

Optimal geographical distribution of Saudi dates exports

Saudi dates exports

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Abstract

Purpose – This research aimed to maximize the value of date exports for the Kingdom of Saudi Arabia.

Design/methodology/approach – To achieve its objective, this study relied on secondary data and quantitative economic analysis represented by the Linear programming model.

Findings – This study showed that Saudi Arabia exports dates to the United Arab Emirates, Yemen, Kuwait, Turkey, Somalia, Jordan, Oman, India, Indonesia, Bangladesh Morocco, Lebanon, and others. The geographical concentration coefficient for the quantity and value of date exports was 35.05% and 34.74%, respectively, during the study period. Saudi Arabia exported a quantity of dates amounting to 83.08 thousand tons, representing 40.57% of the average total amount of Saudi dates exports during the study period, to Yemen, Somalia, India, Indonesia, Bangladesh, Egypt, China, Djibouti, Bahrain, and Ethiopia, at prices lower than the average export price of 1200.31 dollars/ton, and therefore the export policy needs to restructure the geographical distribution of date exports. Based on the models of geographical distribution, Saudi date exports value can be increased by 32.76–127.12 million dollars, meaning can be increased by 13.77% – 53.44%. In light of the results of the proposed models, this study recommends the need to restructure the geographical distribution of Saudi date exports so that the value of Saudi date exports can be increased by 127.12 million dollars from the current situation for the period 2017–2021.

Originality/value – The paper's original contribution lies in its proposal to restructure the geographical distribution of Saudi date exports to increase the value of exports.

Keywords Geographical distribution, Dates, Exports, Linear programming

Paper type Research paper

Introduction

Dates occupy an important economic position, as the global production of dates reached 9.82 million tons in 2021. Egypt contributed 17.8%, followed by Saudi Arabia by 16.0%, Iran and Algeria by 13.3%, and 12.1% each, respectively. Iraq, Pakistan, Sudan, Oman, United Arab Emirates, and Tunisia contributed 7.6%, 5.4%, 4.7%, 3.8%, 3.6% and 3.5%, respectively. Due to the expansion of the area planted with palm trees and the production of dates, the self-sufficiency rate of dates increased from 103.1% in 1990 to 118.0% in 2021 (Ministry of Environment, Water & Agriculture, 2021). The amount of Saudi exports of dates increased from 20.3 thousand tons with a value of 13.96 million dollars in 1990 to 318.37 thousand tons

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with a value of 324.56 million dollars in 2021 (FAOSTAT, 2000-2021). And that the export of dates means the export of the virtual amount of water used in the production of quantities that have been exported abroad. With high production costs, including the cost of water used and marketing costs for dates, the benefits of exporting dates are negligible (Ghanem & Ibrahim bin Othman, 2021).

A study Ghanem and Abdulaziz bin Mohammed (2017) showed that the total cumulative amount of virtual water for dates exported abroad amounted to 633.49 million m³ at the end of the period 2010–2015. By comparing the average export prices of dates of 4.01 thousand riyals/ton with the average production costs of 4.12 thousand riyals/ton under the inclusion of the cost of irrigation water, the export price coverage rate for average production costs reached 97.3% during the period 2010–2015. Taking into account the marketing costs of dates, the economic logic dictates not to expand the production and export of dates and to be content with the requirements of local consumer needs.

Muhsen, Al-Mulhim, and Samir El-Habbab (2014) examined how to reach the optimal geographical distribution of Saudi date exports during the period 1997–2011. This study showed that Saudi dates went to many countries of the world, and Yemen ranked first in terms of import quantities (29.49% of the total exports from Saudi Arabia), followed by Jordan, Pakistan, Turkey, and India. It was also found that the proposed geographical redistribution of Saudi Arabia's exports of dates leads to an increase in the value of date exports by about 11.87 million dollars annually.

Shammout (2018) studied the export opportunities of Jordanian dates (Foreign Markets Study). This study showed that there are many international markets importing dates from all over the world. Export opportunities are available for Jordanian date products. Although some Jordanian producers have had access to these markets in previous years, they are still available and useful to them today.

A study Alnafissa Mohamed, Alderiny, Yosef and Alhashim (2021) showed that although the production of dates in Saudi Arabia increased during the period 1970–2019, it was not accompanied by a commensurate increase in exports to global markets. The results showed that Saudi Arabia and other date exporting countries (Iran, Iraq, Israel, Pakistan, Tunisia, and the United Arab Emirates) are highly competitive in the global market. By dividing markets into groups of countries, Saudi Arabia has a comparative advantage over at least four of the top six exporters in three markets (Africa, Asia and the Organization of Islamic Cooperation), while Saudi dates are less competitive in the U.S. and European markets. The competitiveness of Saudi dates is expected to continue to decline during the period 2021–2025.

Also Alnafissa Mohamed *et al.* (2021) conducted a study that showed that Saudi Arabia can increase its exports of dates to international markets, given the superiority of production over consumption and the comparative advantage in date production. It was found that there are significant effects of both local production and consumption of dates, and the prices of exported dates in the long and short term. The comparative advantage of Saudi dates has only a significant impact in the short term since there is no active program to promote Saudi dates in international markets. The total volume of exports is expected to increase to 700,000 tonnes in 2025.

Abda Emam, Kinawy, Hadid and Elmasaad (2023) studied the determinants of the export of Saudi dates during the period 1985–2020. This study showed that both the international price and the production of Saudi dates are among the most important determinants of the quantity of Saudi exports. This study recommended the need to increase date exports by increasing domestic production. In fact, this recommendation does not take into account the environmental dimension of water scarcity and the comparison between the average export price of dates and the average production costs, including the cost of water used in the production of exported quantities.

The kingdom of Saudi Arabia exported a quantity of dates amounting to 83.08 thousand tons, representing 40.57% of the average total amount of Saudi exports of dates during the period 2017–2021, ([General Authority for Statistics, 2021](#)) to Yemen, Somalia, India, Indonesia, Bangladesh, Egypt, China, Djibouti, Bahrain, and Ethiopia, at prices lower than the average export price of 1200.31 dollars/ton, which justifies moving forward with restructuring the geographical distribution of date exports. Finally, the average amount of date exports to the Kingdom of Saudi Arabia reached 204.76 thousand tons, with a value of 237.89 million dollars during the period 2017–2021. In this regard, the study raises the following question: Is it possible to export the same amount of dates at a higher value than during the period 2017–2021?

Research objectives

This research aimed to maximize the value of date exports for the Kingdom of Saudi Arabia, by studying the following sub-objectives:

- (1) The development of the production and quantity of date exports for the Kingdom of Saudi Arabia during the period 2000–2021.
- (2) The current geographical distribution pattern of the quantity and value of Saudi exports of dates during the period 2017–2021.
- (3) Determine the most appropriate or proposed geographical distribution pattern for the export of dates for the Kingdom of Saudi Arabia.

Research methodology

In achieving its objectives, this study relied on published secondary data issued by government agencies, the most important of which are the Ministry of Environment, Water and Agriculture, and the General Authority for Statistics, in addition to international organizations, the most important of which is the Food and Agriculture Organization (FAO). This study also relied on quantitative economic analysis represented in the following models:

- (1) The coefficient of geographical concentration, measured by several indicators, the most important of which is the Hirschman index ([Hirschman, 1964](#); [Lapteacru, 2012](#)):

$$C_{jx} = 100 \times \sqrt{\sum \left(\frac{X_{sj}}{X_i} \right)^2}$$

where:

C_{jx} : Geographic concentration coefficient,

X_{sj} : The quantity and value of exports of Saudi dates to a country,

X_i : Total quantity and value of Saudi exports of dates.

The value of the geographic concentration coefficient is between zero and the correct one, if the index value is closer to the correct one, more exports are distributed over a few international markets. If the value of the index is close to zero, this indicates expansion in international markets.

- (2) Linear programming model used to maximize the value of Saudi date exports. It could be expressed as follows ([Bakheet, Abdul-Jabbar, Saad Ahmed, & Abbas Hussein, 2013](#); [Bector & Chandra, 2005](#)):

$$\text{Max } Z = C X$$

Subject to :

$$A X \leq b$$

$$X \geq 0$$

where: **Z** represents the value of the objective function to be maximized, **C** represent the average export prices of dates, **X** Representing international markets for dates, **b** The restrictions imposed represent the minimum and maximum exports of dates for each country (Kamara, 2013), in addition to the average total quantity of Saudi exports of dates during the period 2017–2021.

Research results

First: The development of the production and quantity of date exports for the Kingdom of Saudi Arabia

By studying the development of the production and quantity of Saudi exports of dates during the period 2000–2021, it is clear from the data contained in [Tables 1 and 2](#) and [Figures 1 and 2](#) that the local production of dates increased from 734.8 thousand tons in 2000 to 1565.8 thousand tons in 2021, with an annual average of 1057.47 thousand tons during the study period. Local production of dates increased at an annual growth rate of 2.7% during the study period. The amount of Saudi exports of dates increased from 28.25 thousand tons, representing 3.84% of domestic production in 2000, to 318.37 thousand tons, representing 20.33% of local production in 2021 which means the amount of Saudi exports of dates and their ratio to local production increased at an annual growth rate of 10.4% and 7.7% respectively. The quantity of Saudi exports of dates and their ratio to local production was characterized by instability during the study period, as evidenced by the high values of the coefficient of variation of 74.72% and 57.52% respectively during the period 2000–2021.

Second: The current geographical distribution pattern of the quantity and value of date exports for the Kingdom of Saudi Arabia

By studying the current geographical distribution pattern of date exports during the period 2017–2021, it is clear from the data contained in [Table 3](#) and [Figures 3 and 4](#) that the Kingdom of Saudi Arabia exported to the United Arab Emirates a quantity of dates amounting to 45.90 thousand tons, with a value of 59.67 million dollars, representing 25.08% of the average value of exports of dates amounting to 237.89 million dollars during the period 2017–2021. The Kingdom of Saudi Arabia exported to Yemen approximately 20.88% of the average total exports of dates, followed by Kuwait, Turkey, Somalia, Jordan, Oman, India, Indonesia, Bangladesh, Morocco, and Lebanon, with rates of 8.40, 5.84, 4.29, 3.79, 3.41, 3.15, 2.78, 2.50, 2.43, and 2.29% respectively.

Table 1. Statistical analysis of the evolution of production and quantity of Saudi exports of dates during the period 2000–2021

Statement	Area thousand hectares	Production thousand tons	Quantity of exports thousand tons	Ratio of export quantity to domestic production %
Average	140.81	1057.47	97.80	8.66
Standard deviation	18.54	246.76	73.08	4.98
Coefficient of variation %	13.17	23.33	74.72	57.52

Source(s): Data from [Figure 1](#)

From the above, it is clear that the total relative importance of the quantity of date's exports to the aforementioned countries amounted to 85.94%, while the total relative importance of date's exports to the rest of the countries does not exceed 14.06% during the period 2017–2021. The coefficient of geographical concentration of the quantity and value of date exports was 35.05% and 34.74%, respectively. The coefficient of geographical concentration is relatively low for both the quantity and value of date exports since it is less than 40% (Michaely, 1967).

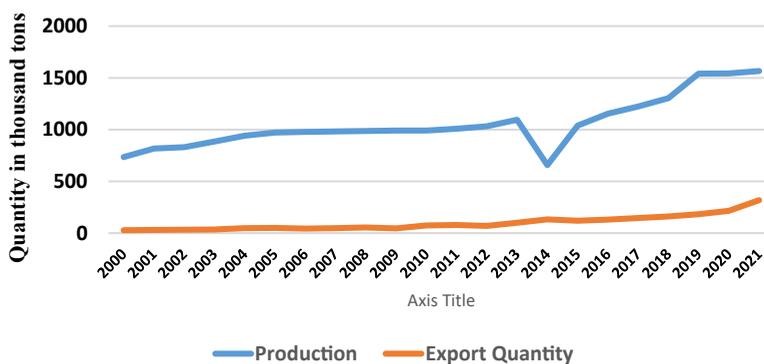
The average export price of dates ranged from a minimum of 479.50 dollars/ton for Ethiopia and a maximum of 2368.4 dollars/ton for Britain and Northern Ireland, with an average of 1200.31 dollars/ton during 2017–2021. The Kingdom of Saudi Arabia exported a quantity of dates amounting to 83.08 thousand tons, representing 40.57% of the average total

Variable	Growth rate %	F	R ²	Equation
Local production	2.7	31.40	0.61	$Ln \hat{Y} = 6.627 + 0.027 T(104.41)^{**} (5.60)^{**}$
Saudi Exports Quantity	10.4	446.08	0.96	$Ln \hat{Y} = 3.154 + 0.104 T(48.82)^{**} (21.12)^{**}$
Ratio of export quantity to domestic production	7.7	118.65	0.86	$Ln \hat{Y} = 1.132 + 0.077 T(12.22)^{**} (10.89)^{**}$

Note(s): ** Significant at the probability level of 1%

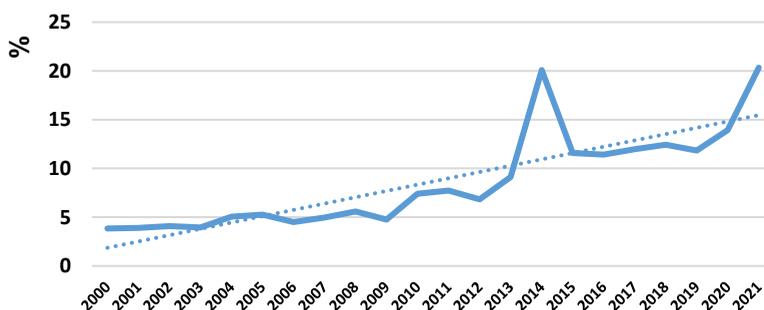
Source(s): Calculated from the data provided in Figures 1 and 2

Table 2. Equations of the general trend of the evolution of production and quantity of Saudi exports of dates during the period 2000–2021



Source(s): FAOSTAT (2000-2021)

Figure 1. Evolution of production and exports of dates in thousand tons during the period 2000–2021



Source(s): Data from figure (1)

Figure 2. Evolution of the ratio of the quantity of exports to the local production of dates during the period 2000–2021

Country	Quantity thousand tons	Saudi dates exports		Relative importance %	
		Value million dollars	Average price dollars/ton	Quantity	Value
U.A.E	45.90	59.67	1300.0	22.42	25.08
Yemen	42.75	22.90	535.7	20.88	9.63
Kuwait	17.21	22.21	1290.5	8.40	9.34
Turkey	11.96	15.10	1262.5	5.84	6.35
Somalia	8.78	7.51	855.4	4.29	3.16
Jordan	7.75	11.44	1476.1	3.79	4.81
Oman	6.97	9.29	1332.9	3.41	3.91
India	6.46	7.32	1133.1	3.15	3.08
Indonesia	5.70	6.73	1180.7	2.78	2.83
Bangladesh	5.11	3.81	745.6	2.50	1.60
Morocco	4.98	11.24	2257.0	2.43	4.73
Lebanon	4.70	7.47	1589.4	2.29	3.14
Egypt	3.78	2.92	772.5	1.85	1.23
China	3.11	1.93	620.6	1.52	0.81
Djibouti	2.69	2.08	773.2	1.31	2.08
Bahrain	2.51	2.40	956.2	1.22	2.40
Britain and Northern Ireland	2.28	5.40	2368.4	1.11	5.40
Ethiopia	2.19	1.05	479.5	1.07	1.05
Other countries	19.94	37.42	1876.6	9.74	15.73
Total	204.76	237.89	–	100.00	100.00

Table 3.
Geographical distribution of the quantity and value of date exports during the period 2017–2021

Source(s): FAOSTAT (2017–2021)

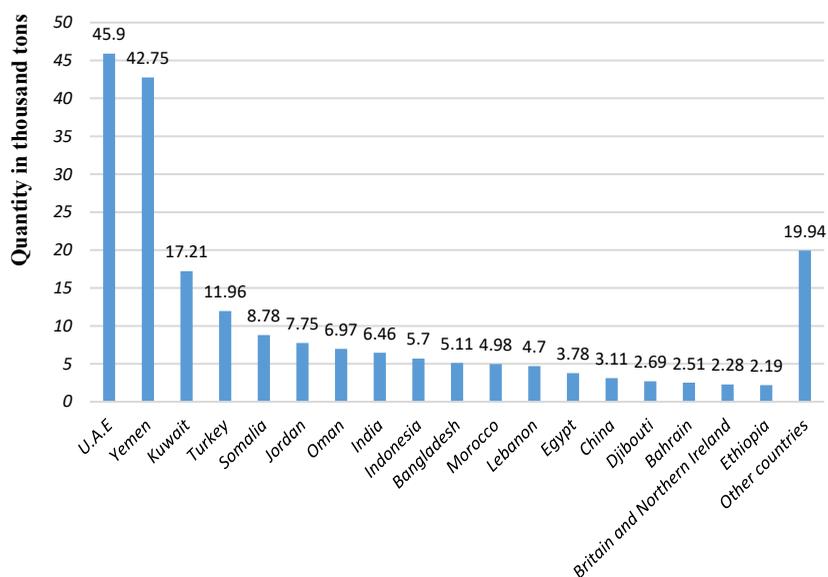


Figure 3.
Geographical distribution of the quantity of date exports during the period 2017–2021

Source: Data from Table (3)

Saudi dates exports

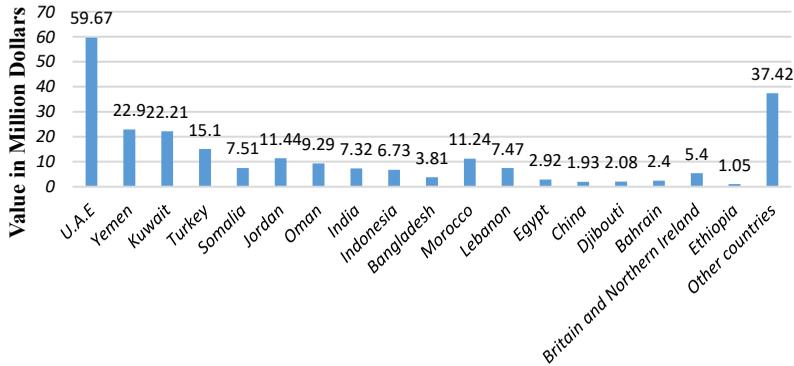


Figure 4. Geographical distribution of the value of date exports during the period 2017–2021

Source(s): Data from Table (3)

quantity of Saudi exports of dates, to Yemen, Somalia, India, Indonesia, Bangladesh, Egypt, China, Djibouti, Bahrain, and Ethiopia, at prices lower than the average export price of 1200.31 dollars/ton, which justifies moving forward with the need to restructure the geographical distribution of date exports.

Third: Proposed geographical distribution of Saudi date exports

The geographical distribution was made to maximize the value of date exports to the Kingdom of Saudi Arabia, in the light of four proposed models, which are as follows:

The first proposed model:

It included the distribution of date exports to all 19 importing countries, according to the average export price and the minimum and highest quantities exported for each country during the period 2017–2021. The objective and constraints function of the proposed model is as follows:

$$\begin{aligned}
 \text{Max} : & 1300.0 X_1 + 535.7 X_2 + 1290.5 X_3 + 1262.5 X_4 + 855.4 X_5 + 1476.1 X_6 + 1332.9 X_7 \\
 & + 1133.1 X_8 + 1180.7 X_9 + 745.6 X_{10} + 2257.0 X_{11} + 1589.4 X_{12} + 772.5 X_{13} \\
 & + 620.6 X_{14} + 773.2 X_{15} + 956.2 X_{16} + 2368.4 X_{17} + 479.5 X_{18} + 1876.6 X_{19}
 \end{aligned}$$

Subject to:

$$\begin{aligned}
 75.03 \geq X_1 \geq 32.15 & \quad 12.54 \geq X_8 \geq 3.58 & \quad 6.38 \geq X_{15} \geq 1.40 \\
 67.29 \geq X_2 \geq 25.39 & \quad 15.67 \geq X_9 \geq 0.67 & \quad 2.98 \geq X_{16} \geq 1.19 \\
 20.80 \geq X_3 \geq 13.49 & \quad 14.28 \geq X_{10} \geq 1.37 & \quad 3.42 \geq X_{17} \geq 1.69 \\
 15.48 \geq X_4 \geq 10.15 & \quad 8.17 \geq X_{11} \geq 2.56 & \quad 2.83 \geq X_{18} \geq 1.25 \\
 10.96 \geq X_5 \geq 6.75 & \quad 5.74 \geq X_{12} \geq 3.58 & \quad 29.81 \geq X_{19} \geq 15.24 \\
 11.43 \geq X_6 \geq 6.26 & \quad 9.21 \geq X_{13} \geq 1.40 & \\
 11.51 \geq X_7 \geq 2.48 & \quad 4.69 \geq X_{14} \geq 1.45 &
 \end{aligned}$$

$$X_1 + X_2 + X_3 + X_4 + X_5 + \dots + X_{19} \leq 204.76$$

The first 19 restrictions indicate that the amount of date exports does not exceed the maximum amount exported and also not less than the minimum amount exported to each

country during the study period. The last restriction indicates that the total amount of date exports to all countries are no more than the average total amount of Saudi date exports during the study period.

The proposed geographical distribution according to the first model shown in Table 4, included an increase in the amount of date exports to the United Arab Emirates to 66.59 thousand tons, with a value of 86.57 million dollars. The volumes exported to Jordan, Oman, Morocco, Lebanon, Britain, Northern Ireland, and other countries are also increasing. The proposed geographical distribution also includes reducing the quantities exported to the rest of the countries. Through the proposed geographical distribution, the value of Saudi exports of dates can be increased from 237.89 million dollars to 270.65 million dollars, an increase of 32.76 million dollars, representing 13.77% of the average value of Saudi exports of dates during the period 2017–2021 (see Table 5).

Second proposed model:

It included directing date exports to stable countries, which is continuing to import Saudi dates during 2017–2021, amounting to 19 countries. The objective and constraints function of the proposed model is as follows:

$$\begin{aligned} \text{Max} : & 1300.0 X_1 + 535.7 X_2 + 1290.5 X_3 + 1262.5 X_4 + 855.4 X_5 + 1476.1 X_6 + 1332.9 X_7 \\ & + 1133.1 X_8 + 1180.7 X_9 + 745.6 X_{10} + 2257.0 X_{11} + 1589.4 X_{12} + 772.5 X_{13} \\ & + 620.6 X_{14} + 773.2 X_{15} + 956.2 X_{16} + 2368.4 X_{17} + 479.5 X_{18} + 1876.6 X_{19} \end{aligned}$$

Country	First model		Second model	
	Quantity thousand tons	Value million dollars	Quantity thousand tons	Value million dollars
U.A.E	66.59	86.57	32.15	41.80
Yemen	25.39	13.60	25.39	13.60
Kuwait	13.49	17.41	13.49	17.41
Turkey	10.15	12.81	10.15	12.81
Somalia	6.75	5.77	6.75	5.77
Jordan	11.43	16.87	6.26	9.24
Oman	11.51	15.34	2.48	3.31
India	3.58	4.06	3.58	4.06
Indonesia	0.67	0.79	0.67	0.79
Bangladesh	1.37	1.02	1.37	1.02
Morocco	8.17	18.44	36.46	82.29
Lebanon	5.74	9.12	3.58	5.69
Egypt	1.40	1.08	1.40	1.08
China	1.45	0.90	1.45	0.90
Djibouti	1.40	1.08	1.40	1.08
Bahrain	1.19	1.14	1.19	1.14
Britain and Northern Ireland	3.42	8.10	9.42	22.31
Ethiopia	1.25	0.60	1.25	0.60
Other countries	29.81	55.94	46.32	86.92
Total	204.76	270.65	204.76	311.82

Table 4. Proposed models for the geographical distribution of the quantity and value of Saudi exports of dates

Source(s): Results of the solution of linear programming of the proposed models using WinQSB2.0

Country	First model		Second model		Saudi dates exports
	Quantity thousand tons	Value million dollars	Quantity thousand tons	Value million dollars	
U.A.E	66.17	86.02	32.15	41.81	
Yemen	25.39	13.60	–	–	
Kuwait	17.22	22.22	13.49	17.41	
Turkey	17.55	22.16	10.15	12.81	
Somalia	6.75	5.77	–	–	
Jordan	6.32	9.33	6.26	9.24	
Oman	6.96	9.28	2.48	3.32	
India	3.58	4.06	–	–	
Indonesia	10.05	11.87	–	–	
Bangladesh	1.37	1.02	–	–	
Morocco	36.46	82.29	36.46	82.29	
Lebanon	4.09	6.50	3.58	5.69	
Egypt	1.40	1.08	–	–	
China	1.45	0.90	–	–	
Djibouti	–	–	–	–	
Bahrain	–	–	–	–	
Britain and Northern	–	–	9.42	22.31	
Ireland	–	–	–	–	
Ethiopia	–	–	–	–	
Other countries	–	–	90.66	170.13	
Total	204.76	276.10	204.76	365.01	

Source(s): Results of the solution of linear programming of the proposed models using WinQSB2.0

Table 5.
Complement

Subject to:

$$\begin{aligned}
 75.03 \geq X_1 \geq 32.15 & \quad 12.54 \geq X_8 \geq 3.58 & \quad 6.38 \geq X_{15} \geq 1.40 \\
 67.29 \geq X_2 \geq 25.39 & \quad 15.67 \geq X_9 \geq 0.67 & \quad 2.98 \geq X_{16} \geq 1.19 \\
 20.80 \geq X_3 \geq 13.49 & \quad 14.28 \geq X_{10} \geq 1.37 & \quad 3.42 \geq X_{17} \geq 1.69 \\
 15.48 \geq X_4 \geq 10.15 & \quad 8.17 \geq X_{11} \geq 2.56 & \quad 2.83 \geq X_{18} \geq 1.25 \\
 10.96 \geq X_5 \geq 6.75 & \quad 5.74 \geq X_{12} \geq 3.58 & \quad 29.81 \geq X_{19} \geq 15.24 \\
 11.43 \geq X_6 \geq 6.26 & \quad 9.21 \geq X_{13} \geq 1.40 & \\
 11.51 \geq X_7 \geq 2.48 & \quad 4.69 \geq X_{14} \geq 1.45 &
 \end{aligned}$$

$$X_1 + X_2 + X_3 + X_4 + X_5 + \dots + X_{19} \leq 204.76$$

The first 19 restrictions indicate that the amount of date exports is not more than 40% of the average import capacity and not less than the minimum amount exported to each country during the study period. The last restriction indicates that the total amount of date exports to all countries are no more than the average amount of Saudi date exports during the study period.

It is clear from the data contained, in [Table 4](#) that the proposed geographical distribution according to the second model ensures an increase in the amount of date exports to the state of Morocco to 36.46 thousand tons, with a value of 82.29 million dollars. The volumes exported to Britain, Northern Ireland, and other countries that continue to import dates from Saudi Arabia are also increasing. The proposed geographical distribution also includes reducing the quantities exported to the rest of the importing countries of Saudi dates. Through the proposed geographical distribution, the value of Saudi exports of dates can be

increased from 237.89 million dollars to 311.82 million dollars, an increase of 73.93 million dollars, representing 31.08% of the average value of Saudi exports of dates during the period 2017–2021.

Third proposed model:

It included directing date exports to traditional international markets (markets for which the total amount of Saudi exports amounted to about 85% of the total quantities exported during the period 2017–2021). The number of traditional international markets reached 14 countries (UAE, Yemen, Kuwait, Turkey, Somalia, Jordan, Oman, India, Indonesia, Bangladesh, Morocco, Lebanon, Egypt, and China). The objective and constraints function of the proposed model is as follows:

$$\begin{aligned} \text{Max : } & 1300.0 X_1 + 535.7 X_2 + 1290.5 X_3 + 1262.5 X_4 + 855.4 X_5 + 1476.1 X_6 + 1332.9 X_7 \\ & + 1133.1 X_8 + 1180.7 X_9 + 745.6 X_{10} + 2257.0 X_{11} + 1589.4 X_{12} + 772.5 X_{13} \\ & + 620.6 X_{14} \end{aligned}$$

Subject to:

$$\begin{aligned} 66.17 \geq X_1 \geq 32.15 & \quad 152.61 \geq X_8 \geq 3.58 & \quad 1.89 \geq X_{15} \geq 1.40 \\ 26.92 \geq X_2 \geq 25.39 & \quad 16.83 \geq X_9 \geq 0.67 & \quad 1.56 \geq X_{16} \geq 1.19 \\ 17.22 \geq X_3 \geq 13.49 & \quad 16.34 \geq X_{10} \geq 1.37 & \quad 9.42 \geq X_{17} \geq 1.69 \\ 17.55 \geq X_4 \geq 10.15 & \quad 36.46 \geq X_{11} \geq 2.56 & \quad 3.33 \geq X_{18} \geq 1.25 \\ 8.39 \geq X_5 \geq 6.75 & \quad 4.09 \geq X_{12} \geq 3.58 & \quad 109.05 \geq X_{19} \geq 15.24 \\ 6.32 \geq X_6 \geq 6.26 & \quad 1.89 \geq X_{13} \geq 1.40 & \\ 6.96 \geq X_7 \geq 2.48 & \quad 4.68 \geq X_{14} \geq 1.45 & \end{aligned}$$

$$X_1 + X_2 + X_3 + X_4 + X_5 \dots \dots \dots + X_{14} \leq 204.76$$

The first 14 restrictions indicate that the amount of date exports is not more than 40% of the average import capacity of dates and not less than the minimum amount exported to each country during the study period. The last restriction indicates that the total amount of date exports to all countries are no more than the average amount of exports of Saudi dates during the study period.

The proposed geographical distribution according to the third model shown in [Table 4](#), included an increase in the amount of date exports to the United Arab Emirates to 66.17 thousand tons, with a value of 86.02 million dollars, followed by Morocco, Turkey, and Indonesia. The proposed geographical distribution also includes the constancy of the exported quantities for both the states of Kuwait and the Sultanate of Oman. The proposed geographical distribution also includes reducing the volumes exported to the rest of the countries (Yemen, Somalia, Jordan, India, Bangladesh, Lebanon, Egypt, and China). Through the proposed geographical distribution, the value of Saudi exports of dates can be increased from 237.89 million dollars to 276.10 million dollars, an increase of 38.21 million dollars, representing 16.06% of the average value of Saudi exports of dates during the period 2017–2021.

Fourth proposed model:

It included directing date exports to international markets, for which the export price increased from the average price of 1200.31 dollars/ton during 2017–2021. In this case, Yemen, Somalia, India, Indonesia, Bangladesh, Egypt, China, Djibouti, Bahrain, and Ethiopia were excluded. The objective and constraints function of the proposed model is as follows:

$$\begin{aligned} \text{Max : } & 1300.0 X_1 + 1290.5 X_3 + 1262.5 X_4 + 1476.1 X_6 + 1332.9 X_7 + 2257.0 X_{11} \\ & + 1589.4 X_{12} + 2368.4 X_{17} + 1876.6 X_{19} \end{aligned}$$

Subject to:

Saudi dates exports

$$\begin{array}{lll} 66.17 \geq X_1 \geq 32.15 & 6.32 \geq X_6 \geq 6.26 & 4.09 \geq X_{12} \geq 3.58 \\ 17.22 \geq X_3 \geq 13.49 & 6.96 \geq X_7 \geq 2.48 & 9.42 \geq X_{17} \geq 1.69 \\ 17.55 \geq X_4 \geq 10.15 & 36.46 \geq X_{11} \geq 2.56 & 109.05 \geq X_{19} \geq 15.24 \end{array}$$

$$X_1 + X_3 + X_4 + X_6 \dots \dots \dots + X_{19} \leq 204.76$$

The first nine restrictions indicate that the amount of date exports is not more than 40% of the average import capacity of dates and not less than the minimum amount exported to each country during the study period. The last restriction indicates that the total amount of date exports to all countries are no more than the average amount of Saudi date exports during the study period.

It is clear from the data contained in [Table 4](#) that the proposed geographical distribution according to the fourth model includes an increase in the amount of date exports to the group of other countries to reach 90.66 thousand tons, with a value of 170.13 million dollars, followed by the state of Morocco, Britain, and Northern Ireland. The proposed geographical distribution also includes reducing the quantities exported to the rest of the countries (UAE, Kuwait, Turkey, Jordan, Oman, and Lebanon). Through the proposed geographical distribution, the value of Saudi exports of dates can be increased from 237.89 million dollars to 365.01 million dollars, an increase of 127.12 million dollars, representing 53.44% of the average value of Saudi exports of dates during the period 2017–2021.

Discussion

Due to the expansion of the area planted with palm and date production, and the desire of the Saudi Export Development Authority to increase non-oil exports, the quantity of Saudi exports of dates increased at an annual growth rate of 10.4% to reach 318.37 thousand tons, representing 20.33% of the local production of dates in 2021 ([FAOSTAT, 2000-2021](#)). There is no doubt that the export of dates includes a quantity of virtual water. With high production costs, including the cost of water used and marketing costs for dates, the benefits derived from the export of dates are small. A study ([Ghanem & Abdulaziz bin Mohammed, 2017](#)) showed that the export price coverage rate for average production costs reached 97.3% during the period 2010–2015. Taking into account the marketing costs of dates, the economic logic is not to expand the production and export of dates and to be satisfied with the requirements of local consumer needs only.

By studying the geographical distribution pattern of date exports, it was found that the Kingdom of Saudi Arabia exported a quantity of dates amounting to 83.08 thousand tons, representing 40.57% of the average total quantity of exports, to Yemen, Somalia, India, Indonesia, Bangladesh, Egypt, China, Djibouti, Bahrain, and Ethiopia, at prices lower than the average export price of 1200.31 dollars/ton. Intending to maximize the value of exports, it becomes necessary to restructure the geographical distribution of date exports.

The value of Saudi exports of dates was maximized, using linear programming in light of a set of assumptions, the most important of which are: (1) directing date exports to all importing countries, (2) directing date exports to stable countries, which is continuing to import dates annually from Saudi Arabia, (3) directing date exports to traditional international markets (markets for which the total quantity of Saudi exports is 85% of the total amount of exports), (4) directing date exports to international markets for which the export price has increased, from the average, The price is 1200.31 dollars/ton during the period 2017–2021.

In light of these assumptions and determinants, four proposed models were made for the geographical distribution of date exports, the best of which is the fourth model, due to its ability to increase the value of Saudi exports of dates from 237.89 million dollars to 365.01 million dollars, an increase of 127.12 million dollars, representing 53.44% of the average value of Saudi exports of dates during the period 2017–2021.

Conclusion

Since the country exports approximately 40.57% of the average total export quantity of dates at prices lower than the average export price of 1200.31 dollars/ton, it becomes necessary to restructure the geographical distribution of date exports. By comparing the four proposed models of geographical distribution, the same amount of 204.76 thousand can be exported at a higher value than during the period 2017–2021. The increase in the value of Saudi exports of dates ranged from a minimum of 32.76 million dollars for the first model to a maximum of 127.12 million dollars for the fourth model. In light of the goal of maximizing the value of Saudi date exports, this study recommends the need to restructure the geographical distribution of Saudi date exports in light of the fourth proposed model so that the value of Saudi date exports can be increased by 127.12 million dollars from the current situation for the period 2017–2021.

References

- Abda Emam, Kinawy, A., Hadid, M., & Elmasaad, E. (2023). The determinants of date exports in the kingdom of Saudi Arabia. *Universal Journal of Agricultural Research*, 11(3), 507–516. doi: 10.13189/ujar.2023.110301. Available from: <http://www.hrpub.org>
- Alnafissa Mohamed, A., Alderiny, M., Yosef, A., & Alhashim, J. (2021). The future of Saudi Arabia's date exports using a cointegration model. *Asian Journal of Agriculture and Rural Development*, 11(1), 113–119. doi:10.18488/journal.ajard.2021.111.113.119.
- Bakheet, Abdul-Jabbar, A.-K., Saad Ahmed, A., & Abbas Hussein, B. (2013). *Introduction to linear programming models between theory and practice* (First Edition). Baghdad: Asawer Press.
- Bector, C. R., & Chandra, S. (2005). *Fuzzy mathematical programming and fuzzy matrix games*. New York: Springer Berlin Heidelberg.
- FAOSTAT (2000-2021). Food and Agriculture Organization, FAOSTAT website, period 2000-2021.
- FAOSTAT (2017-2021). Food and Agriculture Organization, FAOSTAT website, period 2017-2021.
- Ghanem, A. M. K., & Abdulaziz bin Mohammed A.-D. (2017). The economic dimension of the production and export of dates to the kingdom of Saudi Arabia, *The Egyptian Journal of Agricultural Economics*, XXVII June, 427–436.
- Ghanem, A. M. K. & Ibrahim bin Othman, A.-N. (2021). The food sovereignty of dates and their impact on water consumption in the kingdom of Saudi Arabia, *Egyptian Journal of Agricultural Economics*, 31 June, 491–504.
- General Authority for Statistics (2021). International trade statistics bulletin.
- Hirschman, A. (1964). The paternity of an index. *American Economic Review*, 54(4-6), 761–762.
- Kamara, S. A. M. (2013). The economic importance of current and proposed Egyptian production and exports of dry onions. *Egyptian Journal of Agricultural Economics*, 23(1), 75–88.
- Lapteacru, I. (2012). Assessing lending market concentration in Bulgaria: The application of a new measure of concentration. *The Journal of Comparative Economics*, 9(1), 79–102.
- Michaely, M. (1967). *Concentration in international trade* (2nd ed.). Amsterdam: North Holland Publishing.
- Ministry of Environment, Water and Agriculture (2021). Statistical book.

Muhsen, A. A., AL-Mulhim, F., & Samir El-Habbab, M. (2014). Optimizing geographical distribution for Saudi Arabia exports of date palm. *Bulgarian Journal of Agricultural Science*, 20(4), 754–760.

Shammout, A. (2018). *Export opportunities for Jordanian dates - foreign market study*. Jordan Enterprise Development Corporation.

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