Basrah Journal of Date Palm Research
Volume 21 Issue (2) 2022
BJDPR
مجلــة البصــرة لأبحاث نخلــة التمــر
المجلد 21 العدد (2) 2022

The effect of different drying methods on the chemical content and antioxidant activity of three cultivars of Iraqi dates

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Abstract

The current study aimed to study the chemical content and antioxidant activity traits of three cultivars (Dairy, kabkab, Zahdi), dried by different drying methods (Solar, Electric oven, Microwave). The results of chemical composition of date fruit powders showed that the moisture content decreased during drying by different drying methods, especially when dried in the Microwave, where the microwave-dried Dairy powder recorded the lowest percentage and reached 3.59%, while the percentage of total soluble solids for the same powder increased and was 58.79%, followed by Zahdi powder dried by Microwave 58.38%. The dried date powder by the different drying methods did not record significant differences in the percentage of ash, total acidity, and pH. The protein percentage increased when the fruits were dried in the microwave, whereas, Kabkab powder, dried in the electric oven, recorded the highest value in the percentage of fat, which amounted to 0.71%, as for the microwave-dried Zahdi powder, the percentage of fibers increased by 5.95%. Total sugars increased during solar drying. The solar-dried Zahdi powder recorded the highest percentage of total sugars and sucrose at 77.41 and 17.27%, respectively. As for reducing sugars, no significant differences were recorded for all treatments. The phenolic content of date fruit powders increased when the fruits were dried by different drying methods. The microwave-dried Zahdi powder recorded the highest phenolic content and reached 70.1 mg 100 gm^{-1}. The antioxidant activity of date powders increased during various drying processes, Zahdi powder dried by microwave and electric oven recorded the highest percentage of 87.57 and 87.33%, respectively.

Keywords: Date palm, drying methods, date powder, chemical composition, phenolic compounds, antioxidants.

Hamza, R. S. and Al-Hashimi, A.G. (2022). The effect of different drying methods on the chemical content and antioxidant activity of three cultivars of Iraqi dates. Basrah Journal of Date palm Research, 21(1):64-81.

Introduction

Sugars are a major source of energy that the body relies on the continuation of its vital activities and is considered the main component of dates, 100 g of dates is enough to provide the human body with 300 calories (Djoudi, 2013). The carbohydrate content (65.2-88.02% of the dry weight) of the date pulp can vary according to the type of cultivar and the stages of maturity (Hussain et al., 2020). Date pulp contains easily digestible sugars (70%), glucose (35%), fructose (26%), and sucrose (0.5%), (Al-Juhaimi et al., 2018). Sugar contents show a gradual upward trend during ripening (El-Arem et al., 2012). Dates are one of the abundant sources of carbohydrates, as sucrose, maltose, glucose, and fructose constitute more than 80% of its dry matter. (Maqsood et al., 2020). Soft date fruit consists primarily of inverted sugars (fructose and glucose) with little or no sucrose; while dry fruits contain a high percentage of sucrose, accordingly fruits are classified based on their sugar type into three groups, the second group is called mixed sugars, such as Khadrawi, Hellawi, Zahdi and Sayer, while the last group contains mainly sucrose, such as Degla Nour and Degla Abida (Eid et al., 2013). Although dietary fiber is not a nutrient, it is essential for human health. Fiber found in vegetables includes pectin, mucilage, and soluble beta-glucan, while lignin, cellulose, and hemicellulose are insoluble in different plants (Chawla and Patil, 2010); these components are not digested or absorbed in the small intestine and pass into the large intestine properly and are resistant to enzymatic digestion, fiber is classified as soluble or insoluble based on its solubility (Ambuja and Rajakumar, 2018), fiber plays an essential functional role in the human body against various diseases because fiber is indigestible and passes through the small intestine to the large intestine without absorption, in the minor intestine nutrients such as fat and glucose are absorbed. However, fiber binds to the extra fat and glucose and pushes it into the large intestine; in this way, the fiber prevents excess glucose and fats from reaching the blood, which helps reduce the chances of developing diabetes and cardiovascular disease (He et al., 2010; Ambuja and Rajakumar, 2018). Date fruits are a rich source of dietary fiber, as they constitute (6.5-11.5%) of which 84-49% are insoluble such as cellulose, hemicellulose, and lignin, while the soluble constitute 6-16% of the fibers, such as pectin, inulin, galactomannan and beta-glucan (George et al., 2020). Phenolic compounds are considered one of the most important active substances and are characterized by powerful antioxidants and free radical scavengers that can act as hydrogen donors, reducing agents, and chelating compounds that bind metals (Abdeen, 2018). Phenolic acids are considered one of the main secondary aromatic plant receptors. They can be divided into two main parts: benzoic acid

derivatives, which contain seven carbon atoms, and cinnamic derivatives, which contain nine carbon atoms. They are also considered effective antioxidants because they work to curb free radicals, the dates are rich in phenolic acids (Saleh et al., 2011; Benmeddour et al., 2013; El-Sohaimy et al., 2015). Dates are a good source of antioxidants such as tannins, carotenoids, sterols, and polyphenols (Martiín-Sanchez et al., 2014). (Boudries et al., 2007) noted the abundance of carotenoids in date oil, mainly carotene and beta-lutein. These carotenoids are common precursors to vitamin A and are active antioxidants, as well as the maturity stage of dates, as the antioxidants differ from one stage to another (Maqsood et al., 2020). Bano et al. (2022) conducted a study to determine the effect of the four stages of maturity on the chemical composition and antioxidant activity of date cultivars (Phoenix dactylifera L.). Four varieties of date palms were used, namely (Zahdi, Aseel, Hellawi, Daki) in four stages of maturity (Kamri, Khalal, Rutab and Dates); the researchers observed that the total phenolic content, antioxidant activity and total flavonoid content gradually decreased in all the selected date cultivars from the citrus stage to the date stage during the fruit ripening process. The content of antioxidants varies, although this fruit is believed to be rich in antioxidants; for example, it was discovered that the soluble phenolic compounds in Omani dates are significantly higher (217-343 mg eq ferulic acid 100 g-1) compared to other fruits (Ghnimi et al., 2017). However, it has also been shown that storage conditions affect date fruits' antioxidant content and activity. The content of antioxidants may decrease during storage at ambient temperature due to the conversion of soluble tannins to insoluble tannins (Samad et al., 2016) and enzymatic oxidation of flavonoids and caffeoyl shikimic (Ali Haimoud et al., 2016).

This study aimed to study the chemical composition of the powders of three cultivars of local and dried dates by different drying methods and to estimate the phenolic content and antioxidant activity of these powders.

Materials and Methods

Date powder Preparation:

Three low-quality dates (Dairy, Kabkab, Zahdi) were used, obtained from Abi Al Khasib farms, Basrah, for the 2021 harvest season. The dates were cleaned, the seeds were removed, then the fruit was divided into two halves, then each variety was divided into three parts, transfer the first part of each variety to solar drying. Dates were placed on a papyrus mat and left under the solar for two weeks or more, depending on the cultivar of dates. The second part was placed in an oven

at a temperature of 50±5 ˚C for 72 hours until it was completely dry (Izli, 2017). An electric oven of the Chinese origin Gosonic solar was used. The third part, was placed in a microwave oven (120 watts) for two minutes, from a solar of Gosonic of Chinese origin (Izli, 2017). The dried dates were ground using a German-made Silver Crest grinder,to obtain the date powder. The powders were placed in special bags at room temperature until the necessary tests were carried out.

Chemical analysis of the powder:

Determination of moisture, ash, fat, and fiber content:

The percentage of moisture, ash, fat and fiber of date fruit powders (Dairy, Kabkab, Zahdi) was estimated according to the method used in (A.O.A.C, 2007).

Estimation of total dissolved solids (TSS):

The total soluble solids were estimated according to Howrtiz (1975).

Estimation of total acidity and pH:

The total acidity and pH were estimated according to A.O.AC. (2002).

Estimation of the protein percentage: The total protein of date powders was estimated based on the percentage of nitrogen using the microcalcium method, according to what was mentioned in (A.A.C.C, 1998) and according to the following equation:

Total Protein (%) = Percentage of Total Nitrogen x 6.25

Estimation of total and reducing sugars and sucrose:

Total reducing sugars and sucrose were estimated for date powders using Lane & Eynon method, which is mentioned in Howrtiz (1995).

Total phenolic compounds

Preparation of the alcoholic extract:

The extract was prepared for powdered date fruits with some modifications according to the method Biglari *et al*. (2008). The solvent (methanol/water) was used 1:4, 100 gm of date powder was weighed, and 300 ml of the solvent (methanol/water) was added to it for 15 minutes, then placed in the dark for 24 hours. It was filtered using filter paper (Watman No.1). Then the filtrate was concentrated using a rotary evaporator to obtain the crude extract; it was poured into Petri dishes and placed in the dryer for 8 hours at a temperature of 40° C. The crude extract was kept in dark-colored sealed containers in the refrigerator until use.

Determination of Total Phenolic Compounds

Biglari et al. (2008) followed the method to estimate the total phenolic compounds. 1 ml of alcoholic extracts of the date palm fruits under study were mixed with 1.5ml of Folin_Ciocalteu reagent, and 10ml of distilled water was added to it. The mixture was for (3 minutes) and then 2 ml of sodium carbonate solution 20 % Na_2CO_3 of concentration was added to it, the mixture was left for two hours at room temperature. The absorbance was measured at a wavelength of 765 nm, showing the maximum absorption of phenolic compounds as the standard curve was prepared. This is done by using gallic acid at concentrations of (0, 0.2, 0.4, 0.6, and 0.8) gm/ml and as shown in Figure (1).

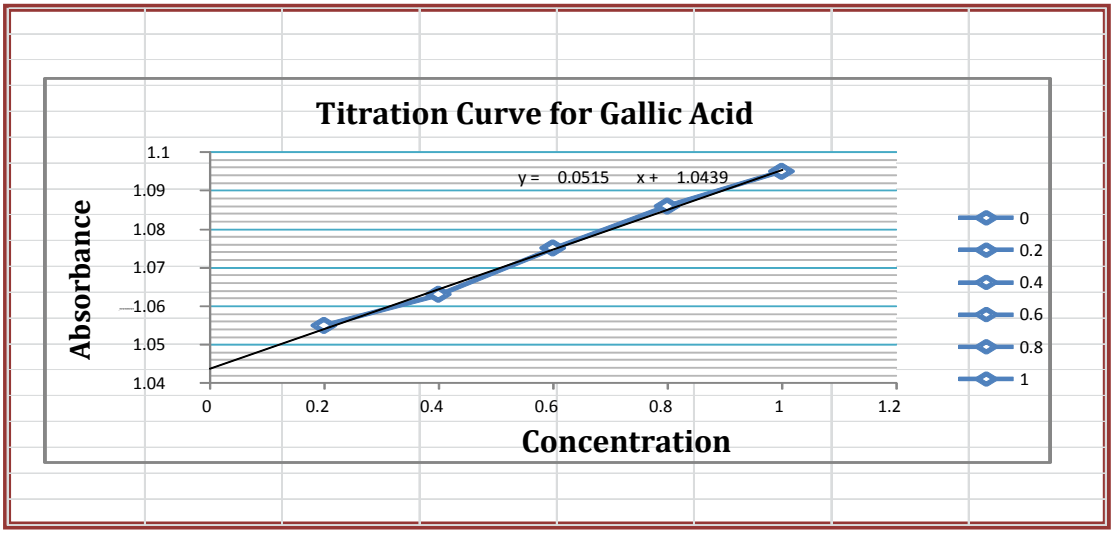

Figure (1) titration curve for gallic acid

Antioxidant capacity determination

The antioxidant activity was measured using (DPPH) 2,2-Diphenyl-1-1- Picrylhydrazyl based on the method described by Brand-williams & Bereat (1995). 250 µl of alcoholic extract of palm fruits under study was taken at the Tamer stage and diluted with distilled water to a volume of 10 ml. A sample of 250 µl was taken from the extract and mixed with 2 ml of DPPH solution in methanol 100 µmol, stirred using a magnetic mixer, and then placed in dark at laboratory temperature for 60 minutes. The absorbance of the resulting solution was read using a spectrophotometer at a wavelength of 520 nm, and the antioxidant activity was expressed as % DPPH free radical inhibition activity. The ability to inhibit DPPH radicals was calculated using the following equation:

$$DPPH\ root - inhibiting\ efficacy\ \% = \frac{A1-A0}{A0} \times 100$$

A1: absorbance of the sample after 60 minutes

A0: Witness absorbance after 60 minutes

Statistical analysis :

Statistical analysis of the data experiment was carried out according to the complete random design (CRD), and the results were analyzed within the ready-made statistical program Release GenStat based on the least significant difference between the means R.L.S.D at the probability level of $P<0.05$.

Results and discussion

The chemical composition of the powder of three types of local dates (Dairy, Kabkab, Zahdi) and dried in different ways (solar, electric oven, microwave):

Table (1) indicates the effect of the three drying processes (solar, electric oven, and microwave) on the chemical composition of powdered date varieties (Dairy, Kabkab, Zahdi). The results of the statistical analysis of date powders, at the probability level of P<0.05, showed that there were significant differences in the moisture content between the powders of the different types of dates dried by different drying methods, but no significant differences were observed for the moisture content of the dried powders with the same heat treatment, as for the powders treated by solar drying, as well as for the microwave treatment, no significant differences were recorded for all varieties, as for the electric furnace treatment, significant differences were observed between the moisture content of Dairy powder and the moisture content of Kabkab and Al-Zahdi powders. Dairy powder with microwave treatment recorded the lowest percentage of moisture content, which was 3.59%, while the highest level of moisture in the solar Kabkab powder was 5.36%, as the humidity was close within one heat treatment, while it differed among the varieties under study. The current results in estimating the moisture content of date powders were in agreement with El-sharnouby *et al*. (2007). They proved in their study that heat treatments are able to reduce the moisture content in date fruits, as they noticed a difference in moisture loss ratios from one treatment to another. The lowest moisture was obtained in the microwave treatment compared to the other treatments. This result is consistent with the results obtained (Alsmairat *et al*., 2019). The reason may be due to, as mentioned before (Alsmairat *et al*., 2019). That drying may lead to adverse changes in the physical properties of date fruits, such as hardness, changes in color, and total soluble solids. Raza *et al*. (2019) indicated in his study of three cultivars of dates, the humidity decreased when dried in an electric oven, and the moisture content was 1.55, 2.39 and 2.53%, respectively. The humidity was very low and it was somewhat close to the study in terms of heat treatment, but the difference came according to the studied varieties. Table (1) show the

percentage of total soluble solids for date powders. It is noted that there are significant differences between Kabkab, Dairy and Zahdi powders at the probability level of $p<0.05$ in the percentage of total soluble solids, as for the heat treatments, the microwave-dried sample did not record significant differences with the electric oven treatment, while the two treatments recorded significant differences with the solar treatment. The highest percentage of total soluble solids for Dairy and Kabkab powders was 58.79-58.38%, as for the solar treatment, it obtained the least significant difference, and it was 52.52% for the solar-dried Kabkab powder. As it is noted from Table (1), there was a rise in the percentage of total soluble solids during heat treatments, as it recorded a remarkable increase, especially in the microwave treatment, followed by the electric oven. The results did not agree with (Alsmairat *et al*., 2019). In their study of the percentage of total dissolved solids (TDS) for the cultivar Majdoul. Table (1) showed the percentage of acidity calculated on the basis of citric acid for date powders, as the total acidity ranged between 0.14 - 0.173%, while the value of the acidity function (pH) of date powders and dried by different methods ranged between (5.86-6.88), as the results of the statistical analysis showed that there were no significant differences between date powders and also between heat treatments at the probability level $p<0.05$. The percentage of protein and fat, the results of the statistical analysis shown in Table (1) indicate that there are significant differences between the powders (Dairy, Kabkab and Zahdi), as well as the drying treatments, a difference in protein and fat percentages is observed from one heat treatment to another, the drying treatment by electric oven and microwave recorded a slight increase in protein percentages from the solar dried powder, as the results were close in value. The highest values in the percentage of protein for Dairy powder dried by microwave and electric oven were (3.12-3.06)%, respectively, while Kabkab powder recorded the highest percentage by solar drying 2.86%, while the percentage of protein for the powdered Kabkab dried by electric and microwave oven was 2.26-2.35% respectively, as well as for the fat, significant differences were noted between the three powders. The highest value in the percentage of fat of Kabkab powder in the electric oven was 0.71%, while the percentage was (0.54-0.42)% for the same powder treated by solar and microwave drying, as it was lower than the sample dried in the electric oven, these results agreed with AL-Farsi *et al*. (2005) in his study of the Omani varieties dried by the solar method, as the percentage of protein ranged (1.47-1.68)%, while the percentage of fat was 0.52-1.41%, as the percentages vary according to the varieties. AL-Farsi & Lee (2008) found in their study that the protein content in fresh and dried dates ranges from 1.50-2.14%, respectively. Likewise, the fat ranged between fresh and dried

dates 0.14-0.38%, as the percentage increased significantly during drying and the reason was due to moisture loss. The results reached Raza *et al*. (2019) in studying the chemical composition of the powders of three varieties of Pakistani dates, the percentage of protein in his study ranged 4.1-5.61%. This percentage in protein for the powders dried by the electric oven was higher, and this does not agree with the date powders of the varieties listed. The study of the percentages in his study of fat ranged between 0.34-0.87% for the same treatment, so the results are somewhat identical with what we found, but the difference is due to the differences between the varieties. As for the percentage of ash, the results of the statistical analysis showed that there were no significant differences between the powders of the date varieties under study, as well as no significant differences between the heat treatments at the probability level of $p<0.05$, as the results were close in the percentage of fat and ranged between 2.37-2.71%. Table (1) indicate that there were significant differences in the percentage of fibers in the date powders of the varieties (Dairy, Kabkab, and Zahdi), as the Zahdi powder dried in the microwave and in the electric oven recorded the highest values in the percentage of fibers, which amounted to 5.95 and 5.76%, followed by the Kabkab powder. The dried in the microwave and in the electric oven reached 5.75, 5.75%, while the solar-dried dairy powder and the electric oven recorded the lowest values in the percentage of fiber (5.12, 5.29), respectively. The results were within the limits reached by AL-Farsi & Lee (2008) in his study of a number of dried cultivars, as the percentage of fiber ranged between 3.57-10.9%, while the results were inconsistent with what was found by El-sharnouby *et al*. (2007) in the percentage of fiber as it ranged 9.60-10.31% for Rothana and plant powders on the dried in electric and microwave ovens. Table (1) indicated that there were significant differences between date powders. At the same time, there were no significant differences between the heat treatments, as the solar-dried Dairy powder recorded the highest percentage in total sugars, which amounted to 77.41%. In contrast, the microwave-dried Kabkab powder recorded the lowest difference significant and amounted to 71.22%, as the results were close within one heat treatment, the estimated results for total sugars were not in agreement with what was found by AL-Farsi *et al.* (2005), El-Sharnouby *et al*. (2007), as the percentages of total sugars in his study of electric oven-dried date powders were close to the current results, as for microwave-dried powders slightly higher, as the drying methods affected the sugar contents of the dried items, especially the powders prepared in the electric oven and microwave, which decreased significantly compared to the dates fruits. The reason for the low sugar content is due to the occurrence of Maillard interactions between reducing sugars and amino acids during the

drying process, and this result consistent with the current study, as decrease in total sugars is observed than the date fruits were before the drying process. There were significant differences between date powders and also between heat treatments, the solar-dried Zahdi powder recorded the highest value in the percentage of sucrose, which reach to 17.27%, while the powder of the same variety dried by microwave and electric oven recorded percentages 13.42 and 15.67%, respectively. The percentages were close to the powdered dates dried in an electric oven; therefore, no significant differences were recorded in drying in the electric oven. The lowest value was recorded in the proportion of sucrose in the microwave-dried Kabkab powder, which reach to 12.87%, and a noticeable difference was observed in the percentage of sucrose.It did not agree with the results Al-Farsi & Lee (2008) obtained in the sucrose proportion. The results were in agreement with El-Sharnouby *et al*. (2007) in the percentage of sucrose with Rothana powder dried by electric and microwave, which amounted to 17.53 and 15.10%, respectively. The results did not agree with Raza *et al*. (2019), as the percentages of sucrose for the electric oven-dried date powders were lower than the limits we reached, and the reason may be due to the effect of heat treatment and also to the type of variety, and this affects the percentage of sucrose in the powder. As for reducing sugars, there were no significant differences between date powders and different drying methods at the probability level of $p < 0.05$. Dairy powder dried by the solar and the electric oven recorded the highest values, amounting to 60.14 and 60.02%, while the rest of the powders were close in proportions and ranged between 58.35, and 59.95%. Table (1) shows the number of calories in the date powders of the varieties under study that was dried by different drying methods. The results of the statistical analysis showed significant differences between date powders and also between heat treatments at a substantial level $P<0.05$. The solar-dried Zahdi powder recorded the highest value of the total calories, which was 323.01 gm100/Kcal, followed by the solar-dried al-dairy powder (319.38 gm100/Kcal). As for the microwave-dried Kabkab powder, it recorded the lowest value in total calories and amounted to 300.66 gm/100/Kcal. The results did not agree with the findings of AL-Farsi *et al*. (2005) in their study of three cultivars of solar-dried Omani dates. The total calories of the cultivars (individual, khasab, and khalas) were 278, 281, and 301gm100/Kcal, respectively. At the same time, the results were close with the microwave-dried Kabkab powder and the solar-dried extract. In a study conducted on two cultivars of Iraqi dates, when they used nano-fertilizers, they noticed that the cultivars were affected by the fertilizer used and gave positive results. These differences are due to different

cultivars, harvest/post-harvest practices, and growing environments such as soil fertility, temperature, humidity, etc. (Altmemimy *et al*., 2019; Abd *et al*., 2020).

Table (1) Chemical properties of date powders of varieties (Dairy, Kabkab, Zahdi) dried by different drying methods (solar, electric oven, and microwave).

Traits	Solar			electric oven			microwave			R.L.S.D P<0.05
	Dairy	Kabkab	Zahdi	Dairy	Kabkab	Zahdi	Dairy	Kabkab	Zahdi	
Humidity%	4.403	5.36	5.26	3.70	4.56	4.61	3.59	4.38	4.50	0.5568
TSS%	53.45	52.52	53.32	56.39	52.65	55.72	58.79	54.72	58.38	3.47
Total Acidity%	0.14	0.14	0.17	0.15	0.16	0.166	0.16	0.17	0.173	NS
pH	5.96	6.67	6.23	6.40	6.83	5.86	6.45	6.88	5.92	NS
Protein%	2.83	2.86	2.33	3.06	2.95	2.54	3.12	3.03	2.75	0.2968
Fat%	0.46	0.54	0.45	0.64	0.71	0.55	0.59	0.42	0.35	0.0506
Ash%	2.43	2.40	2.39	2.71	2.58	2.37	2.75	2.60	2.39	NS
Fiber %	5.12	5.36	5.55	5.29	5.57	5.76	5.50	5.75	5.95	0.3508
Total sugars%	75.98	74.18	77.41	74.25	73.74	75.69	72.89	71.22	73.25	0.3723
Sucrose%	16.04	14.66	17.27	15.23	15.193	15.67	14.14	12.87	13.42	0.5364
reducing sugars%	59.95	59.52	60.14	59.02	58.48	60.02	59.08	58.35	59.83	NS
Calories Kcal/100g	319.38	313.02	323.01	315.00	313.15	317.87	309.35	300.66	309.22	0.2973

Determination of total phenolic compounds

Figure (2) shows the total content of phenols for powders of different varieties of local dates (Dairy, Kabkab, and Zahdi) dried by different drying methods. According to the statical analysis, it was noted there were significate differences between microwave-dried Zahdi and microwave-dried Kabkab powder, but recorded no significant differences with Dairy cultivar, since the microwav-treated Zahdi powder exceeded the phenolic content, which amounted to 70.1 mg/gm on the basis of Gallic acid, while the solar-dried Kabkab powder recorded the lowest phenolic content and reached 41.5 mg/100gm, so the microwave-dried Zahdi powder recorded significant differences with all powders and with different heat treatments at probability level $p<0.05$. No significant differences were recorded between Dairy powder dried in the microwave and between the solar-dried Zahdi powder and dried in the electric oven, due to its closeness to the phenolic content, and it amounted to (50.2-50) mg/100 gm, as shown in Figure (2), while significant differences were recorded with the rest of the other powders. According to the findings of Izli (2017) microwave drying of date fruits gives the highest phenolic content and the highest antioxidant capacity, while the use of different temperatures during drying in the electric oven

reduces the phenolic content as a result of the decomposition of the complex phenolic tannins by heat and the occurrence of enzymatic and non-enzymatic oxidation that affects the extraction of phenols. The increase in total phenols can also be explained by the formation of Maillard reactions, which would cause the formation of new phenolic compounds during heat treatment (Que *et al*., 2008; Sultana *et al*., 2012). In other studies, it was shown that heat treatment is very effective in increasing the total phenolic content in foods, although some studies have noticed that the total phenols decrease during heat treatment of different foods such as dried apricots (Sultan *et al*., 2012; Zanoelo *et al*., 2006). While Dewanto *et al*. (2002) showed the opposite phenolic compounds were not affected by different heat treatments, and in studying the phenolic content of solar-dried Medjool cultivar, the results did not agree with the findings of Alsmairt *et al*. (2017).

Estimation of antioxidant activity

Figure (3) indicates different drying methods' antioxidant activity of dried date powders. According to the statistical analysis, it was noted that there were no significant differences for Dairy powder dried by drying methods (solar, electric oven, microwave), as the results were close and amounted to (81.45, 81.41). , 81.96 % respectively, while significant differences were recorded between Al- Dairy powder and the powders of other varieties and for various treatments, as it is noted from Figure (3) that there were no significant differences between Zahdi powder dried in the microwave and in the electric oven, which amounted to (87.57, 87.33)%, respectively. The percentage was the highest between the powders, and the microwavable and electric oven labs did not register significant differences for the convergence of the two ratios, it amounted to 61.02-61.62%, while significant differences were recorded between them and the solar-dried Kabkab powder, as it recorded the lowest percentage of antioxidant activity and reached (58.59)% and at the $p<0.05$ probability level. The antioxidant activity of date palm fruits is affected by the method of drying and the temperature used. Izli (2017) found that varieties of Turkish dates by different drying methods, that microwave drying increases the antioxidant activity compared to fresh dates, and it was also shown that drying in an electric oven at a temperature of 60 ˚C was better than the temperatures (70-80) ˚C, as these degrees decrease the antioxidant activity. The reason is the instability of these compounds at high temperatures. The antioxidant activity increases with the increase in the total phenolic content, which is consistent with the current study. The results are obtained better for microwave dried date powders

compared to solar drying and electric oven drying. The increase in the antioxidant activity using different drying methods may be due to the formation of antioxidant compounds (Albanese *et al*., 2013). According to what was mentioned by new, the decrease may be related to the interactions between oxidation and other components of the fruit, as noted by Di scala *et al*. (2011) for two varieties of Iranian dates and the use of two drying methods. A study conducted by Shahdadi *et al*. (2015), one of which was in the electric oven at a temperature was ranging from 50-80 ˚C, and the second method was solar drying. Note the decrease in the antioxidant activity of the two varieties at high temperatures during the drying process, he also attributed the reason to the fact that the varieties of dates vary among themselves in their content of the antioxidant activity, as the percentage varies from one variety to another. The high temperature affects the overall effectiveness of the antioxidants and causes its reduction. The study pointed out that the temperature at 50 ° C and the sun-dried methods gives close proportions of antioxidants, and this is consistent with the results obtained between dates powders treated with electric oven at the same temperature and with sun-dried date powders, as shown in Figure (3).

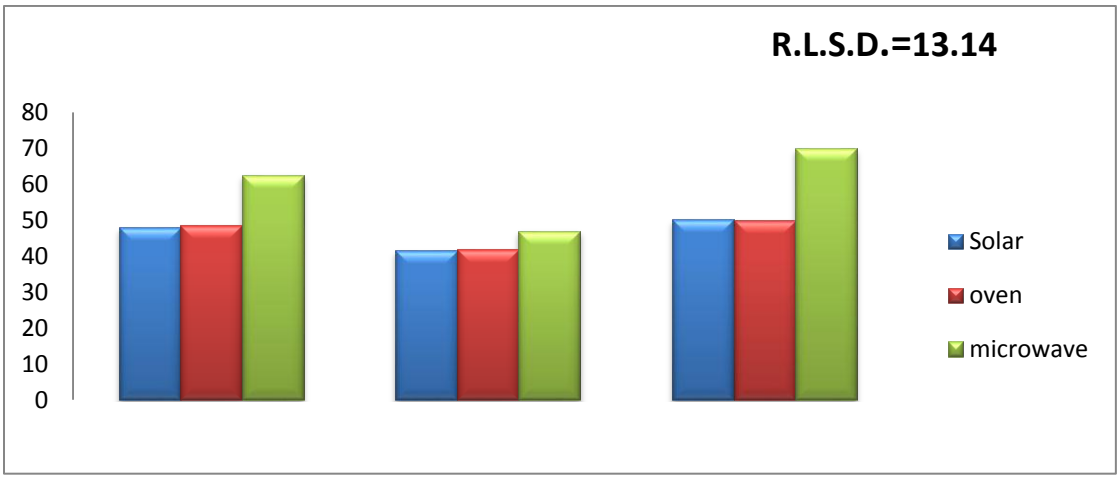

Figure (2) The total phenol content of date powders (Dairy, Kabkab, Zahdi) dried by different drying methods (mg/100gm) based on gallic acid.

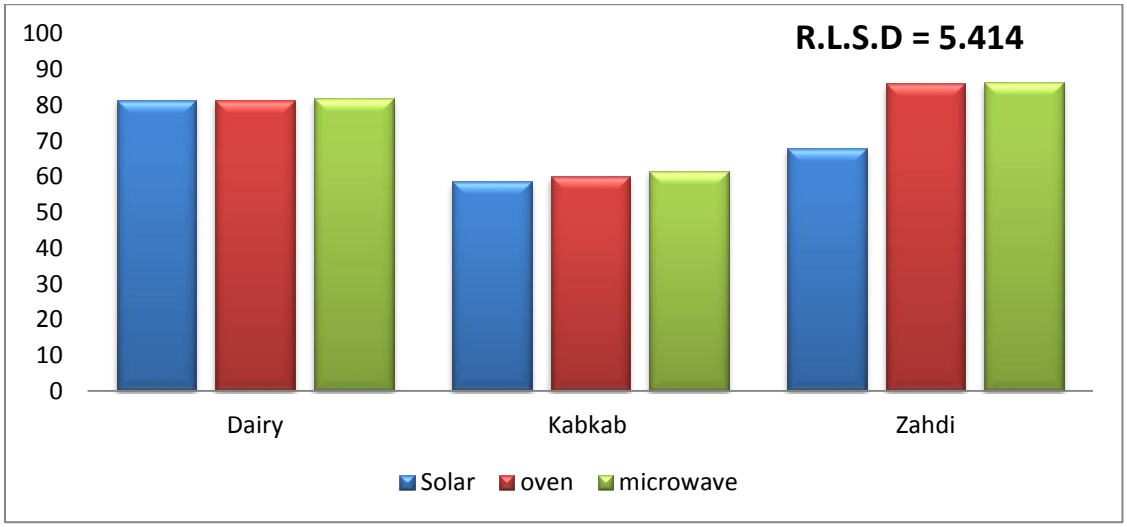

Figure (3) shows the antioxidant activity of date powders (Dairy, Kabkab, and Zahdi) dried by different drying methods

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دراسة تأثير طرق التجفيف المختلفة على المحتوى الكيميائي والفعالية المضادة للأكسدة لثلاث اصناف من التمور العراقية

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الخلاصة

اجريت هذه الدراسة بهدف معرفة التركيب الكيميائي والمحتوى الفينولي والفعالية المضادة للاكسدة لمساحيق ثلاثة اصناف من التمور العراقية المنخفضة الجودة (الديري ، الجبجاب والزهدي) ، جففت التمور بثلاث طرق تجفيف (الشمسي ، الفرن الكهربائي ، الميكروويف) ، تم دراسة التركيب الكيميائي لمساحيق ثمار التمر أذ لوحظ انخفاض نسبة الرطوبة اثناء تجفيفها بطرق التجفيف المختلفة وبالاخص عند تجفيفها بالميكروويف حيث سجل مسحوق الديري المجفف بالميكروويف اقل نسبة وبلغت (3.59)% ، في حين ارتفعت نسبة المواد الصلبة الذائبة الكلية لنفس المسحوق وكانت (58.79)% تلاه مسحوق الزهدي المجفف بالميكروويف (58.38)%. لم تسجل مساحيق التمور المجففة بطرق التجفيف المختلفة فروقاً معنوية بنسبة الرماد وبنسبة الحموضة الكلية والرقم الهيدروجيني ، كما ويلاحظ ارتفاع نسبة البروتين عند تجفيف الثمار بالميكروويف أذ بلغت اعلى نسبة بروتين لمسحوق الديري المجفف بالميكروويف (3.12)% ، في حين سجل مسحوق الجبجاب المجفف بالفرن الكهربائي اعلى قيمة في نسبة الدهون وبلغت (0.71)% ، اما مسحوق الزهدي المجفف بالميكروويف فقد ارتفعت فيه نسبة الالياف (5.95)%.ارتفعت السكريات الكلية اثناء التجفيف الشمسي أذ سجل مسحوق الزهدي المجفف شمسيًا النسبة الاعلى في السكريات الكلية والسكروز(77.41 ، 17.27)%على التوالي. اما السكريات المختزلة فلم يسجل فروقاً معنوية ولجميع المعاملات. أزداد المحتوى الفينولي لمساحيق ثمار التمر عند تجفيف الثمار بطرق التجفيف المختلفة حيث سجل مسحوق الزهدي المجفف بالميكروويف اعلى محتوى فينولي وبلغ (70.1) ملغم/100غم، كما لوحظ ارتفاع في الفعالية المضادة للأكسدة لمساحيق التمر اثناء عمليات التجفيف المختلفة أذ سجل مسحوق الزهدي المجفف بالميكروويف والفرن الكهربائي اعلى نسبة (87.57، 87.33) % على التوالي.

الكلمات المفتاحية : تمور النخيل ، طرق تجفيف ، مسحوق التمر، التركيب الكيميائي ، المركبات الفينولية، مضادات الاكسدة.