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Determination and Comparative Evaluation of Fruit Nutritional Value of two Sudanese Date palm (*Phoenix dactylifera* L.) Cultivars

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Abstract

The main goal of this study was to determine and compare the nutritional value of 'Barakawi' – a dry date cultivar- and 'Mishrig Wdkhateeb', which is a semi-dry cultivar. The fruit chemical composition, minerals content and energy values of both cultivars were studied. The results obtained showed significant variations between fruits of the two cultivars. On basis of 100 g dry weight, 'Barakawi' fruits had higher concentrations of dry matter (94.80 %), total carbohydrates (94.37%), available carbohydrates (88.40 %), non-reducing sugars (44.51%) and energy value (380.22 k. cal.), whereas, 'Mishrig Wdkhateeb' had higher concentrations of protein (5.70%), fats (1.52%)), fibers (6.76%)), total sugars (86.27%) and reducing sugars (60.44%). Regarding minerals content, fruits of 'Mishrig Wdkhateeb' had higher concentrations of potassium (160.26 mg), sodium (17.01 mg), magnesium (06.09 mg), manganese (2.22 mg) and zinc (2.10 mg), while 'Barakawi' fruits had higher concentrations of calcium (129.75 mg) and iron (3.96 mg). The study confirmed the high nutritional value of both cultivars which justifies intensive processing research aiming towards manufacturing diverse food products based on date palm fruits.

Keywords: Date fruits, Cultivar, Nutritional value, Sudan.

Introduction

Date palm (*Phoenix dactylifera* L.) is one of the oldest fruit crops grown in the arid regions of Sudan, the Arabian Peninsula, North Africa, and the Middle East where it is considered as staple food (Ahmed, 2008). Dates can grow in very hot and dry climates, and are relatively tolerant of salty and alkaline soils (Chao and Krueger, 2007). In Sudan, about 30 Date palm cultivars (*Phoenix dactylifera* L.*)* are distributed throughout the country (Obied, 2004). According to the FAO (2013), the top 10 date-producing countries are Egypt, Saudi Arabia, Iran, United Arab Emirates (UAE), Pakistan, Algeria, Sudan, Oman, Libyan Arab Jamahiriya, and Tunisia. According to More (2014), the top five date-

exporting countries are Iran, Pakistan, UAE, Saudi Arabia, and Tunisia. Date fruits are of high nutritional value and constitute a major source of income to the majority of the inhabitants of the Northern State of Sudan (Daoud and Ahmed 2006). In general, date fruits provide a wide range of essential nutrients such as sugars (44% - 88%), fibers (6.4% - 11.5%), proteins (2.3% - 5.6 %), vitamins and minerals such as thiamin (B_1), riboflavin (B_2), ascorbic acid (vit. C), potassium, sodium, magnesium, manganese, calcium, boron, cobalt, copper, fluorine, selenium, and zinc (Chao and Krueger, 2016; Assirey, 2015; Zaid and Jimenez, 2003). However, the chemical composition of date fruits was found to vary depending on cultivars, soil conditions, agronomic practices as well as the ripening stages (Mohammed *et al.,* 2014; Elleuch *et al.,* 2008). Most of date fruits are consumed fresh, dry or processed. Al-Yahyai and Manickavasagan (2012) mentioned that, several processed products have been made out of date fruits such as date juice, syrup, jam, gorrasa, madida, sharbout, paste and date dissert. However, processing is largely based on chemical composition of products. Such studies are meager in Sudan. Therefore, the main goal of this study was to determine and compare the fruit nutritional value of two Sudanese date cultivars namely, 'Barakawi', a dry cultivar and 'Mishrig Wdkhateeb' a semi-dry cultivar.

The specific objectives were:

1. To determine the fruit chemical composition and minerals contents.
2. To determine the fruit energy values of both cultivars.

Materials and Methods

To determine and compare the chemical composition and nutritional value of 'Barakawi' and 'Mishrig wdkhateeb' date cultivars, samples were obtained from an orchard in Alghaba Locality, the Northern State, Sudan, at the harvest season in September 2015. The samples were tightly kept in polyethylene bags and stored at -18 $^{\circ}$C until needed for the different investigations. The fruits were subjected to the following analysis according to standard method of the Association of Official Analytical Chemists (AOAC, 2003) based on three replicates from each cultivar: the moisture content, the crude protein, the fat content, the total carbohydrates, the crude fiber, the total sugar, the reducing and non-reducing sugar and the ash content. To determine the minerals content, 10 milliliters of (2N) HCl were added to the remaining ash sample and placed in a hot sand path for about 10-15 min. Then, the sample was diluted to 100 ml in a volumetric flask and filtered. The trace elements ferrous (Fe^{++}), zinc (Zn) and manganese (Mn^{++}) were determined according to Perkin Elmer (1994) by using Atomic Absorbance Spectroscopy (JENWAY 3110, UK). Sodium (Na) and potassium (K) were determined by using Flame Photometer (Model PEP7 JENWAY). Calcium (Ca) and magnesium (Mg) were determined as described by Chapman and Parratt (1961). The energy value of date fruits was calculated based on Atwater factors as indicated by Leung (1968) in which 1 g of protein = 3.87 K. calorie, 1 g of fat = 8.37 K. calorie, 1 g of carbohydrate = 4.12 K. calorie and each K. calorie = 4.184 K. Joule.

Data were subjected to analysis of variance (ANOVA), and means were separated by Duncan's Multiple Range Test with the aid of SAS statistical package as described by Steel *et a1.,* (1997).

Results and Discussion

Table (1) shows the chemical composition of 'Barakawi' fruits on dry weight basis. The dry matter, protein, fat, total carbohydrates, crude fiber, ash and total sugars were found to be 94.80%, 02.17%,

00.91%, 94.37%, 05.97%, 02.55% and 69.20%, respectively. The reducing sugars and non-reducing sugars constituted about 24.68% and 44.51%, respectively. The results obtained in this study are in agreement with those reported by Zaid and Jimenez (2003); Elleuch *et al.,* (2008) and Mohammed *et al.,* (2014), but they disagree with those reported by Daoud and Ahmed (2006), especially for moisture, fiber, ash and reducing sugars content.

Table (2) shows the chemical composition of 'Mishrig Wdkhateeb' fruits on dry weight basis. The dry matter, protein, fat, total carbohydrates, crude fiber, ash and total sugars were found to be 81.12%, 05.70%, 01.52%, 89.73%, 06.76%, 03.06% and 86.27%, respectively. The reducing sugars and non-reducing sugars constituted about 60.44% and 25.82 %, respectively. The results obtained in this study are also in agreement with those reported by Zaid and Jimenez (2003); Elleuch *et al.,* (2008) and Mohammed *et al.* (2014). Except for the total sugars, the other results disagree with those published by Daoud and Ahmed (2006).

Table (3) presents the minerals content of 'Barakawi' fruits, on wet and dry basis as (mg/100g). From the results, the concentration of calcium was highest among the different minerals (129.75), followed in descending order by potassium (84.39), sodium (12.97), magnesium (3.21), iron (3.06), zinc (1.27) and manganese (1.16), on dry weight basis. In general, the results of this study are in an agreement with those reported by Daoud and Ahmed (2006); Elleuch *et al*., (2008) and Assirey (2015).

Table (4) illustrates the minerals content of 'Mishrig Wdkhateeb' fruits, on wet and dry basis as (mg/100g). From the results, the concentration of potassium was the highest among the different minerals (160.26), followed in descending order by calcium (72.73), sodium (17.01), magnesium (6.09), iron (3.70), manganese (2.22) and zinc (2.10),on dry weight basis. In general, the results of this study agree with those reported by Daoud and Ahmed (2006); Elleuch *et al*., (2008) and Assirey (2015).

Table (1): Chemical composition of 'Barakawi' fruits (a dry date cultivar)

Parameter measured	Values (%)	
	On wet basis	On dry basis
Moisture or Dry matter	05.20 ± 0.14	94.80 ± 0.14
Protein	02.06 ± 0.02	02.17 ± 0.01
Fat	00.86 ± 0.02	00.91 ± 0.03
Total carbohydrates	89.46 ± 0.11	94.37 ± 0.02
Fibers	05.66 ± 0.03	05.97 ± 0.04
Available carbohydrates	83.80 ± 0.13	88.40 ± 0.02
Total sugars	65.60 ± 0.00	69.20 ± 1.78
Reducing sugars	23.40 ± 0.00	24.68 ± 0.54
Non-reducing sugars	42.20 ± 0.00	44.51 ± 2.24
Ash	02.42 ± 0.05	02.55 ± 0.05
Caloric value/ 100 g	360.43± 0.04 K. cal 1508.02 ± 0.06 K. J	380.22 ± 0.17 K. cal 1590.85 ± 0.70 K. J

Table (2): Chemical composition of 'Mishrig Wdkhateeb' date fruits (a semi-dry cultivar)

Parameter measured	Values (%)	
	On wet basis	On dry basis
Moisture or Dry matter	18.88 ± 0.02	81.12 ± 0.03
Protein	04.62 ± 0.24	05.70 ± 0.30
Fat	01.23 ± 0.23	01.52± 0.22
Total carbohydrates	72.79 ± 0.11	89.73 ± 0.28
Fibers	05.48 ± 0.15	06.76 ± 0.18
Available carbohydrates	67.31 ± 0.13	82.98 ± 0.40
Total sugars	69.98 ± 0.32	86.27 ± 0.47
Reducing sugars	49.03 ± 0.59	60.44 ± 0.88
Non-reducing sugars	20.95 ± 1.55	25.82 ± 0.27
Ash	02.48 ± 0.32	03.06 ± 0.39
Caloric value/ 100 g	305.49 K. cal 1278.68 K. J	376.66 ± 2.90 K. cal 1575.95 ± 12.15 K. J

Table (3): Minerals content of 'Barakawi' date dry cultivar

Minerals		Values (mg/ g)	
		On wet basis	On dry basis
Sodium	[Na]	012.30 ± 0.09	012.97± 0.10
Potassium	[K]	80.00 ± 0.11	84.39 ± 0.12
Calcium	[Ca]	123.00 ± 0.11	129.75± 0.10
Magnesium	[Mg]	003.04 ± 0.00	003.21 ± 0.00
Iron	[Fe]	002.90 ± 0.05	003.06 ± 0.04
Manganese	[Mn]	001.10 ± 0.02	001.16± 0.02
Zinc	[Zn]	001.20 ± 0.01	001.27± 0.00

Table (4): Minerals content of 'Mishrig Wdkhateeb' date semi-dry cultivar

Minerals		Values (mg/ 100 g)	
		On wet basis	On dry basis
Sodium	[Na]	013.80 ± 0.22	017.01 ± 0.03
Potassium	[K]	130.00 ± 0.09	160.26 ± 0.11
Calcium	[Ca]	059.00 ± 0.15	072.73 ± 0.17
Magnesium	[Mg]	004.94 ± 0.50	006.09 ± 0.54
Iron	[Fe]	003.00 ± 0.02	003.70 ± 0.01
Manganese	[Mn]	001.80 ± 0.02	002.22 ± 0.04
Zinc	[Zn]	001.70 ± 0.01	002.10 ± 0.00

Table (5) illustrates the comparison between the chemical composition and energy value of 'Barakawi' and 'Mishrig Wdkhateeb' date fruits, on dry basis. 'Barakawi' fruits had higher concentrations of dry matter (94.80%), total carbohydrates (94.37%), available carbohydrates (88.40%) and non-reducing sugars (44.51%), whereas, 'Mishrig Wdkhateeb' were of higher concentrations of protein (05.70%), total sugars (86.27%) and reducing sugars (60.44%). In spite of these variations, the differences between the two cultivars were not significant with respect to their caloric values. 'Barakawi' caloric value was 380.22 k. cal. /100g, whereas that, of 'Mishrig Wdkhateeb' was 376.66 k. cal. /100g pulp.

Table (6) shows the comparison of minerals content of 'Barakawi' and 'Mishrig Wdkhateeb' fruits (mg/ 100g), on dry basis. In general, the two date cultivars had high concentrations of potassium, calcium, sodium and low concentrations of magnesium, iron, zinc, and manganese. However, 'Mishrig Wdkhateeb' fruits had higher concentrations of potassium (160.26 mg), sodium (17.01 mg), magnesium (6.09 mg), iron (3.70 mg), manganese (2.22 mg) and zinc (2.10 mg), while 'Barakawi' fruits had higher concentrations of calcium (129.75) and iron (3.96). These results are partially in conformity with those reported by Assirey (2015) who also reported relatively variable values for minerals content for 10 Saudi date cultivars. The variation in such values may owe to genotypic characteristics and/ or other variables such as soil factors, cultural practices or agro-climatic conditions. When compared to cereals mineral and chemical composition (khatier *et al.,* 2013), the date fruits seemed to be better sources for total carbohydrates, calories and calcium while the iron content are almost similar. These criteria justify the use of date fruits as high value energy food. Besides, Elleuch *et al.,* (2008) stated that, the high potassium and low sodium contents in date fruits were found to be useful for people suffering from hypertension. The average per capita daily calorie needs is widely differ depending to varies factors such as gender, age, weight and physical activity, but in general ranging from 1500 to 2300 K. cal., therefore around 500g of dates can satisfy this need (FAO, 2003). From the results obtained in this study it can be concluded that, both 'Barakawi' and 'Mishrig Wdkhateeb' date fruits have high nutritional value with respect to their chemical composition, energy value and minerals content. Considering the growing global food needs, expansion in date palm culture may contribute to alleviation of food crisis in tropical and subtropical countries.

Table (5): Comparison between fruit chemical composition of 'Barakawi' and 'Mishrig Wdkhateeb' date cultivars on dry weight basis

Chemical composition and energy value	Values (%)		P-value	SE±
	'Barakawi'	'Mishrig Wdkhateeb'		
Dry matter	$94.80^{a} \pm 0.14$	$81.12^{b} \pm 0.03$	0.002^{**}	0.06
Protein	$02.17^{b} \pm 0.01$	$05.70^{a} \pm 0.30$	0.0003^{**}	0.12
Fat	$00.91^{b} \pm 0.03$	$01.52^{a} \pm 0.22$	0.0138^{*}	0.09
Total carbohydrates	$94.37^{a} \pm 0.02$	$89.73^{b} \pm 0.28$	0.0004^{**}	0.11
Fibers	$05.97^{b} \pm 0.04$	$06.76^{a} \pm 0.18$	0.002^{**}	0.08
Available carbohydrates	$88.40^{a} \pm 0.02$	$82.98^{b} \pm 0.40$	0.0001^{**}	0.16
Total sugars	$69.20^{b} \pm 1.78$	$86.27^{a} \pm 0.47$	0.0001^{**}	0.75
Reducing sugars	$24.68^{b} \pm 0.54$	$60.44^{a} \pm 0.88$	0.0002^{**}	0.42
Non-reducing sugars	$44.51^{a} \pm 2.24$	$25.82^{b} \pm 0.27$	0.0001^{**}	0.92
Ash	$02.55^{a} \pm 0.05$	$03.06^{a} \pm 0.39$	$0.0944^{n.S}$	0.16
Caloric value	$380.22^{a} \pm 0.17$ K. cal	$376.66^{b} \pm 2.90$ K.cal	0.0435^{*}	1.19
	$1590.85^{a} \pm 0.70$ K. J	1575.95 b ± 12.1K.J	0.0435^{*}	4.97

n ≡ Number of independent determinations.
Mean within row with the same letter(s) are not significantly different.

*: Significant at (P≤0.05), **: highly significant at (P≤0.01) and n.s.: not significant

Table (6): Comparison between minerals content of Barakawi and Mishrig Wdkhateeb date fruits on dry weight basis

Minerals		Values [mg/ 100g, n= 2± SD]		P-value	SE±
		'Barakawi'	'Mishrig Wdkhateeb'		
Sodium	[Na]	$12.97^{b} \pm 0.10$	$17.01^{a} \pm 0.03$	0.0006**	0.11
Potassium	[K]	$84.39^{b} \pm 0.12$	$160.26^{a} \pm 0.11$	0.0001**	0.07
Calcium	[Ca]	$129.75^{a} \pm 0.10$	$72.73^{b} \pm 0.17$	0.0002**	0.08
Magnesium	[Mg]	$003.21^{b} \pm 0.00$	$006.09^{a} \pm 0.54$	0.0001**	0.22
Iron	[Fe]	$003.96^{a} \pm 0.04$	$003.70^{b} \pm 0.01$	0.0412*	0.02
Manganese	[Mn]	$001.16^{b} \pm 0.02$	$002.22^{a} \pm 0.04$	0.2826**	0.02
Zinc	[Zn]	$001.27^{b} \pm 0.00$	$002.10^{a} \pm 0.00$	0.0003**	0.00

n ≡ Number of independent determinations.
Mean within row with the same letter(s) are not significantly different.

*: Significant at (P≤0.05), **: highly significant at (P≤0.01) and n.s.: not significant.

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تقدير وتقييم مقانة القيمة التغذوية لثمار صنفين من أصناف البلح السودانية

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المستخلص

هدفت هذه الدراسة لتحديد ومقارنة القيمة التغذوية لثمار نخيل التمر من صنف الجاف "البركاوي" والصنف شبه الجاف "مشرق ودخطيب". لذلك تمت دراسة التحليل الكيميائي ، محتوي المعادن ومحتوي الطاقة لكلا الصنفين. ولقد أظهرت النتائج المتحصل عليها من هذه الدراسة أن محتويات كل من المادة الجافة ، البروتين ، الدهن ، الكربوهيدريتات الكلية ، الالياف ، الرماد ، السكريات الكلية و السعرات الحرارية لصنفي البلح تراوحت ما بين 81.12 – 94.80 %، 02.17 –5.17 %، 0.91 –1.52 %، 89.76 – 94.37 %، 5.97 – 06.76 %، 2.55 – 03.06 %، 59.20 – 86.27 %، 376.66 – 380.22 كيلو سعر حراري علي التوالي لكل 100 جرام علي أساس الوزن الجاف. كما أوضحت النتائج إختلافات معنوية بين صنفي البلح بركاوي ومشرقي ود خطيب ، إحتوت ثمار بلح البركاوي علي أعلي نسبة من المادة الجافة (4.80 %)، الكربوهيدريتات الكلية (4.37 %)، الكربوهيدريتات متاحة (8.40 %)، السكريات غير المختزلة (4.51 %) والطاقة (380.22 كيلو سعر حراري لكل 100 جرام). بينما إحتوت ثمار الصنف مشرقي ود خطيب علي أعلي نسب من البروتين (5.70 %)، السكريات الكلية (6.27 %) والسكريات المختزلة (0.44 %)، علي أساس الوزن الجاف. و مقارنة محتوي الثمار من المعادن لصنفي البلح لكل 100 جرام من لب الثمار، وجد أن ثمارالصنف مشرقي ودخطيب قد إحتوت علي

أعلي تركيز من عنصر البوتاسيوم (160.26 ملجم)، الصوديوم (7.01 ملجم)والمغنيسيوم (06.09 ملجم)، بينما إحتوت ثمار الصنف بركاوي علي أعلي تركيز من عنصر الكالسيوم (29.75) لكل 00 جرام من المادة الجافة. وعموماً وجد أن كل من الصنف مشرقي ودخطيب والصنف بركاوي يحتويان علي تركيزات منخفضة من الحديد، المغنيسيوم والخارصين والتي تراوحت ما بين 03.70 – 3.06ا ، 02.22 – 01.19 و 02.10 – 01.27 ملجم لكل 00 جرام مادة جافة من الصنف مشرقي ودخطيب والصنف بركاوي، علي التوالي.