

# Comparative Study on Five Sudanese Date (*Phoenix dactylifera* L.) Fruit Cultivars

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## ABSTRACT

The date palm (*Phoenix dactylifera* L.) is one of mankind's oldest cultivated plants. A date palm fruit is an important component of the diet in most of the hot arid and semi arid regions of the world. The present study aimed at investigating the physical and chemical properties as well as microbiological characteristics of five date palm cultivars cultivated in Sudan. The results showed that the physical characteristics like fruit weight, length, flesh thickness, seed weight differed significantly between the various cultivars. Although most of the cultivars had similar chemical components, there were some few differences. However, the microbiological analyses proved that no significant differences were found among the cultivars.

**Keywords:** Amino Acids; Carbohydrates; Chemical Composition; Dates; Fatty Acids; *Salmonella*

## 1. Introduction

The date palm (*Phoenix dactylifera* L.) is one of mankind's oldest cultivated plants. It has been used as food for 6000 years [1]. It could be used for generations to come due to its remarkable nutritional, health and economic value, in addition to its aesthetic and environmental benefits. Every part of the date palm is useful. Dates offer useful prospects for fighting hunger and diseases.

A date palm fruit is an important component of the diet in most of the hot arid and semi arid regions of the world. It is found to contain carbohydrates (total sugars 44% - 88%), fats (0.2% - 0.4%), proteins (2.3% - 5.6 %), fibers (6.4% - 11.5%), minerals and vitamins [2].

Carbohydrates in dates are mostly in the form of fructose and glucose, which are easily absorbed by the human body. Interestingly, dates contain high concentrations of protein when compared to other cultivars of fruits such as apples, oranges, bananas and grapes (0.3%, 0.7%, 1.00%, and 1.00% proteins, respectively), as was reported by Al-Showiman [3].

Twenty three different amino acids were found in date's proteins, many of which are not found in the most popular fruits [4]. There are more than 2000 different varieties of fresh dates [1]. Many fresh varieties are available throughout 8 months of the year. Packed, dry dates keep well without the addition of preservatives for at least 8 months, the high sugar content acting as an effective preservative.

Date palm is one of the major fruit crops in the Sudan.

This mainly due to the prevailing favorable climate for date cultivation, availability of abundant irrigation water and long term experience acquired by the population in date cultivation together with related activities. The major production areas of dates are therefore, the Northern and Nile states, where the hot dry long summers and consequently the low relative humidity are ideal for date production. Thus a large number of cultivars are growing in this semi desert region of the country a long side the river Nile banks beside Eastern and Western regions of Sudan. These cultivars include; Mishrigy, Wad Lagai, Wad Khatib, Barakawi, Gondeila, Gau and others differ mainly in moisture contents.

The objectives of the study were to determine the physical properties of five Sudanese dates fruits cultivars and evaluation of the nutritional value its chemical composition.

## 2. Materials and Methods

### 2.1. Collection of Samples

Date fruits of cultivars: Gondeila, Barakawi, white Gau, Red Gau, and Black Gau were purchased from the local markets of Port Sudan city, Red Sea State, and from Khar-toum State, Sudan. The origin of these fruits is the Northern Region of Sudan. Each sample was collected randomly to assure good representation, and each sample was cleaned by remove foreign matter and taken in polyethylene bags with labels, and stored in a refrigerator till analyses.

## 2.2. Preparation of Date Fruits for Analyses

All date fruits samples were cleaned and pitted. The fruit pulp was ground with electric mincer and the fine sample was kept in a clean polyethylene bag, before being analyzed physically, chemically and microbiologically.

## 2.3. Physical Methods

Fruits dimensions (weight, length, and width) were measured in centimeters using Vernier caliper. Fruit and seed weight in grams were determined using an electrical balance, then pit percentage was calculated. Surface area (S) was calculated by using the following equation:

$$S = \pi \cdot D_g^2$$

where:

$$D_g = \text{Geometric Mean diameter} = (L \cdot W \cdot T)^{1/3}$$

L = length (L) cm

W = width (W) cm

T = thickness (T) cm<sup>2</sup>

$\pi = 3.14$  mathematical constant (Pi).

## 2.4. Chemical Methods

The contents of moisture, ash, protein and fats were determined according to AOAC [5].

### 2.4.1. Determination of Carbohydrates

Date fruit samples were analyzed for mono and disaccharides by High Performance Liquid Chromatography (HPLC) according to the AOAC [6]. A sample of 5 gm to which 20 ml of water were added, was transferred into 50 ml volumetric flask, then 12.5 ml ethanol were added and the volume was completed by water to the mark. The final solution was filtered through filter paper and syringe filter 0.45  $\mu$ m nylon disc into vial, and 20 ml were injected into the column of the HPLC. Standard solution of each sugar was prepared. All sugars were separated using a normal phase column (Shim-pack CLC I.d  $\times$  15 cm, KYOTO, Japan).

The mobile phase was Acetonitrile 80:20 Acetonitrile/water at 30°C and the flow rate was 1 ml/min. The data were recorded as percentage (w/w).

### 2.4.2. Amino Acid Composition

Amino acid content was determined according to AOAC [6]. A sample of 200 mg was taken in the hydrolysis tube and 5 ml of 6 N HCl was added and the tube was tightly closed, and incubated at 110°C for 24 hrs. After that the solution was filtered through 125 mm filter paper and 200 ml of the filtrate were taken and evaporated at 140°C for about an hour. To one ml of the dried sample a diluting buffer was added. The samples were then injected into amino acid analyzer (SYKNM).

### 2.4.3. Fatty Acid Profile (Qualitative Test)

The fatty acid profile was detected in the extracted oil samples using the method described by AOAC [7]. To 1 ml of oil sample, 7 ml of methanolic sodium hydroxide 0.5 N were added, and then 7 ml of 1% methanolic sulfuric acid were also added, after that 2 ml of hexane were added and the mixture was shaken well. Then the tube was filled to the mark by standard sodium chloride and shaken well again, and 1 ml of the upper layer was taken in a new tube to which anhydrous sodium sulphate was added. The fatty acid was then determined by Gas Chromatography-Mass Spectrophotometer (GC-MS-QP-2010-Shimadzu-Japan).

### 2.4.4. Mineral Content

Ten minerals namely potassium, sodium, magnesium, manganese, iron, copper, zinc, phosphorous, calcium and cobalt were determined in date palm fruit according to AOAC [6] method using Atomic Absorption Spectroscopy (AAS). Mineral analysis carried as, a 3 g portion of each sample was ignited and ashed at about 550°C in a muffle furnace. The ash was then dissolved in 5 ml of fuming nitric acid and transferred to 50 ml volumetric flask using double distilled deionized water. Standard solutions of each element were prepared as follows: 250  $\mu$ l were taken from the stock standard solution (1000 mg/l) in a plastic volumetric flask (25 ml) and made up to the mark with 0.5 normality of hydrochloric acid solution, thus made the intermediate standard solution (10 mg/l). Working control solutions were prepared to be suitable to the concentration of each element in the sample solution. The samples and controls were analyzed by AA-6800, SHIMADZU. Before the reading of the controls or samples solution, the absorption value of the blank solution was taken (all added reagents except sample). The absorbance value of each sample solution was taken then the blank value was subtracted from the sample value.

## 2.5. Microbiological Analysis

For determination of total viable count, one ml aliquots from suitable dilution ( $10^3$ ) were transferred aseptically into sterile Petri dishes. To each dilution 10 - 15 ml of melted and cooled (42°C) plate count agar were added. Inoculums was mixed well with the medium and allowed to solidify. The plates were then incubated in an incubator at 37°C for 24 - 48 hours.

Yeast and mould count was determined using Potato Dextrose Agar medium (PDA) with 40 ppm chloramphenicol added to inhibit bacterial growth. The plates were incubated at 25°C - 28°C for 48 hours. While the staphylococcus count was determined using Baird Parker Agar medium. The plates were then incubated at 37°C for 24 -

48 hours and the counts were presented as colony forming units per gram (cfu/g).

For *coliform* test, one ml of sample was plated onto (MacConky Agar) media. The plates were incubated at 37°C for 48 hours and the counts were presented as colony forming unites per gram (cfu/g). Plates showing positive *coliform* were subjected to the confirmed test using Brilliant green bile lactose broth in test tubes with Durham tubes. The test tubes were then incubated at 44°C for 48 hours. Each confirmed positive tube was subcultured into E.C. broth medium and then incubated at 44.5°C for 24 hours. Tubes showing any amount of gas production were considered to be positive.

For detection of *Salmonella*, ten grams of sample were weighted aseptically and mixed well with 100 ml sterile nutrient broth. This was incubated at 37°C for 24 hours. Then 10 ml were drawn aseptically and added to 100 ml selenite broth. The broth was incubated at 37°C for 24 hours. Then with a loopful streaking was done on dried Bismuth sulphite agar plates. The plates were then incubated at 37°C for 72 hours. Black metallic sheen discrete colonies indicated the presence of *Salmonella*. A confirmatory test was carried out by taking a discrete black sheen colony and subculturing it in a Triple sugar iron agar tubes. Production of a black colour at the bottom of the tube confirms the presence of *Salmonella*.

## 2.6. Statistical Analysis

The data was assessed by analysis of variance (ANOVA) procedure. Means were separated using Least Significant Difference (LSD) test with probability  $p < 0.05$  [8].

## 3. Results and Discussion

### 3.1. Physical Characteristics

Black Gau showed the maximum fruit weight (12.78 g) which was significantly higher than all other cultivars (**Table 1**) while Red Gau had the least fruit weight (6.57 g) significantly lower than of the other cultivars. The average of date weight (9.16 g) was higher than that reported by Abdullah and Salah [9] for three date palm cultivars grown in Libya which showed that the highest value was 8.69 g. According to Hussein, *et al.* (1976) on their study on eighteen date cultivars in Saudi Arabia, the fruits exceed 15 g were classified as fruits of heaviest weight. Barakawi had the highest value of pit percentage (15%), followed by Red Gau (14%) and the lowest was Black Gau (9%). However no records were found in the literature concerning the pit percentage.

Black Gau had the maximum fruit length (5.1 cm) followed by white Gau (4.74 cm), Gondeila had the least fruit length (4.30 cm) which was significantly lower than all other cultivars (**Table 2**). Black Gau had the maximum

fruit diameter (1.82 cm) this value was significantly higher than those of other cultivars. Barakawi cultivars exhibited the least fruit diameter (1.38 cm). The highest surface area was showed in Black Gau (7.51 cm<sup>2</sup>), the lowest value was shown in White Gau (3.69 cm<sup>2</sup>).

The average of fruit length was 4.62 cm which is higher than that reported by Abdullah and Salah [9] for the Libyan cultivars which ranged between 3.78 and 3.79 cm, with insignificant differences between cultivars. The average in fruit diameter was 1.61 cm which is lower than Libyan cultivars investigated by Abdullah and Salah [9], which were in the range between 1.86 and 2.34 cm. The same study showed that flesh thickness in Libyan cultivars ranged from 0.38 to 0.6 cm which is higher than the result of this study. The thickness in this study ranged from 0.2 to 0.5 cm.

Characters like fruit weight and length, flesh thickness, seed weight, seed length and diameter are of importance in differentiation between the cultivars. Other studies also proved significant differences of the fruit characters in the study of cultivars [10-12]. Meligi, *et al.* [13] studied the fruit quality and general evaluation of some Iraq dates grown under Egyptian condition.

### 3.2. Chemical Characteristics

Fat content (**Table 3**) ranged from 0.32% in white Gau to 0.33% in Black Gau. The statistical analysis showed that there was no significant differences ( $p < 0.05$ ) between the five cultivars tested. These results were higher than those reported by Al-Hooti [14] in Kuwait. However these

**Table 1. Date weight (g), pit weight (g) and pit % of five date cultivars.**

Date Cultivar	Pit (%)	Pit Weight (g)	Date Weight (g)
White Gau	13%	1.18±	9.41±
Red Gau	14%	0.92±	6.57±
Black Gau	9%	1.21±	12.78±
Barakawi	15%	1.15±	7.90±
Gondeila	13%	1.23±	9.14±

Values are means of triplicate determinations.

**Table 2. Dimensions of date fruits of five cultivars.**

Date Cultivar	Diameter (cm)	Surface Area (cm <sup>2</sup> )	Length (cm)	Flesh Thickness
White Gau	1.68 ± 0.13	3.69 ± 0.10	4.74 ± 0.25	0.32 ± 0.13
Red Gau	1.40 ± 0.18	5.29 ± 0.14	4.54 ± 0.26	0.28 ± 0.11
Black Gau	1.82 ± 0.18	7.51 ± 0.11	5.10 ± 0.20	0.50 ± 0.20
Barakawi	1.38 ± 0.13	5.50 ± 0.12	4.42 ± 0.21	0.28 ± 0.12
Gondeila	1.80 ± 0.10	5.29 ± 0.20	4.30 ± 0.25	0.30 ± 0.14

Values are means of triplicate determinations.

values are similar to those reported by Sawaya, *et al.* [15] for dates grown in Saudi Arabia, and to those reported by Ahmed, *et al.* [16] for dates grown in the United Arab Emirates. On the other hand the values were lower than those reported for some Iranian varieties [17]. Fats are mainly concentrated in the skin (2.5% - 7.75%) and have a more physiological importance in protecting the fruit than contributing to the nutritional value of the date flesh [18]. The low level of the fat content in date fruit (very low level of fatty acids and cholesterol) compared with its higher content of sugars, means that, consumption of date fruit is safe for people suffering from heart and blood diseases.

The average percentage of ash content as shown in (Table 3), ranged from 2.53% in Gondeila to 3.20% in black Gau. There was significant differences ( $p > 0.05$ ) among the five varieties tested. The ash content was higher than what reported by Al-Hooti [14].

The mean crude protein content of the five cultivars was 2.67%. Gondeila showed the highest level (3.72%), while, white Gau had the lowest level (1.86%) (Table 3). These values comply with those reported by Al-Hooti [14]. However there were significant differences ( $p < 0.05$ ) among the five cultivars tested.

### 3.2.1. Amino Acids

The analysis of amino acids composition showed that the date fruits extract of all cultivars contains a high concentrations of aspartic acid, proline, alanine, theonine, valine, Isoleucine, and leucine but low concentration of glycine, phenyleadnine, and arginine, and very low concentration of histidine, and lysine (Table 4). Almost all cultivars showed similar amino acid composition. Fourteen amino acids were detected in the five dates cultivars. The aspartic acid was the highest in Gondeila (8.57  $\mu\text{g}/8\text{mg}$ ) and the lowest in Red Gau (3.52  $\mu\text{g}/8\text{mg}$ ), while, Threonine was the highest in Red Gau (4.04  $\mu\text{g}/8\text{mg}$ ) and the lowest

in Barakawi (0.68  $\mu\text{g}/8\text{mg}$ ). Glycine was the highest in Black Gau (0.86  $\mu\text{g}/8\text{mg}$ ) and the lowest in Gondeila (0.29  $\mu\text{g}/8\text{mg}$ ), Alanine was the highest in Black Gau (4.71  $\mu\text{g}/8\text{mg}$ ) and the lowest in red Gau (2.60  $\mu\text{g}/8\text{mg}$ ).

Valine was the highest in Black Gau (4.655  $\mu\text{g}/8\text{mg}$ ) and the lowest in Red Gau (2.465  $\mu\text{g}/8\text{mg}$ ), isoleucine was highest in Gondeila (2.509  $\mu\text{g}/8\text{mg}$ ) and the lowest in Red Gau (1.466  $\mu\text{g}/8\text{mg}$ ), phenyleadnine was the highest in Gondeila (1.189  $\mu\text{g}/8\text{mg}$ ) and the lowest in Red Gau (1.466  $\mu\text{g}/8\text{mg}$ ) and didn't found in Black Gau, Histidine was highest in Black Gau (1.306  $\mu\text{g}/8\text{mg}$ ) and lowest in Red Gau (0.192  $\mu\text{g}/8\text{mg}$ ), Lysine was highest in Black Gau (0.598  $\mu\text{g}/8\text{mg}$ ) and was lowest in Red Gau (0.097  $\mu\text{g}/8\text{mg}$ ), Ammonia from 10.115  $\mu\text{g}/8\text{mg}$  in Gondeila to 0.226  $\mu\text{g}/8\text{mg}$  in Black Gau, Aginine was highest in Black Gau (8.246  $\mu\text{g}/8\text{mg}$ ) and lowest in Red Gau (0.808  $\mu\text{g}/8\text{mg}$ ), Proline was highest in Gondeila (11.95  $\mu\text{g}/8\text{mg}$ ) and lowest in Red Gau (7.542  $\mu\text{g}/8\text{mg}$ ), Tyrosine was found just in Gondeila (0.294  $\mu\text{g}/8\text{mg}$ ) and Black Gau (0.225  $\mu\text{g}/8\text{mg}$ ). The results of this study comply with Al-Showiman [3]. The data revealed that, the date palm extract contains suitable amounts of essential amino acids, which means high nutritional value.

**Table 3. The contents of fat, protein and ash (%) in the five dates cultivars.**

Cultivars	Fat	Protein	Ash
Barakawi	0.3257	2.7067	2.6133
Gondeila	0.3233	3.7233	2.5333
Red Gau	0.3233	2.3500	2.6800
White Gau	0.3200	1.8600	2.5600
Black Gau	0.3300	2.7333	3.3200
Mean	0.32	2.67	2.74
S.D.	0.02	0.11	0.23

Values are means of triplicate determinations

**Table 4. The amino acid content of flesh date ( $\mu\text{g}/8\text{mg}$ ).**

Amino Acid	Red Gau	Black Gau	White Gau	Gondeila	Barakawi
Aspartic Acid	3.52	8.17	3.65	8.574	5.916
Threonine	4.04	1.75	0.84	1.017	0.684
Glycine	0.37	0.86	0.31	0.285	0.308
Alanine	2.60	4.72	3.07	4.329	3.042
Valine	2.47	4.66	2.95	4.091	2.902
Isoleucine	1.47	2.39	1.73	2.509	1.799
Leucine	1.31	3.23	1.81	2.421	1.866
Phenyleadnine	0.56	-	0.64	1.189	0.766
Histidine	0.19	1.31	0.31	0.362	0.292
Lysine	0.09	0.59	0.12	0.152	0.368
Ammonia	7.29	0.23	5.48	10.115	8.424
Arginine	0.81	8.43	0.88	2.191	1.173
Proline	7.54	8.73	10.37	11.950	8.572
Tyrosine	-	0.23	-	0.294	-

### 3.2.2. Free Fatty Acids

The characteristic and composition of the flesh of the date fruit cultivars in accordance with their free fatty acids contents are presents in (Table 5). White Gau and Barakawi showed similar fatty acid whereas Red Gau, Gondeila, and Black Gau, are different. Fatty acid analysis revealed that date fat is rich in Myristic acid, Palmitelaidic acid, Palmitolic acid, Palmotoc acid, Margaric acid, Olic acid, Oleic acid, stearic acid, acrylic acid, Erucic acid and Propanoic acid. These results were similar to those reported by Al-Shahib and Marshall [4].

### 3.2.3. Carbohydrates

The carbohydrate analysis showed that they consist of a large amount of glucose, fructose and sucrose, which are easy to digest in human cells and useful for getting the energy for metabolic processes. On the other hand, two cultivars (Gondeila and Black Gau) were found to contain rhaminose whereas, no cultivar was found to contain maltose (Table 6).

### 3.2.4. Mineral Content

The element analysis of date palm extract showed that, the fruit of date palm contains many valuable and useful elements like Calcium, Potassium, Magnesium, Phosphorous, Iron, Cobalt, Copper, Manganese, Zinc, and Sodium (Table 7). All the five date cultivars were different significantly in their mineral levels. Gondeila had the highest Zinc (0.46 ppm) whereas, Barakawi had the lowest level. Gondeila showed the highest Manganese level (0.36 ppm) while Black Gau have the lowest (0.19 ppm). The highest Copper content was in Black Gau (0.43 ppm) and the lowest in White Gau (0.17 ppm).

The highest Cobalt level was found in Barakawi (0.04 ppm), and the lowest in White Gau. The Calcium highest level was in Gondeila (59.09 ppm) and the lowest was recorded in Black Gau (39.38 ppm). Black Gau had the highest level of Iron (33.94 ppm), while, White Gau has the lowest level (2.52 ppm). Magnesium was highest in Barakawi (50.24 ppm), and lowest in Red Gau (36.09 ppm). Sodium was highest in Black Gau (60.00 ppm) and lowest in White Gau (15.00 ppm). The highest level of Potassium was recorded in Barakawi (726.97 ppm), whereas, White Gau has the lowest level (558.99 ppm). The highest level of Phosphorous was in Gondeila (16.201 ppm) and the lowest level was in Red Gau (10.75 ppm).

These results are in accordance with many previous reports which revealed that the date palm contains a suitable concentration of elements which are very important for human body and metabolic operations in the human cells [19]; Al-Showiman [3].

### 3.3. Microbiological Tests

The results of the microbiological tests are shown in (Table 8). The total bacterial viable count was higher in Black Gau ( $3 \times 10^4$  cfu/g) and lower in Red Gau ( $3.5 \times 10^3$  cfu/g); The total *coliforms* were present almost in all cultivars; Black Gau, Red Gau, and Barakawi had the highest value (23 MNP/g). The other cultivars showed few numbers of *coliforms* and the *E. coli* was detected in some cultivars but their levels were lower than that reported by the Sudanese Standards ( $<1.0 \times 10^2$ ). *Staphylococcus aureus* was detected in Barakawi, white Gau (North, West) and Black Gau date cultivars. *Salmonella* spp. were detected in almost all the examined date cultivars. Moulds and yeast

Table 5. Free fatty acids profile of flesh date fruits.

Common Name	Barakawia	Gondeila	Red Gau	White Gau	Black Gau
Palmitoleic Acid	-	+	+	+	+
Palmitilaidic Acid	+	+	+	+	+
Palmitic Acid	+	+	+	+	+
Oleic Acid	+	+	+	+	+
Oleic Acid Ethyl Ester	+	+	+	+	+
Methyl Ester	-	+	+	+	+
Stearic Acid	+	+	+	+	+
Eicosnoic Acid	-	+	+	-	+
Euric Acid	-	+	+	-	+
Myristic Acid	-	+	+	-	+
Euric Acid	-	-	+	-	+
Myristic Acid	-	-	+	-	+
Teracosahexanoic Acid	-	-	+	-	-
Tridecanoic Acid, Methyl Ester	+	-	-	-	-

+: Present; -: Absent.

were detected in Gondeila, Barakawi, Black Gau (East) and in White Gau date fruit cultivars. Moulds are considered to be the major causative agents of the spoilage of date fruits at all stages of ripening on trees as well as during storage and processing. The total bacterial viable count usually indicates the general microbiological quality of date fruits (Moore, *et al.*, 2001).

The results of the present study are in compatibility with those of Aidoo, *et al.* [20] who reported that pre-packed dates purchased in Glasgow contained high levels of *coliform*, moulds and yeasts and little or very low levels of *Staphylococcus aureus*. Moisture content is a critical parameter responsible for the microbiological quality of the dates. Shenasi, *et al.* [21] in United Arab Emirates reported that microbial counts were high at the *kimri* and *rutab* stages then decreased significantly at *tamr* stage which has low water content and high sugar level. It appears therefore, that presence of micro flora in date fruits may be dependent on the variety and the maturation stage.

From these results it could be concluded that the dimensions of the date fruits differ from one cultivar to another but the Black Gau has wide dimensions. Although most

of the cultivars contain almost similar chemical components, however, there are some few differences in these components. The microbial analysis tests proved that no differences are found among the cultivars. However, the differences were found according to the conditions of selling and handling. Barakawi (S) was found to contain all types of micro organisms tested. Pathogenic bacteria (*Sthaph. aureus*, *Salmonella* and *E. coli*) were detected in some date cultivars.

**Table 6. Carbohydrate contents (%) of five date fruits cultivars.**

Date Cultivar	Fructose	Glucose	Sucrose	Rhaminose
Gondeila	18.02	19.10	22.48	1.74
Barakawi	17.88	18.72	16.50	-
Red Gau	17.83	12.88	7.33	-
White Gau	18.89	20.38	13.71	-
Black Gau	23.35	24.56	0.86	1.23

**Table 7. Mineral Concentration (mg/L) of the date fruits of five cultivars.**

Minerals	Black Gau	White Gau	Red Gau	Gondeila	Barakawi
Zn	0.38	0.26	0.37	0.46	0.32
Mn	0.19	0.29	0.33	0.36	0.35
Fe	33.94	2.52	6.52	4.41	3.03
Cu	0.43	0.17	0.18	0.38	0.37
Mg	37.33	37.75	36.09	41.02	50.23
Ca	39.38	54.74	41.58	59.09	46.54
Mg	37.33	37.75	36.09	41.02	50.23
Na	2.69	0.65	1.17	2.04	2.26
K	14.79	14.33	17.51	17.85	18.64
P	14.14	12.11	10.75	16.20	12.34
Co	0.03	0.02	0.03	0.03	0.04

**Table 8. Microbiological results of Date fruits collected from Khartoum Market.**

Date Fruit Cultivar	Total Viable Bacterial Count (cfu/g)	Total <i>coliform</i> (MPN/g)	<i>E. coli</i> (MPN/g)	<i>Staphylococcus aureus</i> (cfu/g)	Moulds and Yeasts (cfu/g)	Detection of <i>salmonell.</i>
Gondeila	$7.0 \times 10^2$	0	0	0	$5.5 \times 10^5$	-ve
Barakawi	$2.30 \times 10^3$	21	0	$3.0 \times 10^2$	$4.7 \times 10^5$	-ve
Black Gau	$4.0 \times 10^3$	0	0	$4.0 \times 10^2$	$4.0 \times 10^2$	-ve
White Gau	$8.0 \times 10^3$	0	0	0	0	-ve
Red Gau	$2.50 \times 10^3$	9	0	0	$3.0 \times 10^2$	+ve

It is highly recommended to improve the harvest and handling methods (storage, grading and packaging) of dates. Since the date fruits are usually sold in open places, and found to be contaminated with microbes, it could be recommended that date fruits must be washed before eating. Further studies need to be made on the chemical composition and the microbial analysis of the other date fruits types grown in Sudan.

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