Chemical Composition and Antimicrobial Efficacy of Date Palm Fruit of Saudi Arabia

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Abstract: Date palm fruit are an important source of nutritional elements to people in Saudi Arabia. In this study Sukkari cultivar of date palm fruit samples were collected and subjected to analyses as well as testing the antifungal and antibacterial activities. The methanolic extract of Sukkari cv. date palm illustrated the stronger antifungal activity than aqueous extract against all fungi. The methanolic fruit extract at 100% cause increase in zone of inhibition in all tested fungi reaching values between 9.25-15.00 mm with an average of 12.08 mm, whereas, at 50% concentration the inhibition zone reaching between 9.00-12.25 mm with an average of 10.88 mm. The aqueous extract of date palm fruit extract at 100% and 50% concentrations showed no effect against all tested fungi. Concerning the antibacterial activity, the aqueous extract was found to be more effective by inhibiting growth of Bacillus subtilis, Escherichia coli and Pseudomonas aeruginosa, while the methanolic fruit extract at 100% cause zone of inhibition in all tested bacteria reaching values of 17.75, 15.00 and 22.25 mm with an average of 18.33 mm, respectively. The fruit of Sukkari cv. contained phenols and flavonoids at higher rate, as the total phenols were 7 mg/g and total flavonoids were 0.697 mg/g. Total protein content was 3.89 g/100g dry matter indicating relatively little protein. The most abundant macronutrients was potassium (0.41%) followed by nitrogen and phosphorus (0.55 and 0.10%, respectively). The results also showed that the Sukkari cultivar contained suitable amount of micronutrients (Zn, Mn, Cu, Mg and Ca reached to 1.9, 6.5 and 1.08 ppm and 0.18 and 0.35%, respectively). The fruits also contained a high percentage of carbohydrate (total sugars, 44-88%), fat (0.2-0.5%), 15 salts and 1.68-3.94% and they contained low concentrations of proteins and lipids (1.72-4.73% and 0.12-0.72%, respectively). She added that the predominant mineral was potassium and the main sugars were glucose and fructose ranging from 65-80%.

Key words: Date fruit - Antimicrobial activity - Minerals - Chemical and phytochemical analyses

INTRODUCTION

Date palm (Phoenix dactylifera L.) is the most successful and commercial important crop in hot arid regions of the world, e.g., Saudi Arabia [1]. Saudi Arabia is the second date producer in the world as more than 300 varieties are grown [2] and 1.07 million tons production [3]. The fruits of date palm are highly nutritious food product rich in simple sugars such as glucose and fructose ranged from 65-80% [4]. They showed that the fruits contain a high percentage of carbohydrate (total sugars, 44-88%), fat (0.2-0.5%), 15 salts and minerals, protein (2.3-5.6%), vitamins and a high percentage of dietary fiber (6.4-11.5%). The date palm fruits also, considered a good source of fibers and some essential minerals and many vitamins, but low in fat and protein with no starch were detected by Barreveld [5] and Al-Rawi et al. [6]. Date fruits are very rich in vitamins A, B and C and dietary fibers. The antioxidants present in dates can aid in lowering the risk of cancer and cardiovascular conditions and also improve immune system [7]. The fruits of date palm is rich in tannin which is an astringent, hence are used as astringent in intestinal troubles treatment for sore throats, cold, bronchial catarrh, fever and gonorrhea [8]. Assirey [2] reported that date palm fruits were rich in sugar, while ash represents 1.68-3.94% and they contained low concentrations of protein and lipids (1.72-4.73% and 0.12-0.72%, respectively). She added that the predominant mineral was potassium and the main sugars were glucose and...
fructose. El-Sohaimy and Hafez [9] reported that the date palm fruit extracts contained 15.80% moisture, 2.13% ash but the protein, carbohydrates and lipids contents were 3.00, 73.00 and 2.90% respectively.

Fruits of date palm are rich in mineral salts and vitamins [10, 11, 12]. Date fruits contain small amounts of vitamins C, B1, thiamine, B3 riboflavin and nicotonic acid [4]. They added that the fatty acids occur in flesh as a range of saturated and unsaturated acids, the fruits containing eight of these fatty acids occur in very low concentration. Unsaturated fatty acids include Palmitoleic, Oleic, Linoleic and Linolenic acids. Numerous numbers fruit of date palm cultivars are known, however only a few of these cvs have been evaluated for chemical composition and antimicrobial activity [13]. Bhat and Al-Daihan [14] reported that methanol extract of date palm fruits illustrate a maximum zone of inhibition against B. subtilis, while aqueous extract showed a highest zone of inhibition against E. coli. Moreover, date fruits possess antioxidant and antimutagenic properties [7, 15, 16] attributable to their high levels of polyphenolic compounds and vitamins [16, 17].

Therefore, the objective of the present work was to determine the chemical composition and the antimicrobial activity of date palm cv. Sukkari against some food poising fungi and bacteria.

**MATERIALS AND METHODS**

**Sampling:** one commercially sample of Phoenix dactylifera L. (Sokkari cv.) was collected from Jeddah province, Saudi Arabia. Seeds were separated out from its fruits and cleaned with distilled water, shade dried and powdered using warring blender and then stored in airtight closed bottle in -20°C.

**Microorganisms for Antimicrobial Activity:** reference bacterial and fungal strains were obtained from Plant Pathology Department, National Research Centre, Dokki, Giza, Egypt. Tested bacterial isolates were Bacillus subtilis, Escherichia coli and Pseudomonas aerogenosa, which were maintained on nutrient broth medium and incubated at 33±2°C for 48h prior to antibacterial screening. Tested fungal isolates were Alternaria tenuis, Aspergillus flavus, A. terreus, Fusarium graminearum, F. oxysporum and Penicillium spp. which were maintained PDA medium at 27±2°C for 5 days prior screening.

**Extraction of Fruit Materials**

**Aqueous Components:** 5g of powder was dissolved in 50ml of distilled water for 24h and then filtered. Filtrate was centrifuged at 10.000 rpm for 3min. The supernatant was obtained and stored at 4°C.

**Methanol Extraction:** 5g of powdered sample was added to 50 ml of methanol in a conical flask, plugged with cotton wool and then kept on a rotary shaker at 200 rpm for 24h. The supernatant was collected and the solvent was slowly evaporated to make the final volume one fourth of the original volume of solvent used and stored at 4°C in airtight bottle [18].

**In-vitro Evaluation of Antimicrobial Activity:**

Antibacterial and antifungal activities of aqueous and methanolic extracts of date palm fruits against three bacterial and six fungal isolates using well diffusion method with sterile cork borer of size 0.6 mm according to Bobbarala et al. [19]. An activity growing bacterial cultures of 24h at 33±2°C and fungal isolates of 72h at 27±2°C were inoculated into nutrient agar and PDA media, respectively. Four holes were punched out of the agar and the well was filled by 20µl of the sterilized supernatants of each extract. The plates were incubated as mentioned before for bacteria and fungi. The zone of inhibition was measured in mm and the experiment was carried out in four replicates.

**Chemical Composition of Fruit Powder:**

- Moisture content was determined after drying in a vacuum oven at 70°C for 2 days according to AOAC [20]. The dried fruits were ground in stainless steel mill with 0.5mm and kept in plastic container to determine the following traits. Samples were analyzed chemically according to the Official methods of analyses described by the Association of Official Analytical Chemist [20].
- Total nitrogen percentage was determined using Micro-Kjeldahl method as described by Peter and Young [21].
- Macro (K, P and N %) and micro (Cu, Mn, Zn and Fe ppm, Mg and Ca %) nutrients were extracted and determined as described by Chapman and Pratt [22] using atomic absorption spectrophotometer apparatus (Zeiss PMQ3). Phosphorus was measured in the digested solution using vanado-molybdate color reaction, according to the method described by Jackson [23].
Total amounts of carbohydrates was determined based a standard calibration curve prepared using glucose. Lipid extraction was carried out with 2.0g of homogenized date with Soxhlet extractor with of petroleum ether and then solvent was removed by evaporation. Results were expressed as the percentage of lipids in the dry matter of date powder.

**Phytochemical Analysis:** The date palm fruit powder were subjected to phytochemical tests for: Total phenols (mg eq GA/g extract)) according to Danial and George [24], total flavonoids (mg eq GA/g extract) by spectrophotometer according to Chang and Wen [25].

**Statistical Analysis:** statistical analysis of experiments were done using one way ANOVA and results were compared using least significant difference (LSD) test at P=5%.

**RESULTS AND DISCUSSION**

**Antifungal Activity of Fruit Extracts:** The results of antifungal activity of methanolic and aqueous extracts of date palm fruits (Sukkari cv.) against some phytopathogenic fungi are shown in Table 1. Date palm fruit extracts showed different degrees of growth inhibition against the tested fungal spp., depending on the fungal strains. The inhibition zone for all fungi was gradually increased with increase concentration of the methanolic fruit extracts. The methanolic extract was found to be more effective than the water extract. The methanolic fruit extract at 100% cause increase in zone of inhibition in all tested fungi reaching values between 9.25-15.00 mm with an average of 12.08 mm, whereas at 50% concentration the inhibition zone reaching between 9.00-12.25 mm with an average of 10.88 mm. However, *F. graminearum* and *Penicillium* sp. were very sensitive towered date extract than other fungi. Moreover, the methanolic extract at 100% concentration had the minimum inhibitory effect against *A. flavus* (9.25 mm). The methanolic extract of date palm fruit at 50% concentration showed also strong effect against *F. graminearum* and *Penicillium* spp. (12.25 mm) but showed lesser activity against *A. flavus* and *F. oxysporum* (9.00 and 10.25 mm zone inhibition, respectively).

The aqueous extract of date palm fruit extract at 100% and 50% concentrations showed no effect against all tested fungi. Thus, the methanolic extract of Sukkari cv. date palm illustrated the strongest antifungal activity. These results are consistent with those obtained by Bokhari and Perveen [26], who found that an antifungal activity of date palm fruit extracts against several fungi. In this respect, they noted that the methanol extracts had good inhibition potential against *F. oxysporum, Fusarium* spp., *F. solani, A. alternata* and *Alternaria* spp., while water extract had almost negligible effect on all fungi tested. Phytochemical screening of date palm fruits revealed the presence of alkaloids, flavonoids,

<table>
<thead>
<tr>
<th>Fungi</th>
<th>Aqueous extract (%)</th>
<th>Methanolic extract %</th>
<th>Mean</th>
<th>100</th>
<th>50</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Alternaria tenuis</em></td>
<td>0.00 0.00 0.00</td>
<td>12.25BC 11.0DEF 0.00</td>
<td>7.75C</td>
<td>3.88BC</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Aspergillus flavus</em></td>
<td>0.00 0.00 0.00</td>
<td>9.25G  9.00G 0.00</td>
<td>6.83D</td>
<td>3.04D</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Aspergillus terreus</em></td>
<td>0.00 0.00 0.00</td>
<td>11.25DE 10.50EF 0.00</td>
<td>7.25C</td>
<td>3.63C</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Fusarium graminearum</em></td>
<td>0.00 0.00 0.00</td>
<td>15.00A 12.25BC 0.00</td>
<td>9.08A</td>
<td>4.54AB</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Fusarium oxysporum</em></td>
<td>0.00 0.00 0.00</td>
<td>11.75CD 10.25F 0.00</td>
<td>7.33C</td>
<td>6.67C</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Penicillium sp.</em></td>
<td>0.00 0.00 0.00</td>
<td>13.00B 12.25BC 0.00</td>
<td>8.42B</td>
<td>4.21AB</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Four replicates were used for each treatment.
- Values followed by the same letter are not significantly different at P ≥ 0.05 according to Duncan's multiple range test.

<table>
<thead>
<tr>
<th>Fungi</th>
<th>Aqueous extract (%)</th>
<th>Methanolic extract %</th>
<th>Mean</th>
<th>100</th>
<th>50</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Bacillus subtilis</em> (G')</td>
<td>15.50DE 13.00FG</td>
<td>9.50BC 17.75C 13.5 EFG</td>
<td>10.42</td>
<td>9.96C</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Escherichia coli</em> (G)</td>
<td>23.00B 17.75C</td>
<td>13.58A 15.00EF 12.50G</td>
<td>9.17C</td>
<td>11.38B</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa</em> (G)</td>
<td>25.50A 14.75EF</td>
<td>13.42A 22.25B 17.50CD</td>
<td>13.25A</td>
<td>13.33A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Four replicates were used for each treatment.
- Values followed by the same letter are not significantly different at P ≥ 0.05 according to Duncan's multiple range test.
saponins, erpenoids, steroids, tannins, cardioglycosides, amino acids and proteins which have antifungal and antibacterial activities.

**Antibacterial Activity of Fruit Extracts:** The antibacterial activity of date palm fruit extracts against bacteria are presented in Table 2. The results of the disk diffusion method indicated that methanolic and aqueous extracts of the Sukkari cv. showed different degrees of growth inhibition, depending on the bacterial strain. All tested extracts recorded stronger antibacterial activity against Gram negative than Gram positive bacteria. The inhibition zone for all bacteria was gradually increased with increase in concentration of the methanolic and aqueous fruit extracts. The aqueous extract was found to be more effective by inhibiting growth of *Bacillus subtilis*, *Escherichia coli* and *Pseudomonas aeruginosa* (the diameter of inhibition zone were 15.50, 23.00 and 25.50 mm respectively with an average of 21.33). While, the methanolic fruit extract at 100% cause zone of inhibition in all tested bacteria reaching values of 17.75, 15.00 and 22.25 mm with an average of 18.33 mm respectively. These results are consisted with those obtained by Al-Seeni [13], Bhat and Al-Daihan [14] and Saleh and Otaibi [27], who found that an antibacterial activity of date palm fruit extracts against several bacterial isolates. The inhibition of bacterial growth could be attributed mainly to the high content of flavonoids, such as quercetin, which was previously reported to offer promising antibacterial activity [28].

**Phytochemical and Elemental Analyses of Date Palm Fruit Powder**

**Phenols, Flavonoids and Protein:** The results of the phytochemical analyses of Sukkari date palm fruit are shown in Table 3. The results showed that the fruit contained phenols and flavonoids at higher rate, as the total phenols were 7 mg/g and total flavonoids were 0.697 mg/g. Total protein content was 3.89 g/100g dry matter in Sukkari cv., indicating relatively little protein. It has been reported previously that dates are not a good source of protein [2, 11]. But contrary to the data, the value of protein reported by Agboola and Adejumo [29], who reported that the value of protein in the fruit of the Nigerian wild date palm was relatively high (17.09%). The presence of phenols, flavonoids and protein are known to be biologically active and therefore, aid the antimicrobial activities of date palm fruits [30].

**Mineral Composition:** it is obvious to find a high content of macronutrients in the Sukkari date palm fruits (Table 3). Potassium concentration was the highest (0.41%) followed by nitrogen and phosphorus (0.55 and 0.10%, respectively). The results also showed that the Sukkari cultivar contained suitable amount of micronutrients. It is clearly to see a very high content of the Fe reaching 91.8 ppm. It is also clear to detect different concentrations of Zn, Mn, Cu, Mg and Ca reached to 1.9, 6.5 and 1.08 ppm and 0.18 and 0.35% respectively. Similarly, Booj et al. [10], Al-Hooti et al. [11] and Taha and Al-Ghtani [12], they reported that dates are a very good source of many minerals which are important of metabolism in human cells. The above data revealed that Sukkari cv. contain a variety of minerals which have a variety of function that help maintain a healthy body. Magnesium and calcium are essential for healthy bone development and for energy metabolism. Iron is essential to red blood cell production. Phosphorus works with calcium to help with bone strength and growth, potassium that helps to keep muscles working correctly.

**Fat, Ash and Humidity:** The date palm fruit of Sukkari powder showed a moderate fat content (1.07 g/100g dry matter) (Table 4), which are similar to those reported previously for dates produced in Saudi Arabia [31] and Emirates [32]. Ash content is an index to nutritive value of

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Table 3: Sukkari date palm fruit contents of flavonoids, phenols, protein, micro and macronutrients

<table>
<thead>
<tr>
<th>Date palm cv.</th>
<th>Total phenolics (mg eq GA/g extract)</th>
<th>Total flavonoids (mg eq Qu/g extract)</th>
<th>Protein (g/100g dw)</th>
<th>Macronutrients % ppm</th>
<th>Micronutrients %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swee</td>
<td>7.00</td>
<td>0.697</td>
<td>3.89</td>
<td>0.55</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Table 4: Chemical composition (%) content of date fruits of Sukkari cultivar

<table>
<thead>
<tr>
<th>Date cv.</th>
<th>Ash</th>
<th>Humidity</th>
<th>Nitrogen</th>
<th>Total protein</th>
<th>Fat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sukkari</td>
<td>1.31</td>
<td>20.00</td>
<td>0.62</td>
<td>3.89</td>
<td>1.07</td>
</tr>
</tbody>
</table>
Table 5: Sugar content of date fruits of Sukkari cultivar (mg/g)

<table>
<thead>
<tr>
<th>Date cv.</th>
<th>Sucrose</th>
<th>Fructose</th>
<th>Glucose</th>
<th>Total sugars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sukkari</td>
<td>672.5</td>
<td>72.27</td>
<td>40.90</td>
<td>792.67</td>
</tr>
</tbody>
</table>

Table 6: Vitamins and the lipolitic acids contents of Sukkari cultivar

<table>
<thead>
<tr>
<th>Vitamins</th>
<th>Fatty acids</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>No. of carbon atoms</td>
</tr>
<tr>
<td>B2</td>
<td>ND</td>
</tr>
<tr>
<td>B3</td>
<td>0.40</td>
</tr>
<tr>
<td>B5</td>
<td>ND</td>
</tr>
<tr>
<td>B6</td>
<td>2.38</td>
</tr>
<tr>
<td>B9</td>
<td>0.05</td>
</tr>
<tr>
<td>B12</td>
<td>0.55</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>19.74</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>ND</td>
</tr>
</tbody>
</table>

food [33]. The ash content was 1.31g/100g dry matter in Sukkari fruit powder and also had highest moisture content (20%). The results are comparable to those reported previously by Assirey [2], Booij et al. [10] and Samarawira [34].

Sugar Content: Sugars are the most important constituents of dates, making them a rich source of energy for the human system [35]. The main sugars found in Sukkari date fruit sample were fructose, glucose and sucrose (Table 5). Total sugar content was quit high reached 792.67mg/g. In particular, the sucrose content was the highest sugar (672.5 mg/g) followed in descending order by fructose (72.27 mg/g) and glucose (40.90 mg/g), suggesting that fruit are rich sucrose sugar. Most of the studied cultivars had higher glucose and fructose concentrations, conversely nabtit, Sukkari and rashodia cultivars has higher sucrose levels [2, 36].

Fatty Acids: The average content of fatty acids in Sukkari cv. was 1.07mg/g dry matter content (Table 6). Also, six main fatty acids identified in the fruits were Lauric, Myristic, Palmitic, Margaric, Stearic and Arachidic acids. Moreover, El-Sohaimy and Hafez [9] added that the low level of lipids content compared with its content of sugars means that the date palm is save to heart and blood patients because its containing a very low level of fatty acids and cholesterol. Ogungbenle [37] reported that the most concentrated fatty acids in date palm were Oleic acid (44.51g/100g)>Palmitic acid (23.05g/100g)>Linoleic acid (11.66g/100g). All these quality food properties make it good source of unsaturated fatty acids and sweetening agent in food processing industry. Al-Shahib and Marshall [4] found that the fatty acids occur in both flesh and seed as a range of saturated and unsaturated acids, the seeds containing 14 types of fatty acids, but only eight of these fatty acids occur in very low concentration in the flesh. Unsaturated fatty acids include palmitoleic, oleic, linoleic and linolenic acids. The oleic acid content of the seeds varies from 41.1 to 58.8%, which suggests that the seeds of date could be used as a source of oleic acid.

Vitamins: Data presented in Table 6 showed that many vitamins were detected in the fruits of Sukkari date palm cv. Vitamin E was the major content reached 19.74 mg/g followed by vitamin B₆ (2.38 mg/g). On the other hand, vitamins B₁, B₂, B₃, B₉ and B₁₂ were the minor vitamins detected in the fruits. Al-Shahib and Marshall [4] reported that dates contain at least six vitamins including a small amount of vitamin C and vitamins B₁ thiamine, B₂ riboflavin, nicotinic acid (niacin) and vitamin A.

REFERENCES