treated with 5.0% cellulase enzyme had significantly higher total phenolic, flavonoids content and antioxidant activity. Meanwhile, the treatment (2:1) siwi dibs treated with 5.0% cellulase enzyme had significantly lower total phenolic content and antioxidant activity. Furthermore, siwi dibs in all treatments treated with cellulase enzyme had the highest total flavonoids compared with water extraction methods. These results are in agreement with those obtained by **Abbès *et al.*, (2011)** and **Abbès *et al.*, (2013)** who found that date dibs treated with cellulase enzyme showed the highest total phenols flavonoids and antioxidant activity compared with water extraction methods.

**Table 7.** Phytochemical compounds and antioxidant activity of Siwi date dibs produced with enzyme extraction methods.

| Blend | Components | Total phenolic compounds (mg/g) | Total flavonoids (mg/g) | Antioxidant activity (%) |
|---|---|---|---|---|
| | **Cont. Siwi dips** | **3.96±0.09$^{c}$** | **0.80±0.01$^{e}$** | **56.96±1.29$^{c}$** |
| **2:1** | **0.5% Siwi dips** | **2.79±0.55$^{d}$** | **0.99±0.09$^{d}$** | **55.99±4.00$^{c}$** |
| | **1% Siwi dips** | **2.93±0.40$^{d}$** | **1.09±0.19$^{cd}$** | **58.71±3.69$^{c}$** |
| | **Cont. Siwi dips** | **3.73±0.11$^{c}$** | **1.00±0.12$^{d}$** | **67.18±1.50$^{ab}$** |
| **3:1** | **0.5% Siwi dips** | **5.20±0.38$^{a}$** | **1.43±0.06$^{a}$** | **70.55±4.47$^{a}$** |
| | **1% Siwi dips** | **5.18±0.59$^{a}$** | **1.21±0.07$^{b}$** | **69.28±3.07$^{a}$** |
| | **Cont. Siwi dips** | **3.68±0.09$^{c}$** | **0.83±0.07$^{d}$** | **62.40±1.09$^{bc}$** |
| **4:1** | **0.5% Siwi dips** | **4.17±0.43$^{bc}$** | **1.27±0.05$^{ab}$** | **67.17±7.78$^{ab}$** |
| | **1% Siwi dips** | **4.63±0.11$^{ab}$** | **1.25±0.12$^{bc}$** | **68.48±0.64$^{ab}$** |
| | **L.S.D 0.05%** | **0.62** | **0.17** | **6.64** |

a, b, c, …: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.

### 3.8. Phytochemical compounds and antioxidant activity of sakkoty date dibs produced with enzyme extraction methods:

Total phenols, flavonoids and antioxidant activity of sakkoty date dibs produced with enzyme extraction methods are presented in Table (8). The obtained results show that there were significant differences in sakkoty date dibs treatments in total phenols, flavonoids and antioxidant activity values. From the results, it can be concluded that, sakkoty dibs in (2:1) and (3:1) treatments treated with cellulase enzyme had the highest total phenolic, flavonoids content and antioxidant activity compared with water extraction methods. The treatment (4:1) control sakkoty dibs had significantly higher total phenolic, content and antioxidant activity. Meanwhile, the treatment (4:1) sakkoty dibs treated with 5.0% cellulase enzyme had low total phenolic content and antioxidant activity. These results are in agreement with those obtained by **Ramadan *et al.*, (2018)** who found that date dibs treated with cellulase enzyme showed the highest total phenols flavonoids and antioxidant activity compared with water extraction methods

**Table 8.** Phytochemical compounds and antioxidant activity of sakkoty date dibs produced with enzyme extraction methods**.**

| Blend | Components | Total phenolic compounds (mg/g) | Total flavonoids (mg/g) | Antioxidant activity (%) |
|---|---|---|---|---|
| | **Cont. Sakkoty dips** | **3.26±0.04$^{de}$** | **1.44±0.31$^{d}$** | **77.05±1.74$^{a}$** |
| **2:1** | **0.5% Sakkoty dips** | **3.53±0.09$^{c}$** | **1.91±0.13$^{c}$** | **80.76±6.5$^{ab}$** |
| | **1% Sakkoty dips** | **3.42±0.05$^{cd}$** | **3.10±0.15$^{a}$** | **81.31±3.74$^{ab}$** |
| | **Cont. Sakkoty dips** | **3.17±0.06 $^{e}$** | **1.08±0.11$^{e}$** | **75.61±3.53$^{b}$** |
| **3:1** | **0.5% Sakkoty dips** | **4.85±0.08$^{a}$** | **1.14±0.09$^{e}$** | **77.05±3.02$^{a}$** |
| | **1% Sakkoty dips** | **4.16±0.09$^{b}$** | **1.28±0.06$^{de}$** | **80.21±1.93$^{a}$** |
| | **Cont. Sakkoty dips** | **4.96±0.39$^{a}$** | **2.17±0.05$^{b}$** | **82.90±1.85$^{a}$** |
| **4:1** | **0.5% Sakkoty dips** | **3.15±0.05$^{e}$** | **1.89±0.03$^{c}$** | **75.14±3.14$^{b}$** |
| | **1% Sakkoty dips** | **4.16±0.10$^{b}$** | **1.73±0.05$^{c}$** | **78.18±4.52$^{a}$** |

**a, b, c, …: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.**

### 3.9. Organoleptic evaluation of siwi date dibs produced with enzyme extraction method

Sensory evaluation of food product is an important by which consumer acceptability can be assessed. Scores of organoleptic properties (color, odor, taste, texture, and overall palatability) of siwi date dibs produced with enzyme extraction method are shown in Table (9). The obtained results show that there were significant differences in siwi date dibs treatments in all sensory attributes. Results showed that siwi date dibs treated with cellulase was the highest overall palatability scores compared with water extraction methods except treatment (4:1). On the other said, in siwi date dibs (2:1) treated with cellulase had significantly higher values of overall palatability scores compared with others treated siwi date dibs. Reference date dibs had had significantly higher scores for most organoleptic properties compared with siwi date dibs treated with cellulase at all treatments except treatment (2:1) treated with cellulase. Date dibs treated with cellulase at all treatments had the highest scores for organoleptic properties than its control date dibs except date dibs (4:1) treated with cellulose. These results are in the line with those obtained by **Abbès *et al.*, (2011) and El-Sharnouby *et al.*, (2009)** who found that date dibs treated with cellulase had the highest scores for organoleptic properties compared with control date dibs and with increasing enzyme concentrations scores for organoleptic properties increased.

**Table 9.** Organoleptic properties of siwi date dibs produced with enzyme extraction methods

| Blend | Treatment | Color | Odor | Taste | Texture | Overall palatability |
|---|---|---|---|---|---|---|
| | **Reference date dips** | **8.20±0.92$^{abc}$** | **8.70±0.82$^{ab}$** | **8.50±0.85$^{abc}$** | **8.50±0.85$^{ab}$** | **8.40±1.07$^{abc}$** |
| | **Cont. Sakkoty dips** | **8.50±0.85$^{ab}$** | **8.80±0.63$^{a}$** | **8.40±0.97$^{abc}$** | **8.30±1.06$^{ab}$** | **7.40±0.52$^{d}$** |
| **2:1** | **0.5% Sakkoty dips** | **8.80±0.92$^{a}$** | **8.20±1.03$^{abc}$** | **8.70±0.67$^{ab}$** | **8.30±0.48$^{ab}$** | **8.50±0.71$^{ab}$** |
| | **1% Sakkoty dips** | **9.00±0.94$^{a}$** | **8.40±0.70$^{ab}$** | **8.90±1.10$^{a}$** | **8.70±0.95$^{a}$** | **8.60±0.97$^{a}$** |
| | **Cont. Sakkoty dips** | **7.80±1.23$^{bcd}$** | **7.50±0.85$^{cd}$** | **7.70±0.95$^{c}$** | **7.80±1.14$^{b}$** | **7.40±0.84$^{d}$** |
| **3:1** | **0.5% Sakkoty dips** | **8.15±0.94$^{abc}$** | **7.85±0.94$^{b}$** | **8.30±1.25$^{abc}$** | **8.00±1.15$^{ab}$** | **7.40±0.84$^{d}$** |
| | **1% Sakkoty dips** | **8.25±0.72$^{abc}$** | **8.50±1.27$^{ab}$** | **8.00±0.82$^{abc}$** | **7.90±0.74$^{ab}$** | **7.80±0.79$^{bcd}$** |
| | **Cont. Sakkoty dips** | **8.18±0.75$^{abc}$** | **7.82±1.08$^{bcd}$** | **7.82±1.17$^{bc}$** | **8.12±0.87$^{ab}$** | **8.09±0.83$^{bcd}$** |
| **4:1** | **0.5% Sakkoty dips** | **7.25±1.14$^{d}$** | **7.30±0.82$^{d}$** | **7.70±1.06$^{c}$** | **7.80±1.14$^{b}$** | **7.40±0.84$^{d}$** |
| | **1% Sakkoty dips** | **7.55±1.01$^{cd}$** | **7.60±1.07$^{bcd}$** | **7.60±0.84$^{c}$** | **7.70±0.82$^{b}$** | **7.70±0.95$^{cd}$** |

**a, b, c, …: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.**

### 3.10. Organoleptic evaluation of sakkoty date dibs produced with enzyme extraction method

Scores of organoleptic properties (color, odor, taste, texture, and overall palatability) of Sakkoty date dibs produced with enzyme extraction method are shown in (Table 10). The obtained results show that there were significant differences in Sakkoty date treatments in all sensory attributes. Results showed that Sakkoty date dibs treated with cellulase was the highest overall palatability scores compared with water extraction methods except treatment (4:1).

On the other said, in Sakkoty date dibs (2:1) treated with cellulase was the highest overall palatability scores compared with others treated Siwi date dibs. Reference date dibs had the highest scores for organoleptic properties compared with Sakkoty date dibs treated with cellulase at all treatments except treatment (2:1) treated with cellulase. Date dibs treated with cellulase at all treatments had the highest scores for organoleptic properties than its control date dibs except date dibs (4:1) treated with cellulose. These results are in the line with those obtained by **Abbès *et al.,* (2011)** and **El-Sharnouby *et al.,* (2009)** found date dibs treated with cellulase had the highest scores for organoleptic properties compared with control date dibs and with increasing enzyme concentrations scores for organoleptic properties increased

**Table 10.** Organoleptic properties of sakkoty date dibs produced with enzyme extraction methods.

| Blend | Treatment | Color | Odor | Taste | Texture | Overall palatability |
|---|---|---|---|---|---|---|
| | **Reference date dibs** | **8.20±0.92$^{abcd}$** | **8.70±0.82$^{a}$** | **8.50±0.85$^{abc}$** | **8.50±0.85$^{ab}$** | **8.48±1.07$^{ab}$** |
| | **Cont. Sakkoty dibs** | **8.50±0.85$^{abc}$** | **7.80±0.63$^{bd}$** | **8.40±0.97$^{abc}$** | **8.30±1.06$^{ab}$** | **7.40±0.52$^{d}$** |
| **2:1** | **0.5% Sakkoty dibs** | **8.80±0.92$^{ab}$** | **8.20±1.03$^{abc}$** | **8.70±0.67$^{ab}$** | **8.30±0.48$^{ab}$** | **8.50±0.71$^{ab}$** |
| | **1% Sakkoty dibs** | **9.00±0.94$^{a}$** | **8.40±0.70$^{ab}$** | **8.90±1.10$^{a}$** | **8.70±0.95$^{a}$** | **8.60±0.97$^{a}$** |
| | **Cont. Sakkoty dibs** | **7.80±1.23$^{cde}$** | **7.50±0.85$^{cd}$** | **7.70±0.95$^{cd}$** | **7.80±1.14$^{b}$** | **7.40±0.84$^{c}$** |
| **3:1** | **0.5% Sakkoty dibs** | **8.15±0.94$^{abcd}$** | **7.85±0.94$^{bcd}$** | **8.30±1.25$^{abcd}$** | **8.00±1.15$^{ab}$** | **7.40±0.84$^{c}$** |
| | **1% Sakkoty dibs** | **8.25±0.72$^{abcd}$** | **7.50±1.27$^{cd}$** | **8.00±0.82$^{bcd}$** | **7.90±0.74$^{ab}$** | **7.80±0.79$^{bc}$** |
| | **Cont. Sakkoty dibs** | **8.10±0.75$^{bcde}$** | **7.60±1.08$^{bcd}$** | **7.60±1.17$^{d}$** | **8.10±0.87$^{ab}$** | **8.00±0.83$^{abc}$** |
| **4:1** | **0.5% Sakkoty dibs** | **7.25±1.14$^{e}$** | **7.30±0.82$^{d}$** | **7.70±1.06$^{cd}$** | **7.80±1.14$^{b}$** | **7.40±0.84$^{c}$** |
| | **1% Sakkoty dibs** | **7.55±1.01$^{de}$** | **7.60±1.07$^{bcd}$** | **7.60±0.84$^{d}$** | **7.70±0.82$^{b}$** | **7.70±0.95$^{c}$** |

a, b, c, …: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.

**Conclusion:**

Through the previous studies we can confirm that second grade of date fruits can be used to produce date syrup be extracting with water, thun treating the sugar extract with cellulose enzyme, then concentrating under vacuum to raise the percentage of total soluble solids to about 70%. This resulted in obtaining dibs (date syrup) containing high concentrations from ash, total and reducing sugars, as well as bioactive components and antioxidants compound. In addition, it was found that the dibs obtained from the sugar extract and treated with cellulose enzyme was acceptable from sensory evaluation of view, as it obtained the highest scores.

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**تأثير طريقة الاستخلاص الأنزيمي على معايير الجودة والقبول الحسي للدبس الناتج من الدرجة الثانية للتمر**

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*** الهيئة القومية لسلامة الأغذية**
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أجريت هذه الدراسة بهدف معرفة تأثير طرق الاستخلاص الإنزيمي علي كفاءة وجودة دبس التمر المصنع من نوعي التمور قيد الدراسة وهي السيوي والسكوتي. تم دراسة التركيب الكيميائي لكلا صنفي التمور، وتم استخدام تركيزين مختلفين من إنزيم السليولاز 0.5 و1.0٪ وذلك لمعرفة تأثيرها على كفاءة استخلاص دبس التمر المحضر من تمر السيوي والسكوتي بإضافة نسب مختلفة من الماء (الماء : اللب بنسب 2 : 1، 3 : 1 و4 : 1) ودراسة خصائصه الفيزيائية والكيميائية ومحتواه من المواد النشطة حيوياً مثل المواد الفينولية والفلافونويدات والمواد المضادة للأكسدة كذلك تم تقييمه من الناحية الحسية. أظهرت النتائج التي تم الحصول عليها وجود فروق غير معنوية بين الصنفين في محتوي السكريات الكلية والمختزلة. لم تلاحظ وجود فروق معنوية بين صنفي التمر في محتوى المركبات الفينولية الكلية. علاوة على ذلك، احتوى تمر السكوتى على أعلى محتوى من كل من الفلافونويدات الكلية والنشاط المضاد للأكسدة تلاه تمر السيوي. أدت طرق الاستخلاص الإنزيمي الي زيادة في محتوى السكريات الكلية والتي تزداد بزيادة تركيز الإنزيم عند نفس ظروف الاستخلاص. احتوي دبس التمر السكوتي على أعلى نسبة سكر مقارنتاً بدبس التمر السيوي في جميع المعاملات ماعدا دبس التمر المحضر بنسبه (2 : 1) ماء : لب، ولوحظ أنه بالنسبة للصنف نفسه عند زيادة تركيز الإنزيم، حدثت زيادة في محتويات الفينولات والفلافونويدات عند نفس ظروف الاستخلاص. احتوت دبس التمر سكوتي على أعلى نسبة من الفينولات والفلافونويدات مقارنة بدبس التمر السيوي لجميع المعاملات. كما أظهرت النتائج ان دبس التمر المعامل بإنزيم السليولاز حصل علي أعلى درجات الخصائص الحسية في جميع المعاملات مقارنة بدبس التمر الكنترول باستثناء المعاملة (4: 1).

**الكلمات الدالة** : البلح السيوي، البلح السكوتي، دبس التمر، الخواص الفيزيائيه والكيميائيه