Prospects and challenges of date fruit value-addition in Oman

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Abstract

Food loss and waste reduction efforts have received a lot of attention recently because of their importance in enhancing food security and environmental sustainability. Value addition of agricultural products is the key to a higher production rate, fewer food losses, and hence more farm income and a better economy. In Oman, agriculture is represented as the first source of life and date is considered one of the most important permanent cultivated crops. This study aimed to evaluate the value addition process of the date palm products and reveal the challenges associated with the productivity improvement in Oman. Six prominent date value-addition factories were visited for data collection. The most date value-added products found were date with nuts, date syrup, and paste, and industries are using most popular date varieties Khalas and Fardh for the value addition processes. Raw dates are supplied by three farm categories and four process mechanization levels were found in these factories. The financial productivity improvement due to the value addition were evaluated. Date with nuts found to be with the highest productivity ratio that reaching up to 540% in Khalas and 360% in Fardh. Highly productive factories had high mechanization levels (ML3–4). A broader improvement in value addition industry is essential to improve the productivities. This includes increase in number of small and medium enterprises, improve mechanization levels, technology transfer, and capacity building needs and additionally to improve the quality of value-added products which will positively affect the farm income and country's economy.

Keywords: Date fruit; mechanization level; postharvest; productivity; value-added products

Introduction

Food production is continued to be squandered and wasted on a global scale. The Food and Agriculture Organization (FAO) estimates that roughly 14% of food is lost before it reaches the market, resulting in a $400 billion loss each year (FAO, 2020). Around a quarter of all agricultural land, water, and fertilizers needed in crop production are lost or wasted, accounting for one-third of total global food output (Shafiee-Jood & Cai, 2016). Postharvest losses have an environmental impact due to attrition in the use of lands, water, energy, and labor in the production of non-consumable products (FAO, 2013). Food loss and waste reduction efforts have recently gained a lot of attention for their role in improving food security and environmental sustainability (Shafiee-Jood & Cai, 2016).

Adding value to agricultural products is one of the most essential aspects of increasing agricultural output, reducing food waste, and boosting farmer-market ties (Kiaya, 2014). Evans (2012) characterized it as a process so that agricultural producers can use to create a new commodity outside of the established framework to increase their profits. According to several studies, adding value to agricultural products helps to improve productivity

and product sustainability (Ravi & Swaminathan, 2012; Al Hinai & Jayasuriya, 2021). The long-term viability of boosting production, minimizing post-harvest losses, and expanding cultivated areas is a critical issue in the operations of production to meet food demand and achieve food security (Kiaya, 2014).

Agricultural machinery, which is involved in all stages of production right from crop planting through harvesting and food processing, is strongly linked with value addition. Agricultural mechanization is a method of increasing agricultural and food production by increasing cropping intensities, eliminating drudgery from some labor-intensive farm and processing activities and eradicating poverty. It is considered one of the greatest engineering achievements of the twentieth century (Clarke, 2000; Hossen, 2019). Seeds, fertilizers, water, labor, and time are examples of manufacturing inputs and production management (Fadavi *et al*., 2010). There is an increasing demand for agricultural machines as they have been proved to reduce production costs and enhance farmer income (Clarke, 2000; Jayasuriya *et al*., 2017).

For Oman, agriculture was history's earliest source of life, with various cultivated crops (MAF, 2017). The economy of Oman is built on crude oil revenues, which account for 51% of the country's gross domestic product (GDP), while agriculture accounts for only 1.2% of the country's GDP, which is predicted to rise to 3.1% by 2020 (OBG, 2018). In Oman, the date palm is a permanent crop that spans a large region among other fruits and vegetables. On the other hand, the postharvest losses in fruit can reach an average of 28% in which date is a part of it and about 28% in vegetables (Al-Dairi *et al*., 2021; Al-Lawati *et al*., 2016). The Ministry of Agriculture and Fisheries has several programs in place to improve land productivity and the quality of agricultural products, particularly the dates needed to achieve food security (MAF, 2011a; Al-Hinai *et al*., 2022a). Recently, interest in date products has increased among international consumers (Abdallah *et al*., 2019). Improving the date palm products through value addition is essential to increase the production value and quality, reduce postharvest losses, and raise the income of farms and the country's economy. A lack of postharvest processing and value-added activities integrated into the production system is causing low agricultural productivity in Oman (Dhehibi *et al*., 2018). Low mechanization at the processing level is one of the main factors contributing to the impairment. The adoption of the value addition process in date products can be the solution to avoid the problems related to the productivity of dates, which is the main focus of this study. Therefore, this study is aimed to evaluate the value addition process of the date palm products and reveal the scope and challenges associated with the productivity improvement in Oman.

Literature Review

Status of date production in Oman

The date palm is the most widely grown crop in Oman, accounting for around 80% of all other fruits and 50% of all cultivated crops (Al-Yahyai and Khan, 2015; Al-Hinai and Jayasuriya, 2021). More than 200 date varieties may be found in diverse locations of Oman (Ishag, 2017), and the top ten varieties are shown in Table 1 (MAF, 2019a). With an annual output rate of 377,000 tons in 2019, Oman is the world's eighth-largest date producer (Al-Yahyai & Khan, 2015; MAF, 2019b; NCSI, 2020).

Status of farm landholdings in Oman

The farm landholdings are numerous and fragmented in different governorates of Oman. The highest number of farm landholdings are located in Al-Dakhiliyah, North Al-Sharqiyah, and South Al-Batinah Governorates with about 21,600, 18,000, and 13,500 respectively (MAF, 2010). The number and percentage of farm landholdings in Oman are shown in Table 2 (Jayasuriya *et al*., 2017, ACoO, 2020).

In Oman, 82% of landholdings are owned by individuals, while 5% are controlled by groups. About 72% of agricultural products produced in farmlands are consumed in the home, 25% are sold locally, 0.9% are exported, 0.1% are processed, and 2% are utilized for other purposes (MAF, 2010).

Status of farming system and mechanization level in Oman

The farming system in Oman is divided into three categories based on total area and mechanization levels (ML): small, medium, and large farms as shown in Table 2.

Table 1. The highest cultivated date varieties in Oman (MAF, 2019a).

Date variety	Date production (ton)	Production (%)
Naghal	37,167	9.86
Khisab	35,504	9.42
Khalas	35,225	9.35
Al-Mabsili	32,708	8.68
Umm Al-Salla	30,151	8.00
Fardh	24,847	6.59
Khunizi	21,152	5.61
Shahal	19,850	5.27
Abu Da'an	11,116	2.95
Madluki	10,877	2.89

Table 2. The mechanization levels with different farm classifications, land holdings and covering areas (Jayasuriya et al., 2017; ACoO, 2020).

Farm classification	Farm size range in hectare (ha)	No. of landholding	Landholding (%)	Total area (%)	Mechanization level
Small	0–0.84	122,829	79.76	11.9	Minimal
Medium	0.84–12.6	21,091	19.56	58.7	Moderate
Large	>12.6	1051	0.69	29.4	High

Table 3. Indication of date production and land productivity in Oman (FAOSTAT, 2019).

	2015	2016	2017	2018	2019
Production (tons)	344690	355332	360917	368808	372572
Area harvested (ha)	24120	24120	24617	25125	25382
Land productivity (tons/ha)	14.291	14.731	14.661	14.679	14.679
Per palm yield (kg/palm)	114.3	117.2	117.3	117.4	117.4

The coastal line of Al Batinah North Governorate, parts of Al-Dakhiliyah Governorate (Nizwa and Bahla), and Dhofar Governorate (Salalah) are home to all types of farm systems (Jayasuriya *et al*., 2017; MAF, 2010).

Small farms (0–0.84 ha) account for 79.76% of all farm landholdings, but only 11.9% of the total farmed area with low mechanization, according to Table 2. In a medium farm system, the overall holding area is approximately 0.84–12.6 ha, which accounts for 19.5% of landholdings and 58.7% of the total farming area with a moderate mechanization. Many farm owners in the moderate farm system are having difficulty in marketing their products as imported commodities become more competitive and there are fluctuations in selling prices (Jayasuriya *et al*., 2017). In a large farm system, the overall holding area exceeds 12.6 ha, accounting for 0.69% of landholdings and 29.4% of farmland. This system is highly mechanized as some of these farming estates have good agricultural practices (GAP) licenses and export their crops to worldwide markets in Europe and the United States (Jayasuriya *et al*., 2017).

Date land, water, and labor productivities in Oman

Various publications have given different statistics on the land productivity of dates in Oman. According to Al-Mulla & Al-Gheilani (2017), the average date output per hectare is around 6.075 tons, with an average income of 1065 Omani Rial (OMR). According to the Ministry of Agriculture and Fisheries, around 6.930 tons of date are produced per hectare (MAF, 2011b). FAOSTAT (2019) indicated the date production and the land productivity numbers for the years 2015–2019, as shown in Table 3. This discrepancy could be related to the fact that there are over 200 varieties with variable yields, as well as the usage of different tree spacing and other reasons.

The water productivity of dates is reported as 0.570 kg/m^3 and the water productivity based on cost is reported to be 0.630 OMR/m^3 (Al-Mulla & Al-Gheilani, 2017), and average labor productivity is reported to be around 0.815 kg/ha (MAF 2011b).

Table 4. The selection of date factories, varieties, and value-added products.

Factory code (Location in Oman)	Date variety	Type of value addition
A (Smail) B (Bahla) C (Nizwa) D (Barka) E (Ibri) F (Nizwa)	1. Khalas 2. Fardh	1. Date with nuts 2. Date syrup 3. Date paste

Methodology

Selection of the date value-added products

Several prominent date factories in Oman were visited to gather information on value-added products, processes, and mechanization levels. Six notable date manufacturers were chosen, and it was discovered that the majority of them use two date varieties for the value addition process: Khalas and Fardh. Three common value-added products from several date varieties were chosen, and the range of data variance between six factories was taken into account during the analysis. The details of the date varieties and value-added products selections of different factories in Oman are shown in Table 4.

Farm categories supplying raw dates for value addition

Individual, group, and small and medium enterprises (SME) type date value-added (DVA) process categories were studied by considering the total farm area and

proportion of farm landholdings in each category is provided in Table 5. According to Table 2, the selected categories for this study account for 89% of farm landholdings and 99% of farming areas. Individual holdings account for around 82% of farm categories in Oman, followed by group farms at 5% and other farm categories at 13% (MAF, 2010; Al-Hinai *et al*., 2022a).

Selection of the mechanization levels for the date value addition process

On a global scale, Krause and Poesse (1997) identified mechanization levels based on their sophistication. The categorization of mechanization is subjective to the region, country, and application activity, ranging from land preparation to postharvest processing (Mrema *et al*., 2014; Pradan *et al*., 2016).

Based on the method/steps of technology adoption and mechanization in different date value addition processes by selected date manufacturers, four mechanization levels were determined in this study. Table 6 illustrates the proportion of mechanization based on the number of mechanized operations compared to the total number of processing activities, classified into four levels, ML-1 to ML-4.

Table 5. The distribution of the total area and farm landholdings percentage of the selected DVA process category (MAF, 2010; ACoO, 2020).

DVA process category	Total farm area (ha)	Farm landholdings (%)
Individual farm	0–0.84	79.76
Group farm	0.84–2.1	9.33
SMEs farm	2.1–12.6	10.23
Others	>12.6	0.68

Productivity improvement of the date value-added products

The following equation is used to calculate the benefit of value-added products (Lewbel, 2003):

$$\text{Net income} = \text{selling price (value} - \text{added)} - \text{purchase price (raw)} - \text{value addition cost.} \quad \text{(Eq. 1)}$$

where selling price, purchase price, and value-added product are in OMR/ton

The following calculation is used to compute the net profit-based productivity ratio (Farooq *et al*., 2001):

$$\text{Productivity Ratio} = \frac{\text{Purchase price of raw product} + \text{Net income}}{\text{Purchase price of raw product}} \quad \text{(Eq. 2)}$$

The following are the main data on land, water, and labor productivity for raw date products, as determined by literature reviews: date palm planting density of 125 palms/ha (Kotagama *et al*., 2014), average raw date price of 0.400 OMR (Al-Mulla & Al-Gheilani, 2017) and, land productivity 6.930 ton/ha (MAF, 2011).

Results and Discussion

Date value-added products and the mechanization level

According to the data collected from the selected date factories, Khalas and Fardh are the varieties used for value addition because of their availability, higher production compared to other varieties, consistency in sugar content (Fardh has less sugar than Khalas), low purchase cost, and more economic value. The three

Table 6. List of Activities used in date value addition process and the mechanization level classification.

Activities in the value addition process and mechanization level (ML) classification		
Dates with Nuts	**Date Syrup**	**Date Paste**
1. Sorting and separating of dates manually or mechanically 2. Cleaning and washing the dates manually or mechanically 3. Grading the dates manually or mechanically 4. Drying the dates manually or mechanically 5. Removing the seeds manually or mechanically 6. Adding nuts manually or mechanically 7. Packaging the date value-added products manually or mechanically	1. Cleaning and washing the dates manually or mechanically 2. Steaming the dates manually or mechanically 3. Extracting the date tissues from the date juice manually or mechanically 4. Cooking the date juice manually or mechanically 5. Filtering the syrup from the juice manually or mechanically 6. Filling and packaging the date syrup manually or mechanically	1. Sorting and separating of dates manually or mechanically 2. Cleaning and washing the dates manually or mechanically 3. Drying the dates manually or mechanically 4. Removing the seeds manually or mechanically 5. Kneading the date manually or mechanically 6. Packaging the date value-added products manually or mechanically
Up to 2 activities—ML-1 Up to 4 activities—ML-2 Up to 6 activities—ML-3 More than 7 activities—ML-4	Up to 2 activities—ML-1 Up to 3 activities—ML-2 Up to 4 activities—ML-3 More than 5 activities—ML-4	Up to 2 activities—ML-1 Up to 3 activities—ML-2 Up to 4 activities—ML-3 More than 5 activities—ML-4

selected value-added products; date with nuts, date syrup and date paste are the most date value-added products that are produced in Oman for both local and export markets.

Table 7 shows the survey results for various date value-added products and the related mechanization levels. The number of mechanized production activities used by the factory for the specific value addition process was used to determine the percentage of mechanization level.

The productivity improvement of the date value-added products

The results of the productivity ratios estimated related to the six date factories are shown in Table 8 based on the selected value-added product, cost of the raw date, cost of the value-added product, and net income of the value-added product.

Table 8 shows that date with nuts in the Khalas variety showed the highest productivity ratio that reached up to 540% and this is because of the large disparity between the selling price and the value-addition cost between the raw date and the final products for about 2500 OMR/ton. Date paste comes in second place with a productivity ratio of 204%, followed by date paste with a productivity ratio of 180%.

Dates with nuts have the highest productivity ratio in the Fardh variety, similar to Khalas variety, but lower than Khalas, reached up to 360%, owing to the higher cost of value-addition activities, as indicated in Table 8. Like the Khalas variety, date syrup reached second-highest productivity ratio of 180%, followed by 129% for date paste. As a contribution to postharvest loss reduction, productivity is increased by applying modern technology and research. Value addition can be one of the best options to achieve sustainability goals, minimize food waste, and improve product quality and exports through improved productivity (Al-Hinai *et al.*, 2022a) .

Table 7. Date factories with various value-added products and mechanization levels (Al Hinai & Jayasuriya 2021).

Factory / Location in Oman	Date variety	Type of value addition	Mechanization level (ML)
A (From Samail)	Khalas and Fardh	Date with nuts	ML-3 (57% mechanized) 4 operations out of 7 (sort, wash, dry, seeds removal)
	Fardh	Date syrup	ML-1 (17% mechanized) 1 operation out of 6 (wash)
B (From Bahla)	Khalas and Fardh	Date with nuts	ML-3 (57% mechanized) 4 operations out of 7 (sort, wash, dry, seeds removal)
		Date syrup	ML-1 (17% mechanized) 1 operation out of 6 (wash)
		Date paste	ML-4 (100% mechanized)
C (From Nizwa)	Khalas and Fardh	Date with nuts	ML-3 (57% mechanized) 4 operations out of 7 (sort, wash, dry, seeds removal)
	Fardh	Date syrup	ML-1 (17% mechanized) 1 operation out of 6 (wash)
D (From Barka)	Khalas and Fardh	Date with nuts	ML-3 (57% mechanized) 4 operations out of 7 (sort, wash, dry, pack)
		Date with nuts	ML-3 (57% mechanized) 4 operations out of 7 (sort, wash, dry, seeds removal)
	Khalas	Date paste	ML-4 (100% mechanized)
E (From Ibri)	Khalas and Fardh	Date with nuts	ML-3 (57% mechanized) 4 operations out of 7 (sort, wash, dry, seeds removal)
	Khalas	Date paste	ML-4 (100% mechanized)
F (From Nizwa)	Khalas and Fardh	Date with nuts	ML-1 (14% mechanized) 1 operation out of 7 (pack)
	Khalas	Date paste	ML-2 (33% mechanized) 2 operations out of 6 (knead and pack)

Table 8. The ranges of productivity ratios of the two selected date verities and three value-added products of the six dates factories (Al-Hinai *et al.*, 2022a; Al Hinai & Jayasuriya, 2021).

Value-added product	Cost for the raw product (OMR/ton)	Cost of the value-added product (OMR/ton)	The selling price of value-added product (OMR/ton)	Net income (OMR/ton)	Productivity ratio (net profit basis) (%)
Khalas dates					
Date with nuts	500–800	400–626	1500–3200	500–2200	183–540
Date syrup	2400	100	5000	2500	204
Date paste	500–600	100–300	850–1200	150-400	130–180
Fardh dates					
Date with nuts	400–800	350–872	1500–3200	400–834	183–360
Date syrup	4200–4800	100	5000–7500	400–2600	109–180
Date paste	700	100	1000	200	129

Threats and weakness hindering the date value-addition progress

Due to the one-season harvesting, the date palm industry's biggest challenge is the vast volume of dates that arrive to the market at the same time, leading to low prices. The date value-addition industry is in its infant-state with low processing capacities and low mechanization adoption. Despite the fact that the country is a major producer of dates, poor postharvest handling and processing results in low market prices due to seasonal gluts and distress sales, as well as significant losses. However, the postharvest handling is considered as the weakest node of the date palm value chain where greatest loss occurs (Dhehibi *et al*., 2018). Indeed, to have a good and decent market price, the date value addition sector should be strong.

Despite the big growing market size and demand projections, the date industry faces several challenges. The date production base across the Oman is smallholder dominated, and with low yield as well as low productivity. Eighty percent of the total land holdings belong to small farmers with average holding size is up to 0.82 ha, limiting the scope for introduction of technology innovations and interventions. Farmers, who are very traditional, many are part-time farmers, are reluctant to accept new value-added technology, resulting in a massive market surplus and low returns. Further, there are changes in socioeconomic situations, with younger generations from farming communities preferring urban jobs over farm jobs. The majority of small-scale date farmers are absent, and the farming system is run by foreign laborers. These workers have little education and must be taught correct postharvest methods from beginning to end.

Moreover, the necessary value-adding technology is not readily available. In most circumstances, the cost of technology is extremely expensive for farmers and processors. Sometimes, the technology offered is irrelevant to SME levels. In addition, efficient and cost-effective dissemination systems for technology are still lacking. As a result, if this issue is not addressed, the country will be unable to grab a significant market share in the global market. A major obstacle to increasing marketing efficiency is the lack of market research data and information. In the production of date value-added products, there is a lack of scientific skills and modern techniques.

Postharvest handling of dates currently in Oman is generally poor, and there is a lack of awareness about the efficiency of the value addition that may increase production (Al-Hinai *et al*. 2022b, Dhehibi *et al*. 2018). The country has not been able to capture significant premium markets due to limited value addition to its exports beyond primary processing. Given the growing importance of date value-added products in national, regional, and worldwide markets, increased value addition is extremely important.

Minimal date industry research on marketing is another potential weakness. Despite the date markets are accumulated with large production volume compared to the rest of the world, only a few studies have looked into major stakeholder elements. Threats are external problems that may cause long-term issues for the sector's strategy plan. They are often presented as strategic issues that the date industry must handle in order to succeed in the future. Climate change poses a longer-term threat, as agricultural systems adjust to changing conditions in order to retain high-quality output. International markets are becoming increasingly demanding of such standards and norms, both for industrial sectors and for consumers. If the date fruit is not properly handled from harvest to final processing, the date value-added industry will not move forward and grow. To meet the minimum marketing standards, low-grade fruit cannot be processed into an added-value or commercial product. In addition, there is a threat for the local value-addition industry due to imported date products from the regional countries. By quality standards, local value-added products are facing unwinnable market competition even in local market space.

Potentials for future improvement

In order to improve agricultural product output, value addition is crucial. Improving the value-added process of date products in Oman is critical for increasing production, reducing postharvest losses, and boosting agricultural income and the country's economy. Further, the ability to increase value-added product exports and compete with other global products will be enhanced. On the other hand, global product imports could be reduced in order to boost local production. The value addition procedure can extend the shelf life of products by providing an opportunity to sell them during the off-season.

The level of mechanization in various farm categories is linked to the advancement of the value-addition process. According to the three farm categories (individual, group, and SMEs) selected in this study, the mechanization level of each category can be improved to increase the production per unit area, to increase the efficiency of the value-added products, and to introduce new value-added products in the markets. It also contributed to raising the level of relations between Oman and various countries of the world and increasing the enthusiasm of farmers for the adoption of new machinery. Consumers of local products will have more confidence if more efficient technologies are used.

The value addition process also contributed in improving the productivity as shown by the results of this study. The productivity can be improved by increasing the production of the value-added products, enhancing the agricultural machinery and technology used, and improving the labor skills. By increasing the productivity resources, the net income will increase and the production cost will decrease, thus will increase the profitability of the farm in the medium- and long-terms.

There are few important areas to improve so that local date value-added products can compete with the products in the international markets or imported products. Three such important areas are the technology transfer, availability of technological services, and capacity building for the stakeholders involved in the value-addition sector. Government ministries have made some initiatives in line with the Oman Visions 2040 development program.

Conclusions

Food loss and waste reduction efforts have recently gained a lot of attention for their roles in improving food security and environmental sustainability. Adding value to agricultural products could result in a higher production rate, less food losses, and hence more farm income and a better economy. This study evaluated the status of the value addition process of the date products in Oman and revealed the challenges associated with the productivity improvement. Six date factories were visited to collect the data of the most industrial date value-added products, date with nuts, syrup, and paste, and the two most popular date varieties used for value addition processes are Khalas and Fardh. The Sultanate of Oman's diversity in farm holdings and mechanization levels led to the identification of three agricultural systems for this study: individual, group, and SMEs, which cover more than 99% of farm landholdings with various mechanization levels.

The value addition process is contributed to the productivity improvement. The date with nuts got the highest productivity ratio compared to the other two selected value-added products that may reach up to 540% in Khalas and 360% in Fardh. Because of the highest productivity ratio, the date with nuts value-added products of the two date varieties Khalas and Fardh achieved the largest productivity improvement compared to the other value-added products based on the base values of the raw date productivities. It is found that the productivity increased with the increase in the mechanization levels.

In order to compete with foreign products in global markets, future improvements in the value addition process of date palm in Oman required are (1) increasing the quality and quantity of production, (2) controlling postharvest losses, (3) improving the mechanization level at different farm categories, and (4) raising the efficiency of local products. The entire process of value addition of agricultural products will enhance the economy by increasing agriculture's GDP contribution, food exports, farmers' income, sustainability, and farmers' dignity. Further, the technology transfer and capacity building needs for the stakeholders of the date value-addition industry should be given the deserved attention which can enhance the quality of local products, increase employment opportunities, and improve the farm income, which will positively affect the country's economy. These studies will contribute to achieving food security by adding value to date products in the Sultanate of Oman and other Gulf Cooperation Council countries.

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