Bionatura
Latin American Journal of Biotechnology and Life Sciences

Article

The performance of moringa leaf extract application and bagging the bunches to improve fruits quality of date palm (*Phoenix dactylifera* L.) cv. Al-Khadrawi and Al-Buraim

MohammedAbdulrahman[1], ManarAlwan[2], KadumAbdullah[2], MariamChaffat[3]*

1 Horticulture and Landscape Department/ College of Agriculture/ University of Kerbala/ Karbala, Iraq; mohammed.s@s.uokerbala.edu.iq. https://orcid.org/0000-0001-6675-8189 2

2 Department Horticulture and Landscape/ College of Agriculture Al-Qasim Green University; manar.a@agre.uoqasim.edu.iq.

2 Horticulture and Landscape Department/ College of Agriculture/ University of Kerbala, Karbala/ Iraq; https://orcid.org/0000-0002-9619-5900

3 Plant Protection Department, College of Agriculture, University of Kerbala, Karbala, Iraq.

** Correspondence: kadum.m@uokerbala.edu.iq.; Tel.: 0771 723 8168*

Available from. http://dx.doi.org/10.21931/RB/2023.08.04.86

ABSTRACT

The study was conducted at the Fadak farm of the Husseiniya shrine/ Karbala governorate during the growth season 2021 to test the role of application with Moringa leaf extract and the paper bagging of the bunches in improving some qualitative characteristics of the fruits of two palm cultivars, Al-Khadrawi and Al-Buraim. The bunches were sprayed with three concentrations of moringa leaf extract (0, 100, 200 ml. L^{-1}) three times after 7, 10, and 13 weeks of pollination and then bagging the bunches after each application process according to the schedule and plan of the experiment. The results indicated that application with moringa extract and bagging increased the proportion of total dissolved solids (T.S.S.), total sugars and reducing sugars, and decreased the total acidity neutralizing, sucrose, and tannins. Al-Khadrawi cultivar was superior in most of the studied traits.

The study's findings suggest that natural plant extracts (such as Moringa leaf extract) can be utilized as organic amendments or fertilizer additives in conjunction with particular farming practices to enhance the quality of the fruits of some varieties of date palms.

Keywords: T.S.S.; natural extract; *Phoenix dactylifera*; Arecaceae; *Moringaoleifera*.

INTRODUCTION

The palm tree species *Phoenix dactylifera* L. is a member of the Arecaceae family of palms. The number of their species worldwide is estimated at 1500 species[1]. About 600 of them are registered in Iraq[2], which is one of the oldest palm plantations in the world. Therefore, it is believed that Iraq and the Arab Gulf region are its original home. The fruit of the date palm has much potential. Its fruits, seeds, pits, and byproducts all contain the potential for both nourishment and medicine because fruits and seeds are packed in nutrients such phenolics, dietary fibers, vitamins, minerals, and amino acids which makes them have many functions such as antibacterial, antioxidant, anticancer, and antidiabetic properties and the presence of phytochemicals such as carotenoids, phenolic acid, flavonoids, tocopherol, phytosterols, etc. boosts these bioactivities [3].

The al-Khadrawi variety is one of the commercial varieties characterized by slight greenness in its fruits. Its cultivation spreads in the central and southern regions of Iraq. It has several names, including Khadrawi Basra

and Khadrawi Mandali. Its fruits are consumed in the wet stage and have a distinctive flavour[4]. Al-Buraim is one of the most important dates in Basra. Its cultivation spreads throughout Iraq, and its ripe fruits are of excellent quality and eaten in the Khalaal and Rutab stages. It is eaten as cooked Khalaal and is not left most of the time until the Tamr stage [5].

In recent years, global interest in the quality of food consumed has increased, so many practices have emerged that improve the quality of fruits without leaving adverse effects on human health and the environment. One of these practices is using plant extracts that can serve the same purpose as industrial materials but without any danger to humans and the environment [6]. Due to their abundant quantity of different active ingredients, plants serve as the primary source of raw substances for the synthesis of essential and practical bio-products (such as food, cosmetics, medications, bio-stimulants, bio-pesticides, and feed) such that many plant components, including seeds, fruits, flowers, stems, leaves, and roots, have been utilized in their productio[7]. The stimulating properties of botanical extracts are attributed to organic compounds, including polyphenols, amino acids, plant hormones, and vitamins, as well as both micro- and macro-elements; however, their impact on enhancing the quantity and quality of crops depends on the crop species, cultivar, stage of growth, environmental conditions, as well as dose, timing, and application method [8,9] Among these extracts is Moringa oleifera leaf extract as a natural alternative because it contains many growth hormones, especially zeatin, which is derived from the plant cytokinin group, antioxidants, nutrients and vitamins[10]and thus its effect is similar for the effect of synthetic growth regulators [11]. In a study conducted in Egypt by [12]application the bunches of the palm cultivar Al-Khadrawi with Moringa leaf extract at a concentration of 3% three times between one spray and another month, where the first spray was three hours before pollination, it was found that the application treatment significantly outperformed the proportion of total soluble solids accumulated in the fruit and total sugars as well as reducing sugars. In contrast, application with the extract reduced the non-reducing sugars. As for the neutralizing total acidity, there are no significant differences between the spray and comparison treatment and the case for total tannins in the fruit.

The process of muzzling, i.e., bagging the bunches with different covers, is an essential physical process, especially in hot and dry areas, as it improves the quality of the fruits and protects them from some insect pests, mechanical damage and unsuitable climatic factors that negatively affect the quality and productivity of the palm fruits [13]. Al-Issawi[14] found that when bagging the Khastawi cultivar with different types of covers (transparent polyethylene, black polyethylene, unique sleeve bags, mesh cloth, and paper bags), all covers increased the quality of the fruits.

In order to improve the quality of the fruits and highlight the importance of using natural extracts and specific agricultural techniques to produce high-quality horticultural crops, the study evaluated the effectiveness of applying Moringa leaf extract on bunches and bagging them with paper. It also examined how these two practices interacted with various cultivars of palm trees (Al-Khadrawi Basra and Al-Buraim).

MATERIALS AND METHODS

The field experiment was launched at the Fadak farm of the Husseiniya shrine during the season 2021. Thirty-six palm trees were selected, with eighteen palm trees for each cultivar at the age of five years, homogeneous in size and growth strength as much as possible. Manual pollination and thinning were carried out by leaving 6 bunches. Palm^{-1}. Three elements were examined in the study. The first element was three different concentrations of moringa leaf extract(200,100.0 ml. L^{-1}) applied on the bunches with three sprays. The first spray was after 7 weeks of pollination (the end of the Hababuk stage and the beginning of the Jamri stage), and between one spray and another was 21 days. The second factor was using bagging with closed-end perforated paper bags, where the bagging process was done immediately after the first spray and the bags were lifted at the third spray. The third factor included two cultivars: Al-Khadrawi Basra and Al-Buraim. The experiment was designed in a Randomized Complete Block design, R.C.B.D., with three replications, and the averages were compared according to Duncan's polynomial test at a probability level of 0.05 [15]. The qualitative characteristics of the fruits were measured, where the proportion of dry mass and water content (%), the proportion of total soluble solids (T.S.S.) (%), which were measured using Hand Refractometer according to [16], total and reducing sugars and sucrose (%) which were estimated using The Lane and Eynon method mentioned by [17], the total neutralizable acidity (%) determined as in [18] and the proportion of tannins (%) calculated by the method of [19].

Chemical components	Leaf Powder	Chemical components	Leaf Powder	Chemical components	Leaf Powder
Moisture (%)	7.5	Iron (mg)	28.2	Histidine (g/16 g N)	0.61
Protein (g)	27.1	Sulfur(mg)	870	Lysine (g/16 g N)	1.32
Fat (g)	2.3	Vitamin A (β-carotene) (mg)	16.3	Tryptophan (g/16 g N)	0.43
Carbohydrate (g)	38.2	Vitamin B1 (thiamine) (mg)	2.6	Phenylalanine (g/16 g N)	1.39
Fiber (g)	19.2	Vitamin B2 (riboflavin) (mg)	20.5	Methionine (g/16 g N)	2
Calcium (mg)	2.003	Vitamin B3 (nicotinic acid) (mg)	8.2	Threonine (g/16 g N)	1.19
Magnesium (mg)	368	Vitamin C (ascorbic acid) (mg)	17.3	Leucine (g/16 g N)	1.95
Phosphorus (mg)	204	Vitamin E (tocopherol acetate) (mg)	113	Isoleucine (g/16 g N)	0.83
Potassium (mg)	1.324	Arginine (g/16 g N)	1.33	Valine (g/16 g N)	1.06
Copper (mg)	0.6				

Table 1. Chemical analytical assessment of 100 g of powdered Moringa oleifera leaves.

RESULTS

Water content of fruits (%)

It is noticed from Table 2 that application with moringa leaf extract reduced the water content of the fruits, as the most significant proportion was observed with the comparative treatment of 29.36 %, while the lowest proportion was detected at a concentration of 200 ml. L^{-1} of 25.69%, while the bagging increased the water content of the fruits, as the bagging treatment reached 28.57%, while treatment without bagging gave 26.23%. The two cultivars also differed in the water content in their fruits, where the fruits of the Al-Khadrawi cultivar recorded the most significant proportion of 31.33%. At the same time, the proportion in Al-Khadrawi variety was 23.56%. Regarding the relationship between extract application and bagging, the application treatment at a concentration of 0 ml. L^{-1} with bagging recorded the most significant proportion, 30.71%, while the concentration was 200 ml. L^{-1} recorded the lowest proportion, which was 24.40% without paper cover.

On the other hand, the comparison treatment of moringa extract on the Al-Khadrawi cultivar outperformed by giving the most significant proportion, reaching 34.21%, while the application dose of 200 ml. L^{-1} on the Al-Buraim cultivar recorded the lowest water content proportion, 22.98%. Regarding the interaction between bagging and cultivar, Al-Khadrawi's bagging treatment outperformed Al-Buraim's non-bagging treatment by recording a proportion of fruit water content that reached 32.12%. In contrast, Al-Buraim's non-bagging treatment recorded the lowest proportion, 22.11%.

The interaction of the three examined variables significantly impacted the water content of the fruits, as it was noted that the spray application was at a concentration of 0 ml. L^{-1} with bagging on Al-Khadrawi cultivar gave the most significant proportion of 35.20%, while application with a concentration of 200 ml. L^{-1} without bagging on the Al-Buraim cultivar recorded the lowest proportion of 21.43% Table 2.

Cultivar	Bagging	Extract (ml. L^{-1})			Interaction between bagging and cultivar	Cultivar averages
		0	100	200		
Khadrawi	**Without bagging**	33.23 b*	31.03 c	27.36 e	30.54 a	31.33 a
	With bagging	35.20 a	31.73 c	29.43 d	32.12 a	
Buraim	**Without bagging**	22.80 h	22.10 hi	21.43 i	22.11 c	23.56 b
	With bagging	26.23 f	24.30 g	24.53 g	25.02 b	
Extract averages		29.36 a	27.29 b	25.69 c		
Interaction between extract and cultivar	**Khadrawi**	34.21 a	31.38 b	28.40 c	Bagging averages	
	Buraim	24.51 d	23.20 d	22.98 d		
Interaction between extract and bagging	**Without bagging**	28.01 ab	26.56 ab	24.40 b	26.23 b	
	With bagging	30.71 a	28.01 ab	26.98 ab	28.57 a	

* Means that share the same letters do not differ significantly among themselves according to Duncan's polynomial test at the 0.05 probability level.

Table 2. Impact of applying moringa leaf extract, bagging the bunches, and their interactions on the water content of the (%) of two palm cultivars.

Fruit dry matter proportion (%)

The data in Table 3 indicated that the proportion of dry matter of the fruits gradually increased with the increase in the concentration of moringa leaf extract, where the spray application was at a concentration of 200 ml. L^{-1} had the most significant proportion of 74.30%. The comparison sprays recorded a proportion of 70.63%, while bagging reduced the dry matter in the fruits, reaching 73.76% in the treatment without bagging. In comparison, it amounted to 71.42% in the bagging treatment. As for the cultivars, it is noticeable that there are significant differences between them, as the Al-Buraim cultivar has a significant score of 76.43%, superior to the Al-Khadrawi cultivar, which has a rate of 68.66%—the spray application with 200 ml. L^{-1} and without bagging was superior to 75.60%, while the 0 ml. L^{-1} treatment with bagging was the lowest, which amounted to 69.28%—also, the application treatment with a concentration of 200 ml. L^{-1} was superior to the Al-Buraim cultivar, with the most significant proportion of 77.01%.

The comparison treatment for the Al-Khadrawi cultivar recorded a smaller proportion of 65.78%. In comparison, the non-bagging treatment of the Al-Buraim cultivar outperformed because it gave the most significant proportion of 77.88%, while the lowest proportion was in the bagging treatment for the fruits of the Al-Khadrawi cultivar, which amounted to 67.87%. The data of the triple interaction indicated that the application treatment with 200 ml. L^{-1} without bagging the Al-Buraim cultivar recorded the most significant proportion of dry matter in the fruits, amounting to 78.56%, during the application with 0 ml. L^{-1} with bagging on the fruits of the Al-Khadrawi variety recorded the lowest rate of 64.80% Table 3.

Cultivar	Bagging	Extract (ml. L^{-1})			Interaction between bagging and cultivar	Cultivar averages
		0	100	200		
Khadrawi	Without bagging	66.76 h*	68.96 g	72.63 e	69.45 c	68.66 b
	With bagging	64.80 i	68.26 g	70.56 f	67.87 c	
Buraim	Without bagging	77.20 b	77.90 ab	78.56 a	77.88 a	76.43 a
	With bagging	73.76 d	75.70 c	75.46 c	74.97 b	
Extract averages		70.63 c	72.70 b	74.30 a		
Interaction between extract and cultivar	Khadrawi	65.78 d	68.61 c	71.60 b	Bagging averages	
	Buraim	75.48 a	76.80 a	77.01 a		
Interaction between extract and bagging	Without bagging	71.98 ab	73.43 ab	75.60 a	73.76 a	
	With bagging	69.28 b	71.98 ab	73.01 ab	71.42 b	

* Means that share the same letters do not differ significantly among themselves according to Duncan's polynomial test at the 0.05 probability level.

Table 3. Impact of applying moringa leaf extract, bagging the bunches, and their interactions on fruit dry matter proportion (%) of two palm cultivars.

Total Soluble Solids (%) (T.S.S.)

Table 4 shows that the proportion of total soluble substances increased with an increase in the application of moringa leaf extract, where the application of 200 ml. L^{-1} gave the most significant proportion of 57.23%, while the comparison treatment revealed the lowest proportion of 51.80%. Also, the proportion of total soluble solids increased with the bagging of the bunches was 55.55%, with a significant difference from the treatment without packaging, which amounted to 53.77%. Al-Khadrawi cultivar significantly outperformed the Al-Buraim cultivar, as their proportions reached 55.86 and 53.46%, respectively.

There was a remarkable effect of the dual interaction between the extract and the bagging, where the application was 200 ml. L^{-1} with the bagging was superior to all treatments, which was 57.46%. In contrast, the comparison treatment recorded the lowest proportions, amounting to 51.00%, and the treatment of application of Al-Khadrawi cultivar with Moringa leaf extract with a concentration of 51.00%. 200 ml. L^{-1} with a ratio of 58.58%, while the comparison application for Al-Buraim gave less proportion, which was 50.88% Table 4,.The process of bagging the fruits of the cultivars had a considerable effect on T.S.S. The bagging of the Al-Khadrawi cultivar excelled by producing the most significant proportion, which was 56.73%.

The cultivar Al-Buraim gave the lowest rate of 52.55% without bagging. As for the effect of the triple interactions of the study factors, it was significantly superior to the spray of 200 ml. L^{-1} with bagging for the Al-Khadrawi variety reached 59.83%, while the lowest proportion was in the comparison treatment for the Al-Buraim variety, which was 50.00% (Table 4).

Cultivar	Bagging	Extract (ml. L^{-1})			Interaction between bagging and cultivar	Cultivar averages
		0	100	200		
Khadrawi	Without bagging	52.00 gh*	55.66 c	57.33 b	55.00 a	55.86 a
	With bagging	53.43 ef	56.93 b	59.83 a	56.73 a	
Buraim	Without bagging	50.00 i	53.00 fg	54.66 cd	52.55 b	53.46 b
	With bagging	51.76 h	54.23 de	57.10 b	54.36 ab	
Extract averages		51.80 c	54.95 b	57.23 a		
Interaction between extract and cultivar	Khadrawi	52.71 c	56.30 b	58.58 a	Bagging averages	
	Buraim	50.88 d	53.61 c	55.88 b		
Interaction between extract and bagging	Without bagging	51.00 d	54.33 bc	56.00 b	53.77 b	
	With bagging	52.60 cd	55.58 b	57.46 a	55.55 a	

* Means that share the same letters do not differ significantly among themselves according to Duncan's polynomial test at the 0.05 probability level.

Table 4. Impact of moringa leaf extract, bagging the bunches, and their interactions on two palm cultivars' total soluble solids (%) (T.S.S.).

Total sugars (%)

The data of Table 5 indicates that application with moringa leaf extract increased the proportion of total sugars in fruits, whereas the application with 200 ml. L^{-1} was significantly superior by giving it the most significant proportion of 51.76%, but the comparison application gave a lower proportion of 46.27%. The bagging practice also increased the proportion of total sugars in the dates. Hence, the proportion in the bagging treatment was 50.65%, with a significant difference from the treatment without bagging, which recorded the lowest rate of 47.75%. The fruits of the two cultivars also varied in terms of the proportion of total sugars, with the Al-Khadrawi cultivar yielding the greatest sugars ratio of 50.74 percent, significantly outperforming the Al-Buraim cultivar, which provided just 47.66 percent.

The same table also demonstrates that the application of the moringa extract and bagging interacted significantly, showing the extract treatment's superiority at a concentration of 200 ml. L^{-1} with bagging, where the ratio reached 52.74%, while the comparative dose gave a rate of 44.63%. When applied to the Al-Khadrawi cultivar, the two treatments were at 200- and 100 ml concentrations. L^{-1} resulted in …..

Respective proportions of 53.18% and 51.21%, whereas the comparative treatment for the Al-Buraim cultivar yielded the lowest proportion of 44.70%. While the comparison treatment for the Al-Buraim cultivar recorded the lowest proportion, 46.21%, the packing treatment for the Al-Khadrawi cultivar recorded the most significant total sugar content, 52.19%.

Regarding the triple interaction, Table 4's findings show the two application treatments with 200- and 100 ml concentrations. L^{-1} with the packaging of Al-Khadrawi fruits was superior. These treatments had the most excellent rates, reaching 53.94 and 52.73%, respectively, while the comparison treatment for the Al-Buraim variety had the lowest rate, 43.49% Table 5.

Cultivar	Bagging	Extract (ml. L^{-1})			Interaction between bagging and cultivar	Cultivar averages
		0	100	200		
Khadrawi	**Without bagging**	45.78 d*	49.70 c	52.42 b	49.30 b	50.74 a
	With bagging	49.91 c	52.73 ab	53.94 a	52.19 a	
Buraim	**Without bagging**	43.49 e	46.00 d	49.14 c	46.21 c	47.66 b
	With bagging	45.92 d	49.89 c	51.53 b	49.11 b	
Extract averages		46.27 c	49.58 b	51.76 a		
Interaction between extract and cultivar	**Khadrawi**	47.84 c	51.21 ab	53.18 a	Bagging averages	
	Buraim	44.70 d	47.94 c	50.33 b		
Interaction between extract and bagging	**Without bagging**	44.63 c	47.85 b	50.78 a	47.75 b	
	With bagging	47.91 b	51.31 a	52.74 a	50.65 a	

* Means that share the same letters do not differ significantly among themselves according to Duncan's polynomial test at the 0.05 probability level.

Table 5. Impact of applying moringa leaf extract, bagging the bunches, and their interactions on Total sugars (%) of two palm cultivars.

Reducing sugars (%)

Table 6. shows that the reduced sugar fraction was dramatically improved by application with moringa leaf extract—the application that involved 200 ml. L^{-1} had the most significant proportion of reducing sugars, which came to 44.07%, while the comparison treatment had the lowest proportion, 37.44%. When compared to the treatment without bagging, which came to 38.56%, the packaging treatment obtained a proportion of 43.65%, a considerable improvement in the proportion of reducing sugars. Regarding the cultivar component, Al-Khadrawi surpassed the Al-Buraim cultivar with a considerable difference since their respective reducing sugar proportions were 43.54 and 38.67%.

The outcomes of the binary overlapping between extract application and bagging showed that the combination of 200 ml. L^{-1} concentration and packaging produced the most significant proportion of reducing sugars, 46.57%, while the comparison treatment produced the lowest proportion, 34.75%—the two application treatments with concentrations of 200- and 100 ml. L^{-1} was superior to the Al-Khadrawi cultivar, where the reducing sugars in them reached 45.55% and 44.80%, respectively, but the comparison treatment on the Al-Buraim cultivar recorded the lowest proportion, 34.60%. The combination of the cultivar and bagging also contributed to the excellence of the packing treatment of the Al-Khadrawi variety, which came in at 46.67%. In contrast, the Al-Buraim variety's treatment without bagging came in at the lowest proportion, at 36.70% (Table 6).In aspects of the triple interaction, the application of 200 ml. L^{-1} combined with the bagging of bunches of the Al-Khadrawi variety yielded the most significant proportion of reducing sugars, amounting to 48.58%, significantly outperformed the comparison treatments for the fruits of Al-Buraim variety, which delivered the lowest proportion, 32.93%—table 6.

Cultivar	Bagging	Extract (ml. L^{-1})			Interaction between bagging and cultivar	Cultivar averages
		0	100	200		
Khadrawi	Without bagging	36.57 f*	42.15 CDE	42.53 CDE	41.41 b	43.54 a
	With bagging	44.02 cd	47.41 ab	48.58 a	46.67 a	
Buraim	Without bagging	32.93 g	36.56 f	42.53 CDE	36.70 c	38.67 b
	With bagging	36.26 fg	41.08 de	44.56 bc	40.63 b	
Extract averages		37.44 b	41.80 a	44.07 a		
Interaction between extract and cultivar	Khadrawi	40.29 b	44.78 a	45.55 a	Bagging averages	
	Buraim	34.60 c	38.82 b	42.58 ab		
Interaction between extract and bagging	Without bagging	34.75 d	39.36 c	41.57 bc	38.56 b	
	With bagging	40.14 c	44.25 ab	46.57 a	43.65 a	

* Means that share the same letters do not differ significantly among themselves according to Duncan's polynomial test at the 0.05 probability level.

Table 6. Impact of applying moringa leaf extract, bagging the bunches, and their interactions on Reducing sugars (%) of two palm cultivars.

Sucrose proportion (%)

Table 7 revealed that the sucrose rate decreased as the application concentration with leaf extract increased. The control treatment (0 ml. L^{-1}) recorded the most significant proportion (8.87%), while the spray treatment with a concentration of 200 ml. L-1 recorded the lowest proportion (6.77%). Fruit packaging also reduced sucrose, as the proportion of sucrose in coated fruits reached 6.97%, while the proportion in unwrapped fruits reached 8.65%. As for the cultivar factor, the two cultivars differed significantly between them, where the fruits of the Al-Buraim cultivar gave the most significant proportion of 8.98%, while the Al-Khadrawi cultivar had a decrease in the proportion of sucrose, which amounted to 6.64%. The binary interaction between the study factors is shown in Table 7, which indicates that application with moringa leaf extract at 0 ml. L^{-1} without bagging produced the most significant proportion of sucrose, 9.97%, while the lowest proportion was 6.07% when treating fruits with a concentration of 200 ml. L^{-1} with packaging. The comparison treatment of the Al-Buraim cultivar was superior in the bilateral interaction between application with the extract and the cultivar, with a proportion of 10.11%, which did not differ significantly from the application treatment with a concentration of 100 ml. L^{-1} on the same variety amounted to 9.14%, while the lowest proportion of sucrose was recorded when applied with 200 ml. L^{-1} for Al-Khadrawi cultivar, which amounted to 5.85%. Regarding the interaction between the packaging and the cultivar, the Al-Buraim cultivar benefited most from the treatment without bagging, where the proportion of sucrose reached 9.48%, comparable to the 8.48% obtained through packaging the same cultivar. Al-Khadrawi cultivar, however, got the lowest proportion, 5.45%, from its bagging treatment Table 7. The triple interaction between the three factors was clear, where it was noted the superiority of the extract spray treatment (0 ml. L^{-1}) + without bagging for the fruits of the Al-Buraim cultivar, which gave a sucrose proportion of 10.55%, while the lowest proportion recorded by the spray application with 200 ml. L^{-1} with the bagging of Al-Khadrawi variety, which amounted to 5.15% Table 7.

Cultivar	Bagging	Extract (ml. L^{-1})			Interaction between bagging and cultivar	Cultivar averages
		0	100	200		
Khadrawi	Without bagging	9.38 bc*	7.54 e	6.55 fg	7.83 b	6.64 b
	With bagging	5.88 gh	5.32 hi	5.15 i	5.45 c	
Buraim	Without bagging	10.55 a	9.49 bc	8.40 d	9.48 a	8.98 a
	With bagging	9.67 b	8.79 cd	6.99 ef	8.48 ab	
Extract averages		8.87 a	7.78 b	6.77 c		
Interaction between extract and cultivar	Khadrawi	7.63 b	6.43 bc	5.85 c	Bagging averages	
	Buraim	10.11 a	9.14 a	7.70 b		
Interaction between extract and bagging	Without bagging	9.97 a	8.52 ab	7.48 bc	8.65 a	
	With bagging	7.78 b	7.05 bc	6.07 c	6.97 b	

*Means that share the same letters do not differ significantly among themselves according to Duncan's polynomial test at the 0.05 probability level.

Table 7. Impact of applying moringa leaf extract, bagging the bunches, and their interactions on sucrose proportion (%) of two palm cultivars.

Total Neutral Acidity (%)

The findings of Table 8 show that the overall acidity was negatively correlated with the rise in Moringa leaf extract concentration, with the control treatment recording the most significant proportion of 0.95% and the 200 ml. L^{-1} spray treatment recorded the lowest proportion of 0.70%. The paper packaging treatment reported 0.75% compared to the control treatment's 0.86%, indicating a reduction in acidity. The cultivars under study did not differ significantly from one another. The interactive outcomes between application extract with bagging showed that the control treatment was preferable; it recorded the most significant proportion (1.02%) during the application with 200 ml. L^{-1} with bagging recorded the lowest proportion, 0.67%—the application treatment with a concentration of 200 ml. L^{-1} on the Al-Khadrawi cultivar recorded the lowest proportion, 0.69%.

In contrast, the comparative treatment for the cultivar Al-Buraim was significantly better than the other treatments due to the interaction between the application of extract and the cultivar, where a proportion of 1.02% was recorded. The interaction treatment between bagging and cultivar did not show significant differences for the Al-Buraim cultivar, while the bagging treatment impacted significantly on the Al-Khadrawi cultivar, where the unwrapped bunches gave this cultivar the most significant acidity proportion of 0.85%. In contrast, the bagging reduced the acidity of the same variety, which amounted to 0.73% Table 8.

Findings from the triple impact in Table 8 revealed that the control application of the Al-Buraim cultivar was significantly superior in recording the most excellent acidity of 1.10%, while the application of 200 ml. L^{-1} with bagging on Al-Khadrawi cultivar recorded the lowest proportion of 0.67% Table 7.

Cultivar	Bagging	Extract (ml. L^{-1})			Interaction between bagging and cultivar	Cultivar averages
		0	100	200		
Khadrawi	Without bagging	0.95 b*	0.85 c	0.75 e	0.85 a	0.79 a
	With bagging	0.80 d	0.73 ef	0.67 h	0.73 b	
Buraim	Without bagging	1.10 a	0.80 d	0.70 gh	0.86 a	0.82 a
	With bagging	0.95 b	0.71 fg	0.68 h	0.78 ab	
Extract averages		0.95 a	0.77 b	0.70 c		
Interaction between extract and cultivar	Khadrawi	0.87 b	0.79 c	0.69 d	Bagging averages	
	Buraim	1.02 a	0.75 cd	0.71 d		
Interaction between extract and bagging	Without bagging	1.02 a	0.82 b	0.72 c	0.86 a	
	With bagging	0.87 b	0.72 c	0.67 c	0.75 b	

*Means that share the same letters do not differ significantly among themselves according to Duncan's polynomial test at the 0.05 probability level.

Table 8. Impact of applying moringa leaf extract, bagging the bunches, and their interactions on total neutral acidity (%) of two palm cultivars.

The proportion of tannins in the fruits (%)

The data in Table 9 indicate that application with Moringa leaf extract and bagging significantly reduced the proportion of tannins in the dates. The application is 200 ml. L^{-1} recorded the lowest proportion of 0.35 compared with the most significant rate of 0.46% with the control treatment, while the treatment of fruit packaging recorded 0.35 % compared with the unwrapped fruits, which recorded 0.46%. As for the cultivar factor, the two cultivars differed in the proportion of tannins. The most significant proportion was in the Al-Khadrawi cultivar. Its fruits contained 0.43%, while the Al-Buraim fruits contained 0.39% g.

The dual interactions in the same table indicate the superiority of the treatment of 200 ml. L^{-1} with the packaging recorded the lowest proportion of 0.33, while the most significant proportion recorded by the comparison treatment was 0.53%, and the application with 200 ml. L^{-1}forAl-Buraim variety showed a significant decrease in the proportion of tannins that amounted to 0.35, While it increased in the comparison treatment for the Al-Khadrawi variety to 0.48%. As for the interaction between the bagging and the cultivar, the unbagged bunches of the Al-Khadrawi cultivar boosted the proportion of tannins in its fruits, which gave 0.48%, while the practice of the Al-Buraim cultivar recorded the lowest proportion, which amounted to 0.34% (Table 9).

Concerning the triple interactions between the experimental factors, the comparison treatments for the Al-Khadrawi cultivar recorded the most significant proportion of tannins, which amounted to 0.54%. In contrast, the application treatment had a concentration of 200 ml. L^{-1}, coupled with the packaging on the Al-Buraim cultivar, recorded the lowest proportion, which amounted to 0.33% (Table 9).

Cultivar	Bagging	Extract (ml. L^{-1})			Interaction between bagging and cultivar	Cultivar averages
		0	100	200		
Khadrawi	**Without bagging**	0.54 a	0.50 b	0.40 d	0.48 a	0.43 a
	With bagging	0.43 c	0.37 e	0.33 g	0.37 b	
Buraim	**Without bagging**	0.53 a	0.44 c	0.37 e	0.44 a	0.39 b
	With bagging	0.35 f	0.34 fg	0.33 g	0.34 b	
Extract averages		0.46 a	0.41 a	0.35 b		
Interaction between extract and cultivar	**Khadrawi**	0.48 a	0.43 ab	0.36 bc	Bagging averages	
	Buraim	0.44 ab	0.39 bc	0.35 c		
Interaction between extract and bagging	**Without bagging**	0.53 a	0.47 b	0.38 c	0.46 a	
	With bagging	0.39 c	0.35 d	0.33 d	0.35 b	

* Means that share the same letters do not differ significantly among themselves according to Duncan's polynomial test at the 0.05 probability level

Table 9. Impact of applying moringa leaf extract, bagging the bunches, and their interactions on the proportion of tannins in the fruits (%) of two palm cultivars.

.

DISCUSSION

The outcomes of the previous tables demonstrate that the use of moringa leaf extract significantly enhances data quality(boosting T.S.S., total and reducing sugars, decreasing sucrose, and tannins), perhaps because the extract contains several hormones, especially auxins, which play a role in luring compounds produced by photosynthesis to be stored in fruits and enhance their quality [20] or maybe that the total sugars increased in the dates as a result of the early ripening of the fruits, which led to an enhancement in sugar and thus the proportion of soluble solids in the fruits increased Additionally, it stimulates several cytoplasmic enzymes that convert organic acids into sugars, reducing the acidity of fruits and boosting their sugar content. The calcium and potassium in the extract, which play a crucial and necessary function in development by regulating and activating enzymes [22], may also cause an increase in sweetness and softness of the fruits. These findings concur with[23,] who found that application of salami palm bunches with a concentration of 6% Moringa leaf extract resulted in the most significant proportion of total soluble solids, the greatest proportion of total and reducing sugars, and the lowest acidity when compared to the control treatment. This is also in line with 24, which discovered that applying the extract on seedless grapes boosted the total soluble solids and sugar proportion while lowering the neutralizing acidity. The outcomes also demonstrated that the fruit bagging procedure enhanced the quality of the fruits by creating an environment favorable for fruit development by increasing the humidity around the fruits, which resulted in the creation of an environment favorable for enzyme activity or by playing a role in the prevention of photo-oxidation of internal hormones[25]. These findings are in line with those made by[13], who found that the brown paper bagging process on the Halawi and Sayer cultivars affected the majority of the fruit's constituent parts as the proportion of total soluble solids, total and reducing sugars, and the fruit's moisture content increased. Additionally, the findings of this study concur with those

of [14] who found that the chemical characteristics of the fruits of the Khastawi cultivar were enhanced by bagging them in various cover materials. Naturally, the difference between the two cultivars in the studied characteristics is due to the genotype controlling the phenotypic characteristics of the fruits.

CONCLUSIONS

The results of this study indicate that it is possible to rely on natural extracts, such as those from Moringa leaves, to enhance the quality characteristics of the fruits because their use increases the proportion of total and reducing sugars as well as total soluble solids while decreasing the proportion of sucrose and neutral acidity. Paper bagging can also be advised as an agricultural approach to improve some of the qualities of fruits and create an appropriate environment for their development and ripening. In addition to the research elements' substantial impacts, utilizing these treatments in combination is desirable since their interactions produced fruits of excellent quality. This research also suggests investigating the effects of other components of this miraculous tree, including its fruits, seeds, and roots, on the development and quality of other horticultural crops, either on their own or in combination with other agricultural techniques**.**

Author Contributions: Mohammed Abdulrahman; Field application of treatments, Data collection, resources, writing and drafting. Manar Alwan: Supervision, guidance and follow-up, review, and editing. Kadum Abdullah: Supervision, guidance and follow-up, review, and editing.

Funding: External support money was not used for this study.

Data Availability Statement: All data is available by the first author.
Acknowledgments: I extend my thanks and gratitude to the management of Fadak farm the Department of Horticulture and Landscaping, and all those who helped in the completion of this research

Data Availability Statement: All data is available by the first author

Conflicts of Interest: The authors declare no conflict of interest.

REFERENCES

1. Jassim, N. S.; Saleh, A. D. Efficiency of using *Bacillus subtilis* as a growth regulator and its effect on the phenotypic and physiological characteristics of date palm offshoots *Phoenix dactylifera* L. under salt stress conditions. *Journal of Kerbala for Agricultural Sciences*,**2018**. *Volume 5*, Issue 4, pp. 1-5.
2. Al-Hamdani,K. A. S.; Muhammad, M. H.; Hussein, M. N. *Date Palm*, first edition. Tikrit University Press,Iraq, **2022**.pp340.
3. Idowu, A. T.; Igiehon, O. O.; Adekoya, A. E. ; Idowu, S. Dates palm fruits: A review of their nutritional components, bioactivities and functional food applications. *AIMS Agriculture and Food*,**2020**. 5(4), 734-755.
4. Al-Aqidi H. K. *The date palm is the lady of the trees and the fruit of the fruit*. first edition. the Hashemite Kingdom of Jordan,**2010**. p 396.
5. Hussein, P. A. Description of some varieties of Iraqi date palms. The National Committee for the Registration and Approval of Agricultural Varieties. The national program for the propagation, improvement and cultivation of date palms. Ministry Of Agriculture. The Republic of Iraq ,**2002**.
6. Ali, A. A.;Falih, S. A.;Idan, R. O.; Aziz, H. M. Response of seedlings of olive cultivar Khudairi to treatment with licorice and yeast extracts., *Journal of Kerbala for Agricultural Sciences,***2017**.*Volume 4*, Issue 4, pp. 56-68.
7. Godlewska, K.; Ronga, D.; Michalak, Izabela. Plant extracts-importance in sustainable agriculture. *Italian Journal of Agronomy***, 2021**, 16.2.

8. Ertani A.;PizzeghelloD. ;Francioso O;Tinti A. ;Nardi S. Biological activity of vegetal extracts containing phenols on plant metabolism. *Molecules*,**2016**,21:1-14.
9. A.L.- Shamary, W. A. .; Alkhateb, B. A. A. H. .; Abdel, E. T. . Role Of Perlite Quantity And Intervals Of Irrigation On Potatoes (Solanum Tuberosum L.) Grown In Gypsiferous Soil. *Journal of Life Science and Applied Research*. 2020, 1, 31-39.
10. Abdalla, M. M. The potential of *Moringa oleifera* extract as a biostimulant in enhancing the growth, biochemical and hormonal contents in rocket (Eruca vesicaria subsp. sativa) plants. *Int. J. Plant Physiol. Biochem*,**2013**,*Volume 5*(3): 42-49
11. Mahmood, N. A. & Abdulateef, S. M. Determining Some Undesirable Behavioral Traits and Their Impact on the Behavioral Performance of Broiler Chicks. in I.O.P. Conference Series: Earth and Environmental Science .2021,vol. 904.
12. Mustafa, A.; Abdel-Hamid, N.; Abd El-Hamid, A.; El-Sonbaty, M.; Abd El-Naby, S. Improving Fruit Set, Yield and Fruit Quality of Khadrawi Date Palm Cultivar. *Arab Universities Journal of Agricultural Sciences*,**2018**. *Volume 26(4)*, 1461–1470.
13. Sharif, H. J. Effect of bagging and licorice extract on early ripening and improvement of fruit characteristics of date palm Phoenix dactylifera L. Al-Sayer and Al-Hallawi cultivars,Master Thesis, University of Basra, College of Agriculture, Horticulture and Palm Department. Iraqi-date palms.net.**2008**.
14. Al-Issawi, M. Evaluation of the efficiency of the date and type of taste mastication in the qualitative characteristics and degree of maturity of date palm fruits of the Khastawy cultivar. Master's thesis, College of Agriculture, University of Anbar, Iraq.**2020**.
15. Al-Rawi, K. M.; Muhammad, K. A. Design and analysis of agricultural experiments, second edition. University of Mosul, Ministry of Higher Education and Scientific Research. Republic of Iraq.**2020**.
16. Noaman A I, Khalaf R M, Emad GH, Al-Abbasy, Mohammed Th. T. Effect of flaxseed oil dosing on fertility, growth characteristics and some physical, biochemical, and hormonal blood parameters during the early pregnancy of Awassi ewes. Revis Bionatura. 2022;7(4) 5. http://dx.doi.org/10.21931/RB/2022.07.04.5.
17. A.O.A.C. Official Method of Analysis. Association of Official Method of Analytical Chemists Washington. D.C**.,1970**. p 910.
18. Howrtiz , W. Official methods of analysis association of official analytical chemists Washington, D.C. **1975** . 221p.
19. Ali, H.H., AL-Rawi, K., Khalaf, Y., Alaaraji, S., Aldahham, B., Awad, M., Al-ani, O., Al-ani, F., Ali, A.T.Serum Caveolin-1 Level is Inversely Associated with Serum Vaspin, Visfatin, and HbA1c in Newly Diagnosed Men with Type-2 Diabetes.Reports of Biochemistry and Molecular Biology,2022, 11 (2), pp. 299-309.
20. H. Muhammed, S., Y. Mohamed, R. Investigation And Molecular Identification Of Cucumber Damping-Off Fungi Under Greenhouse Condition. Anbar Journal Of Agricultural Sciences, 2023; 21(1): 19-31. doi: 10.32649/ajas.2023.179712.
21. Al-Hamoud, F. Some of the physical, chemical and physiological characteristics of the fruits of the fruit. (2019). Master Thesis, College of Agriculture, University of Basra, Iraq.
22. Hasegawa, P.M.;Bressan, R. A.; Zhu, J. K.;Bohnert, H. J. Plant cellular and molecular responses to high salinity.*Annu Rev Plant Physiol*,**2000**.*Volume51*: 463-499.
23. Thabet, A. Y. I.; Abdel-Hak, R. E. S.; Ashour, N. N.; Hassan, H. S. Influence of foliar application with moringa *(Moringa oleifera* L.) aqueous leaf extract on fruit set, yield and fruit quality of Selmy date palms. *Egyptian Journal of Chemistry*,**2022**. *Volume 65 (9),* 1-2.
24. Aly, M. A.; Harhash, M.M.; Bassiony, S. S.; Felifal, M.M. S. Effect of Foliar Spray of Sitofex, Moringa Leaves Extract and Some Nutrients on Productivity and Fruit Quality of "Thompson seedless" Grapevine. *Journal of the Advances in Agricultural Researches*,**2020.** *Volume 25(1)*:112-129.
25. Mohammad, A. A.; Al-Rayes, A. H. Plant physiology. The second part. Ministry of Higher Education and Scientific Research,. College of Agriculture, University of Baghdad, Iraq. **1995**.

Received: 26 September 2023 / Accepted: 15 April 2023 / Published:15 December 2023

Citation: Abdulrahman,M.; Alwan, M.; Abdullah, K. Chaffat, M. The performance of moringa leaf extract application and bagging the bunches to improve fruits quality of date palm (*Phoenix dactylifera* L.) cv. Al-Khadrawi and Al-Buraim. Revis Bionatura 2023;8 (4) 86. http://dx.doi.org/10.21931/RB/2023.08.04.86