

Research Article



Economic Returns from Postharvest Cured Date Palm Cultivars under Glasshouse Conditions

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Abstract | Traditional methods of open sun curing were used for postharvest processing of dates but, the desired quality of fruit could not be achieved due to adverse effects of dust storms and rain spells at ripening and curing stage of fruits. Covering fruit bunches with bags were also not productive and profitable; therefore, the growers switched to solar tunnel drying but couldn't get the required results. The protocols of using solar tunnels needed fine-tuning of temperature and relative air humidity, which affect fruit quality. During dates' drying process high temperature and low humidity is required. This research was conducted at Arid Zone Research Center, D.I. Khan, Pakistan for quick and safe ripening of date fruits under controlled conditions. For ripening of date fruits, $35 \pm 5^\circ\text{C}$ temperature and $80 \pm 5\%$ relative humidity; and for drying, $45 \pm 5^\circ\text{C}$ temperature and $30 \pm 5\%$ relative humidity levels were kept constant. The moisture contents were reduced to recommended moisture of 23-25% for shelf life stability. Data for fresh date production ranged from 39-59% of the initial value. Minimum (39%) and maximum (59%) fresh date yields were recorded in cv. Gulistan and Shakri, respectively. Similarly, minimum and maximum produce recorded in dry dates were 32 and 50% in Gol Basara and Zahidi, respectively. Maximum and minimum length observed were 5.2 cm and 2.5 cm in Dhakki and Gol Basra, respectively. Economic analysis revealed that processing of fresh dates fetched more money than dry dates for most of the popular varieties. However, Dhakki date being more preferred due to its unique taste and the highest fruit yield and the biggest fruit size; needs curing under controlled conditions.

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Introduction

There are more than 150 varieties of date palm (*Phoenix dactylifera* L.) grown in Pakistan which includes Dhakki, Shakri, Zahidi, Baitullah, Muzalti, Gulistan, and Basra etc. (Nadeem et al., 2011) having unique tastes, textures and response of commune's acceptability. These varieties are growing mostly in

arid regions of the country; facing higher temperature, lower humidity, while needing abundant water for optimal growth. Two major provinces, Baluchistan and Sindh contribute about 85 and 90%, respectively to the total date's production of the country. A few varieties are also produced in some parts of Punjab and Khyber Pakhtunkhwa adding up their share in total national production (524041 tons) (FAO, 2013).

The four ripening stages of dates are characterized as Kimri (immature green), Khalal (the mature full colored), Rutab (the soft brown), and Tamar (the hard raisin-like) (Chao and Krueger, 2007). Moisture contents of dates at Khalal, Rutab, and Tamar stage range from 45 – 65%, 30 – 45%, and less than 30%, respectively. At “Tamar” stage the sugar content is about 60 – 80%. At this stage the product is suitable for long term storage due to its improved shelf life. Most dates are harvested at “Rutab” stage, possessing fully-ripen soft stuff and showing light brown color (Al-Hooti et al., 1997)

Dates have become a valuable source of income for Pakistani farmers. However, there occur numerous physical changes and problems due to its natural ripening on palm trees. It may include blistering (detachment of the date flesh from pit) and different kinds of impurity sticking to the fruits causing increased microbial contaminations (Sakr et al., 2010). Processes such as washing, grading, cleaning, and packing are carried for further value addition and proper postharvest management of dates. Under such circumstances the dates are not available in fresh form and are converted into dry dates. Moreover, monsoon season is coinciding with the harvest season of the Dhakki dates due to recent climate change which adversely affects its availability in fresh form. High rainfall and humidity during later stages of fruit development limit the production of date palms, causes certain physiological disorders, and adversely affects the quality of fruit, as it leads to fruit cracking and checking (Yahia and Kader, 2011). Traditional practices of open sun drying were initially used for postharvest processing of dates. But, the desired quality of fruit could not be achieved due to adverse effects of climate change i.e. dust storms and rain spells; occurring especially at the ripening and curing stages of fruits. Later on the practice of covering fruit bunches with bitumen paper to protect it from monsoon rains was adopted but it was a slow process and the desired quality and quantity of fruit could not be attained. Consequently, the farming community switched to dry date processing because of limited opportunity for maintaining quality and quantity of fresh dates. Temperature and humidity are the two main factors affecting the fruit quality. At ripening stage, the fruit needs low temperature and high humidity, while; during drying it requires high temperature and low humidity. For safe ripening of comparatively soft date palm varieties 40–43°C temperature is required

(Hyde, 1948). For thick flesh varieties the temperature ranges of 45–46°C and relative humidity 70% for a time of 2–4 days or more than that may be needed to get ripened. In all the previous research work carried out on solar tunnel drying, only one parameter i.e. temperature was considered (SBI, 2010). Also, there are many designs of the tunnel set to accommodate considerable quantities of dates (Abul-Soad et al., 2015). However, these studies were ended up with a special design that could accommodate a half of ton in a single cycle of 3 days and adjusted the way to handle unripe date within the tunnel (Abul-Soad, 2017). At ripening stage, the temperature inside the dryer was raised much enough and humidity was not taken in consideration, due to which the flesh got detached from the pit and the desired quality products were not achieved. Moreover, in case of world fame Jambo size date palm cv. Dhakki could not mature on plant and consequently its ripening is done at ground in open sun shine.

The objectives of the present research were, to compare fresh and dry dates production after postharvest curing in glasshouse and to compare economic returns coming from the fresh and dry dates after postharvest curing.

Keeping in view the concern of the growers about safe ripening of the date palms, a research study was carried out where controlled ripening was supposed to be a possible alternative to natural ripening. This will overcome the problems caused by long time exposure of date fruits to climatic atrocities while staying on the palm trees.

Materials and Methods

Eight different varieties of dates including Shakri, Zahidi, Baitullah, Muzalti, Gulistan, Shakri Yellow, Basra and Dhakki were processed to produce fresh dates in the glass house at Arid Zone Research Center, Dera Ismail Khan. These varieties were also processed in glass house to produce dry dates. Market survey was conducted to collect the rates for fresh and dry dates. The varieties under study were compared in terms of economic return accruing from their fresh and dry fruits.

The study was carried out at Arid Zone Research Center, Dera Ismail Khan for two years during 2017 and 2018.

Harvesting of dates

Date varieties (Shakri, Zahidi, Baitullah, Muzavti, Gulistan, Shakri Yellow, Basra and Dhakki) were harvested from selected plants of the orchard at Arid Zone Research Center, Dera Ismail Khan at Khalal stage for experimentation. Dera Ismail Khan is situated in the extreme south of Khyber Pakhtunkhwa Province of Pakistan and lies in between 31° 49' N latitude and 70° 55' East longitude.

Pre-treatment

Harvested dates were collected in bunches, detached from bunches; through opposite side pushing for ensuring the caps attachment. The fruits were cleaned with water to remove dust and other inert material. Sorting was carried out to remove damaged and spoiled fruit (El Mardi et al., 2006).

Sample size

One kilogram sample of each variety was collected from the sorted fruits and replicated three times for processing both fresh date and dry dates in wooden trays. The samples collected for dry dates were immersed in boiling water for five minutes and were placed in perforated trays for processing. While samples meant for fresh date processing were placed on perforated trays after washing with clean water (Ahmad et al., 1995). Both samples were shifted to green glass house.

Glass house operation

The glass house (30 × 60 ft) installed at Arid Zone Research Center, D.I. Khan include ventilators, exhaust fans, blowers, cooling pad, misters and heating cables. For rising inside temperature, the entrance and ventilators were closed and all the running components were shut down. Similarly, for lowering inside temperature, the entrance and ventilators were opened to maintain humidity at required level; exhaust fans and blowers were switched on to blow out the trapped hot air. For increasing the inside humidity, entrance and ventilators were closed while the cooling pad and misters were switched on. In short the humidity and temperature were controlled and kept at constant levels i.e. for ripening of the dates 35°C temperature and 80% relative humidity; and for drying 45°C temperature and 30% relative humidity through respective processing period.

Weight loss of dates in postharvest curing were

recorded by subtracting weight at curing from initial sample weight.

Drying

The moisture contents of date fruit were reduced to desired moisture content (23–25%). To keep the dates soft the moisture contents less than 20% were avoided (Kader, 2009). Moisture tester was used for the confirmation of moisture level.

Data collection

Data on total fruit yield (kg tree⁻¹) were recorded for all the varieties. Data including temperature and humidity inside glass house (GH) and hardness of dates were recorded on daily basis through hardness tester. Both dry dates and fresh dates were re-weighed when attained 0.52 water activity levels and attaining full ripening respectively.

Statistical analysis

The data recorded were analyzed statistically using analysis of variance technique and subsequently Least Significant Difference test (LSD) was applied for comparing the treatment means, by MSTATC computer software using the procedure given by Steel et al. (1997).

Results and Discussion*Physical properties of dates*

At Khalal stage, the shape, color and size of all collected samples were observed and presented in Table 1. On the basis of length, date fruits were categorized as small, medium and large sizes; as compared to each other. The ranges of fruit size were set as small fruit < 4.0 cm, for medium fruit 4.0–5.0 cm and large fruit >5.0 cm (Markhand et al., 2010). Overall quality of the dates regarding physical appearance revealed that Dhakki variety was the most attractive and superior variety among all other varieties.

Fruit yield and weight loss of dates in postharvest curing

Fruit yield and weight loss of different varieties of dates in postharvest curing is given in Table 2. Dhakki date had the highest fruit yield (135 kg tree⁻¹) among all other varieties. The average weight loss compared to initial samples; in “Shakri” was 41% for fresh dates, while; it was 56% for producing dry dates. The average weight loss in “Zahidi” was 50% for fresh dates, while; it was 50% for producing dry dates. The average weight loss in “Baitullah” was 51% in case of

Table 1: *Physical properties of different varieties of dates at maturity.*

S. No.	Variety	Color	Shape	Length (cm)	Category
1	Shakri	Medium Brown	Oval	3	Small
2	Zahidi	Golden Yellow	Oval	3.5	Small
3	Baitullah	Golden Brown	Cylindrical	3	Small
4	Muzawti	Black	Thick Oval	2.5-4.5	Small to Medium
5	Gulistan	Light Brown	Oval	4.5	Medium
6	Shakri Yellow	Yellowish Brown	Oval	3	Small
7	Gol Basra	Yellow	Oval	2.5	Small
8	Dhakki	Light Brown	Oblong Oval	5.2	Large

Table 2: *Fruit yield and weight loss of different varieties of dates in postharvest curing.*

Variety	Fruit yield (kg tree ⁻¹)	Fresh dates weight (kg)			Weight loss (%)	Dry dates weight (kg)			Weight loss (%)
		Initial	Final	Difference		Initial	Final	Difference	
Shakri	115	1	0.59 a	0.41 f	41 f	1	0.44 c	0.56 d	56 d
Zahidi	95	1	0.50 b	0.50 e	50 e	1	0.50 a	0.50 f	50 f
Baitullah	100	1	0.49 c	0.51 d	51 d	1	0.40 d	0.60 c	60 c
Muzawati	85	1	0.49 c	0.51 d	51 d	1	0.48 b	0.52 e	52 e
Gulistan	125	1	0.39 f	0.61 a	61 a	1	0.48 b	0.52 e	52 e
Shakri Yellow	130	1	0.48 d	0.52 c	52 c	1	0.40 d	0.60 c	60 c
Basra	120	1	0.43 e	0.57 b	57 b	1	0.32 f	0.68 a	68 a
Dhakki	135	1	0.50 b	0.50 e	50 e	1	0.36 e	0.64 b	64 b

fresh dates, while; it was 60% for producing dry dates. The average weight loss in “Muzawti” was 51% in case of fresh dates, while; it was 52% for producing dry dates. The average weight loss in “Gulistan” was 61% in case of fresh dates, while; it was 52% for producing dry dates. The average weight loss in “Shakri Yellow” was 52% in case of fresh dates, while; it was 60% for producing dry dates. The average weight loss in “Basra” was 57% in case of fresh dates, while; it was 68% for producing dry dates. The average weight loss in “Dhakki” was 50% in case of fresh dates, while; it was 64% for producing dry dates. The average minimum weight loss of 41% occurred in fresh dates produced from Shakri variety and average maximum weight loss of 61% occurred in fresh dates produced from Gulistan variety. Similarly, the average minimum weight loss of 50% and average maximum weight loss of 68% occurred in dry dates produced from Shakri variety.

Dry dates produced from “Baitullah” variety were of better quality than fresh dates produced from this variety. The fresh dates of “Baitullah” variety became bone dry, its flesh got detached from the pit and its skin got ruptured. “Dhakki” variety on the other hand

produced both good quality fresh as well as dry dates. The fresh dates produced were good in color and taste. The produce was also fleshy and large in size as compared to the other seven varieties. The maximum and minimum size observed among varieties under study was 5.2 cm and 2.5 cm in case of Dhakki and Basra varieties, respectively. A cultivar, Deglet Nour could not be processed for ripening at temperature higher than 35°C in order to avoid fruit darkening and disflavoring (Morton, 1987). However, some soft cultivars like Zahidi, Halawi and Dayri could be ripened at comparatively increased temperatures like 35–38°C.

Comparative economics of fresh dates vs. dry dates after postharvest curing

It is depicted from Table 3 that market rates of fresh dates of almost all varieties were greater than the dry dates except Gulistan wherein due to comparatively high water activity level fresh form was much perishable. This variety was converted into dry dates to reduce the moisture content for safe storage and, hence, was not available in fresh form. Moreover, it is more fleshy and soft to maintain its shape during processing and packaging. Though the fresh dates production

Table 3: *Comparative economics of the different varieties after postharvest curing.*

Variety	Fresh dates			Dry dates			Fresh dates	
	Weight obtained after processing (kg)	Market rate (Rs/kg)	Cost (Rs)	Weight obtained after processing (%age of the initial sample)	Market Rate (Rs)	Cost (Rs)	Comparatively more monetary return (%)	
Shakri	59%	100	59	44%	120	53	10	
Zahidi	50%	150	75	50%	90	45	40	
Baitullah	49%	100	49	40%	85	34	31	
Muzafati	49%	120	59	48%	100	48	19	
Gulistan	39%	100	39	48%	150	72	Fresh date preparation not possible	
Shakri Yellow	48%	120	58	40%	100	40	31	
Gol Basra	43%	75	32	32%	100	32	Equal return	
Dhakki	50%	300	150	36%	250	90	40	

from unit mass of Dhoka was varying from 39 to 59%, however, in Toto it was observed that dates processed for fresh dates production were more economical than the dry dates production. Dhakki and Zahidi varieties in their fresh form had the highest economic return when compared with their dry dates. However, harvesting of these improved varieties coincide with the monsoon rains due to recent change in the climatic conditions for the last few years which may affect the fruit quality as well as the final yield (Abul-Soad et al., 2015; Yahia and Kader, 2011). Curing in glass house condition may thwart the threat from monsoon rains. Thus curing of dates in glass house conditions may be the possible alternative to avoid adverse effect of weather on fruit yield and quality.

Benefit cost ratio (BCR)

Data on benefit cost ratio revealed that fresh dates were more beneficial than dry dates on the basis of higher BCE value (Table 4). It is evident from the table 4 that fresh dates gave double return as compared to dry dates.

Table 4: *Benefit cost ratio for fresh and dry dates (Chuhara).*

Description	Cost (Rs. kg ⁻¹)	Benefit (Rs. kg ⁻¹)	BCR
Fresh Dates	70	200	2.8
Dry Dates	118	125	1.1

Conclusions and Recommendations

Dhakki date fetched highest market rate among all other varieties. Dhakki and Zahidi both varieties had higher economic return (40%) in fresh form than their dry form. Shakri Yellow and Baitullah

were the other two varieties that produced 31% more monetary gain in fresh form than the dry form. All other varieties should also be processed in fresh form for comparative advantage over the dry form. Dhakki date is much preferred due to its unique taste and the highest fruit yield and fruit size; however, monsoon rains at harvesting stage can damage the quality. Thus curing of dates under glasshouse condition is the possible solution in order to maintain yield and quality of the dates.

Novelty Statement

Quality of date cannot be achieved from postharvest processing of dates in an open environment due to adverse climatic conditions. The date needs curing under controlled conditions for keeping the quality.

Author's Contributions

All authors contributed to the present research equally.

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