

Evaluation of Date Valorization Units in the Drâa-Tafilalet Region

Amine Oubrhou^{1*}, Bouchra Ouhejjou¹, Ranya Hajjami¹, Asmae Misbah², Khalid Sellam¹, Eimad Dine Tariq Bouhlali², Addi Nait Mbarek³, Chakib Alem¹

¹Biochemistry of Natural Resources Research Team, Faculty of Sciences and Technologies, Moulay Ismail University, Errachidia, Morocco

²Oasis Systems Research Unit, Regional Center of Agricultural Research of Errachidia, National Institute of Agricultural Research, Errachidia, Morocco

³Chemical Analysis, Environment and Materials Team, Faculty of Sciences and Technologies, Moulay Ismail University, Errachidia, Morocco

Email: *amine.oubrhou@gmail.com

How to cite this paper: Oubrhou, A., Ouhejjou, B., Hajjami, R., Misbah, A., Sellam, K., Bouhlali, E.D.T., Mbarek, A.N. and Alem, C. (2024) Evaluation of Date Valorization Units in the Drâa-Tafilalet Region. *Agricultural Sciences*, 15, 1525-1539.

<https://doi.org/10.4236/as.2024.1512085>

Received: November 13, 2024

Accepted: December 21, 2024

Published: December 24, 2024

Copyright © 2024 by author(s) and Scientific Research Publishing Inc.

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

Efficient storage and handling facilities play a pivotal role in ensuring the quality and longevity of date palm produce. This study aims to contribute to the assessment of the operation of refrigeration units in the Drâa Tafilalet region through a diagnostic study conducted by surveying 12 date-packing units. Interviews and surveys were conducted among 12 date packaging units provided by the State to Economic Interest Groups (EIG) in the Drâa-Tafilalet region. Data focused on general EIG information, unit identification, a four-year operational overview, and 2021 palm date processing activities. To streamline analysis, units were categorized into two groups based on packaging capacity: Group 1 (≥ 400 tons) and Group 2 (< 400 tons). The assessment revealed that the packaging units had enhanced this crucial link in the dating industry and introduced a new dynamic in the date marketing chain. However, operational expertise and optimal equipment utilization often fall short, with over 50% of the EIG failing to use provided equipment, except for cold storage rooms. The chain involves a series of operations to preserve the stored product's intrinsic and extrinsic quality. Evaluated practices include fumigation, meticulous sorting to eliminate visually anomalous dates, calibration during packaging, and storage at temperatures ranging from 0 to 4°C with humidity levels between 50 and 80%, varying based on the date's nature (soft, dry, or semi-dry). Expertise in this process mitigates the risk of desiccation or excessive rehydration, preventing date fermentation. Finally, to reduce their energy consumption and solve the balance sheet deficit issue, the government has equipped all the date packaging units from Group 1 and one from Group 2 in the Daraa Tafilalet region with photovoltaic energy. The date

packaging infrastructure has boosted the value of Moroccan dates, benefiting small-scale agriculture. Despite improved packaging quality and job creation, suboptimal equipment usage by over 50% of EIGs emphasizes the need for enhanced operational efficiency.

Keywords

Dates, Packaging Unit, Cold, Economic Interest Group (EIG), Storage

1. Introduction

The date palm (*Phoenix dactylifera L.*) is a symbol of pride and prosperity in the Saharan and pre-Saharan regions, primarily found along valleys. As one of the oldest and most significant fruit crops in the Middle East and North Africa (MENA) region, it plays important socio-economic and ecological roles. More than 150 million date palm trees belonging to 5000 cultivars are cultivated in more than 30 different countries [1] and an annual global production of dates exceeds 8 million tons [2].

In Morocco, the date palm plays a crucial role in enhancing marginal and degraded soils, contributing up to 60% of the income of 1 million inhabitants of the arid and semi-arid regions [3]. Additionally, date palm cultivation generates more than 3 million working days per year [4], involving activities in palm groves, date processing, and storage, as well as the recovery of by-products.

The date fruit itself is not only delicious but also highly nutritious, offering essential nutrients like carbohydrates, dietary fibers, minerals, and vitamins. Moreover, dates possess various health benefits, including anticancer, antioxidant, antimicrobial, antidiarrheal, and anti-inflammatory properties [5]. In fact, dates have a rich fruit flesh composed of simple carbohydrates such as sucrose, glucose, and fructose throughout their ripening phases. Apart from providing a pleasant flavor, these carbohydrates are a rapid energy source due to their quick absorption. The thick, sticky texture of dates allows for simple binding with complementary foods such as cereals, making them an ideal substrate for direct dietary intake and inclusion in various value-added products such as sweets, confectionaries, syrups, cola, juices, dairy desserts, and candies [6].

Morocco ranks among the world's top 10 producers of dates, producing over 120,000 tons annually. The predominant cultivar planted in Morocco is "Mejhoul", which is widely valued for its big size, sweet taste, and extended shelf life [7]. However, the date palm sector encounters several challenges including bayoud disease, water shortages, low yields, and a lack of structure and valorization units [8]. The Moroccan date palm sector faces numerous critical challenges. First, the diverse varieties of dates necessitate a nuanced approach for effective valorization. Second, ensuring quality and adherence to international

standards is essential. Third, transforming dates into value-added products while maintaining their freshness presents significant hurdles. Fourth, finding markets and establishing efficient distribution channels remains a priority. Fifth, investment in research and innovation is crucial for sustainable development. Lastly, balancing economic growth with environmental preservation is an ongoing challenge [9].

The sustained and increasing demand for palm date quality extends from harvesting to processing. One of the key elements of the Date Palm program contract, signed between the State and the Interprofessional in 2010, is the establishment of refrigerated storage units with a capacity ranging from 100 to 400 tons. These units are designed to be managed by Economic Interest Groups (EIG) to preserve the quality of dates. This is particularly important for addressing the gap between the production period and the peak consumption period, mainly during the month of Ramadan. Improvements in market positioning conditions follow post-packaging operations, including cleaning, glazing, calibration, packaging in suitable crates or boxes, rehydration, and dehydration. These processes aim to enhance the market value and presentation of dates.

The objective of this study is to contribute to the evaluation of the functioning of refrigeration units in the Drâa Tafilalet region through a diagnostic study conducted through surveys with 12 date packaging units.

2. Materials and Methods

2.1. Data Collection

A comprehensive data collection initiative was undertaken through a series of interviews and surveys covering all Date Valorization Units within the Drâa-Tafilalet region (**Figure 1**). This study aimed to gather general information regarding the EIGs, including general EIG data, identification of date conditioning units, operational history of these units over the past four years, and specific date packaging activities during the 2021 campaign.

2.2. Data Analysis

The census reveals the presence of 12 storage units. To streamline data analysis and facilitate result presentation, these units will be grouped into the following two categories:

Group 1: Comprising packaging units with a capacity of 400 tons.

Group 2: Comprising packaging units with a capacity of less than 400 tons.

In the results section, we will initially delve into the structure of the typical packaging unit, followed by an examination of its various equipment components. Subsequently, a diagnostic assessment will be conducted based on the following key aspects:

- The extent of equipment adherence to initially set standards.
- The level of infrastructure utilization.

- The conformity of operational mode with established standards.

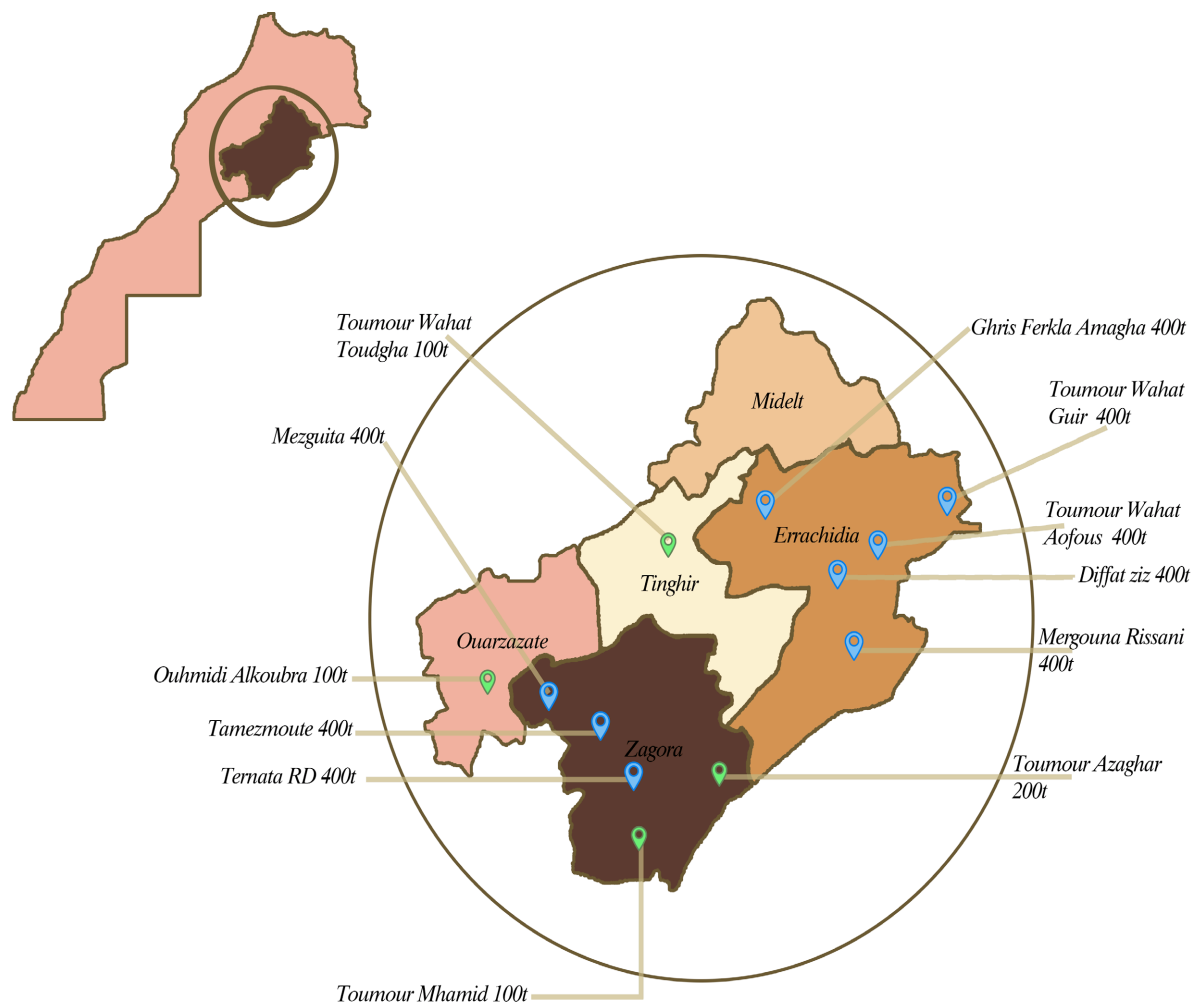


Figure 1. The agricultural economic interest groups in the Drâa-Tafilalet region equipped with a date valorization unit.

3. Results

3.1. Presentation of a Model for the Date Packing Unit

A packaging unit is made up of nine parts: (1) a fumigation chamber, (2) a cold room, (3) sorting tables and conveyors, (4) the packaging unit, (5) machines for washing dates and crates, (6) a glucose coating machine, (7) a drying oven, (8) a date humidifier in the form of an oven, and (9) a laboratory for various analyses (Figure 2).

3.2. Analysis of the Characteristics of the Studied Packaging Units

3.2.1. Diagnostic of the Studied Packaging Units

Geographically, it is significant that every one of the twelve units is situated in an area that is not prone to flooding, is devoid of standing water, and has no offensive smells. Of the units, 67% are located distant from residential areas, and 42% have roads that are compact, uneven, and poorly maintained, making them difficult for

users to reach.

The arrangement of the units, 380V electrical currents are installed in each unit. Their floors have gutters (with inspection traps) and are angled suitably to let liquids flow toward siphon returns. Additionally, every unit has enough ventilation to remove dust, avoid steam condensation, excess heat, or moisture, and refresh stale air. Ninety-two percent of the units are connected to the sanitation network and utilize enough potable water in their manufacturing operations. Likewise, 92% of them follow the “forward motion” theory.

Hygiene is a critical aspect of date palm processing, with all units running under transit and storage circumstances free of contamination. They have requirements for the personal cleanliness and dress of factory workers. The production equipment is also easy to clean, functional, and well-maintained. In addition, all units have cleaning and pest control programs (rats, insects, etc.) and are protected and segregated from animals and other vermin sources. Fumigation with an approved fumigant is a key measure to kill insects and prevent infestation during storage and processing. This process involves treating dates in crates arranged to allow adequate circulation of the fumigant. Phosphine tablets are used in an enclosed environment for 72 hours, followed by a 48-hour airing period to eliminate residual fumigant. A person approved by the ONSSA must carry out this operation.

Furthermore, 83% of units are authorized by ONSSA. Another connection among these units (100% of them) is that they have attended many training sessions provided by institutes within the Ministry of Agriculture.

3.2.2. Investment Cost

The two groups have different storage capacities, therefore Group 1’s construction expenses range from 16 to 19 million dirhams, while Group 2’s expenditures range from 5.6 to 11.4 million dirhams. Furthermore, there are differences in the percentages of each category in the overall cost between groups. A comparison reveals that the bulk of the overall cost is attributed to infrastructure and basic equipment, with rates for Group 1 and Group 2 being 60% and 84%, respectively. Group 1’s packaging and processing equipment accounts for 18% of overall costs, whereas Group 2’s only accounts for 5%. There are significant differences seen in the “photovoltaic” and “handling equipment” categories, with the latter accounting for 7% of Group 1’s total expenditure while Group 2’s is essentially nonexistent. The remaining costs show comparable ratios for the two groups.

3.2.3. Number of Cooperatives and Members

For group 1, it is noted that there are, on average, 16.5 cooperatives per EIG, ranging from 6 to 31. This is double group 2’s average of 8.25 cooperatives, with a minimum of 6 and a maximum of 11 cooperatives.

In terms of membership, group 1 has an average of over 391 members ranging

from 104 to 567, while group 2 has an average of 283 members per EIG, ranging from 260 to 315 (Table 1).

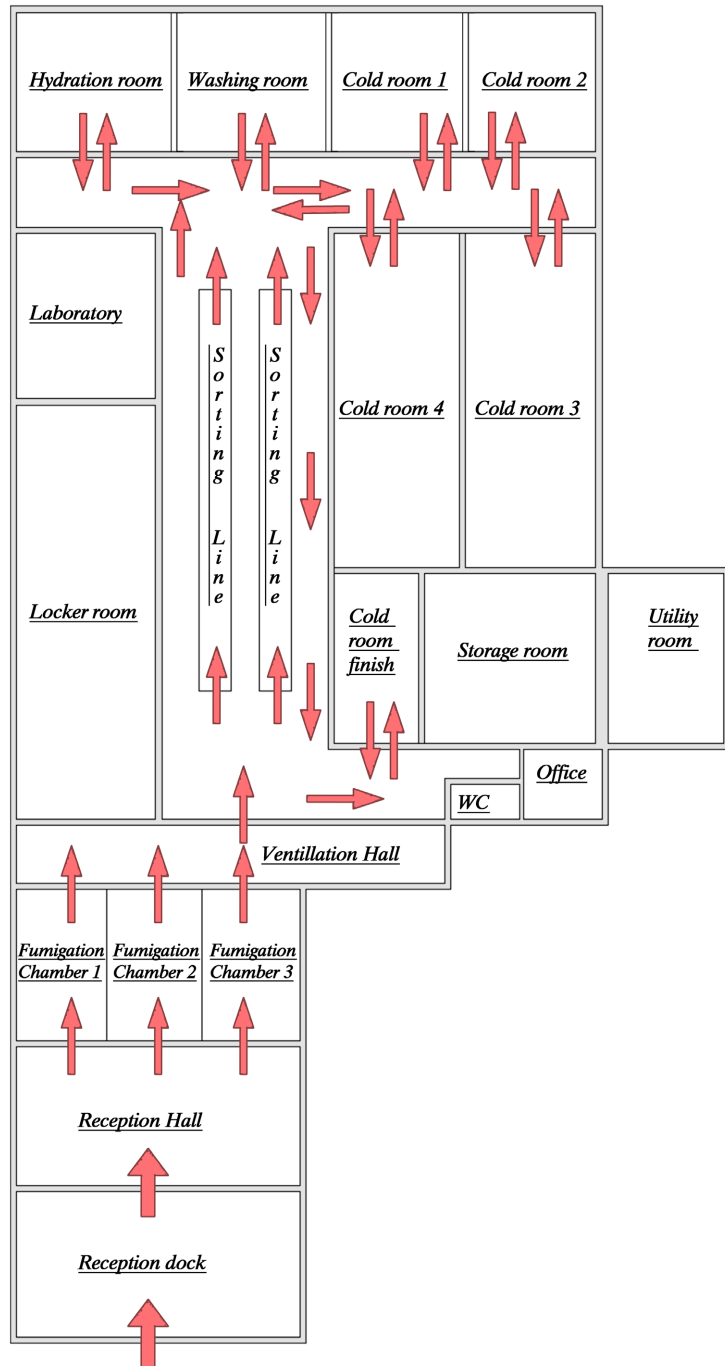


Figure 2. The layout of the packaging unit at the TAMAZEMOUTE EIG (Zagora zone).

3.3. Evolution of Date Stocks 2017 - 2020 and Supply Conditions

3.3.1. Group 1

The stored quantities of dates at the level of the investigated EIGs increased significantly in 2020, representing the second consecutive year of rise. They achieved

an annual average of 851 tons, increasing 127% from 2019 and 477% from 2017 (Figure 3). According to an analysis conducted by EIG, between 2020 and 2019, storage at the Ternata station decreased somewhat, however, storage at the Aoufous station increased significantly to 1371 tons.

Table 1. Number of cooperatives and members.

	Group 1	Group 2
Number of Cooperatives	132	33
Average	16,5	8,25
Min - Max	6 - 31	6 - 11
Total Number of Members	3130	1132
Average	391	283
Min - Max	104 - 567	260 - 315

In the meantime, the Boudnib EIG, which only has an annual tonnage of 400 tons, performed poorly. The following are the primary kinds kept in storage: Majhoul, Boufeggous, Jihel, Bouslikhan, and Bousthami. In terms of the kind of procurement, purchases made without contracts come first, then services rendered to outside parties, and finally, procurements from EIG members.

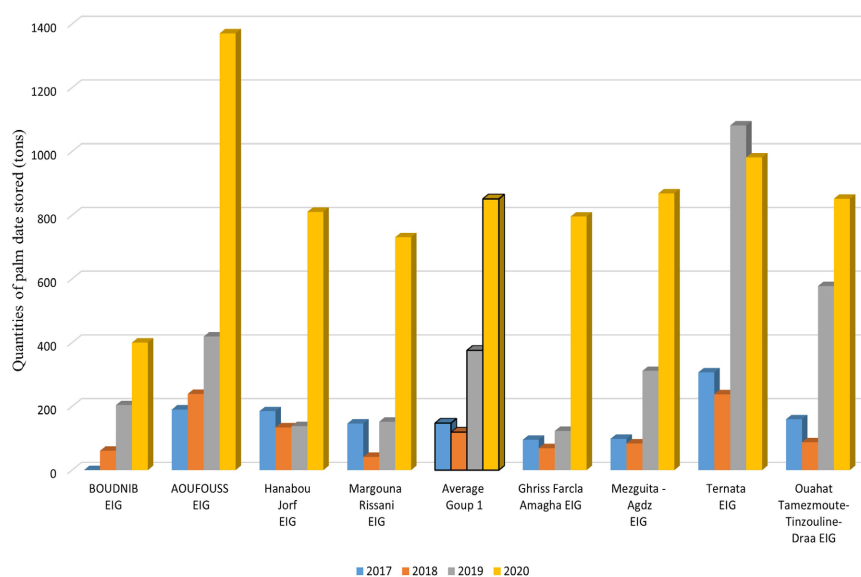


Figure 3. Cumulative stored quantities of dates for Group 1 (2017 - 2020), in tons.

3.3.2. Group 2

There is a significant discrepancy in the stored quantities at the group 2 level. One EIG unit has reportedly already entirely stopped operating. The primary causes mentioned, according to our informant, are problems with irrigation water and the palm grove's lack of vibrancy. Two of the remaining EIG units are operating at a reasonably high level, having stored amounts of about 200 tons in 2020, and one unit is barely supplied at 18 tons (Figure 4). In this group, Jihel, Boufeggous, Bouzekri, and, to a lesser degree, Majhoul and Bousthami are the most preserved

types. It originates only from EIG members in terms of procurement.

3.4. Diagnostic of Date Packaging Operations

The date packaging operations at the level of each studied EIG group consist of 9 steps.

3.4.1. Reception and Weighing of Dates

All EIGs control dates upon receipt. However, the criteria differ from one unit to another. Three EIGs use more than 3 control criteria, such as the case of EIG Risani, which seems very demanding as it controls the variety, the percentage of impurities, the maturity stage, the health condition, and the water content. Others, such as EIG Tamezmoute and EIG Ouhmidi, rely on a single criterion, the health condition, and the possibility of storage.

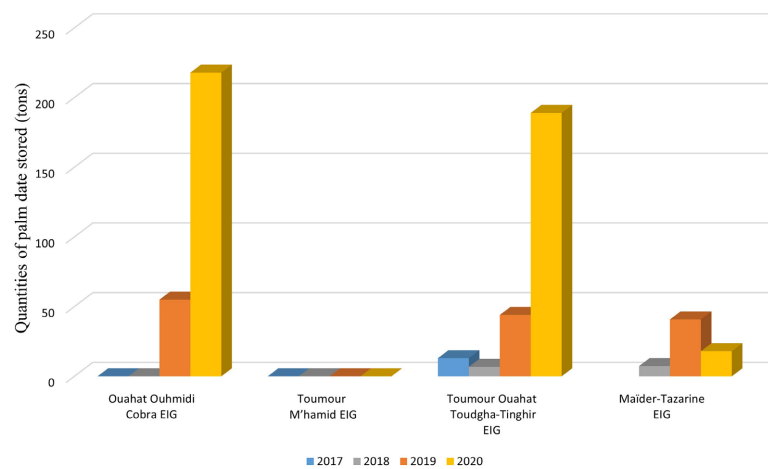


Figure 4. Cumulative stored quantities of dates for Group 2 (2017 - 2020), in tons.

Except for one EIG that did not respond to the entire questionnaire and the non-functional EIG, the others all record and maintain traceability of the received dates. They note the date of entry, information about the supplier, variety, batch number, weight, and number of crates or cartons. Two units belonging to group 2 also add quality information, with one refusing to accept soft dates.

3.4.2. Insect Disinfestation

It should be noted that 10 EIGs operate these chambers. Others do not use them due to sealing problems or lack of necessary infrastructure.

3.4.3. Sorting

Sorting is applied by all EIGs, according to a 4-level classification: Extra (E), Class 1 (C1), Class 2 (C2), and Class 3 (C3). For some varieties, an additional indication of “with or without branches” is added. Almost all EIGs have a conveyor for sorting, except for one EIG that only has tables.

As for the destination of the sorting rejects, in 4 cases they are returned to the client, in 6 cases they are mainly destined for livestock feed, and in one case, they

are offered to transformation cooperatives with a profit-sharing arrangement.

If we look at the tonnage sorted during an 8-hour workday coupled with the number of people mobilized, we observe a wide divergence among the EIGs (Figure 5).

3.4.4. Cleaning/Washing

Cleaning and washing of dates are carried out by 7 EIGs, all from group 1. They are performed taking into account the dirtiness of the dates, their water content, but also the nature of the variety, preferably when they are dry and semi-soft. For some varieties like Jihel, they are never washed because there is a risk of them turning black.

3.4.5. Drying (Dehydration)

Out of the 11 operational units, 5 utilize drying under different conditions. Three (3) have a high-capacity oven, one unit has an oven allowing drying of one ton, while another resorts to direct exposure to sunlight. The remainder, which does not use it, cites the high cost of this operation as the main reason.

3.4.6. Hydration

Six (6) units out of 11 treat the dates through hydration, mostly via a humidifier (electricity + diesel). However, one station applies the greenhouse type manually, while another uses a small oven with added water. Considering its cost, which reaches 1 dirham per kg, this operation mainly concerns the Majhoul variety.

3.4.7. Storage

Storage modalities take 3 main forms: crates, cardboard boxes, and bulk. Naturally, each EIG controls the temperature of its stock. However, only 4 EIGs additionally carry out individualization of the raw material. Moreover, this is done based on different criteria, either the variety of dates, whether organic or not, or even based on their belonging to a supplier or the EIG. The storage period is linked to the end of the month of Ramadan.

3.4.8. Soaking in Glucose Syrup

Only the Hannabo-Jorf EIG carries out glucose soaking. This process aims to enhance moisture retention, improve firmness, and extend the shelf life of the dates. The glucose syrup is specifically chosen due to its hygroscopic properties, effectively preventing dehydration while improving the texture and sweetness of the dates.

In terms of statistics, it specified that in 2019, it processed 6T of the Khalt variety and 5T of Bouslikhan at a rate of 300 to 400 kg per hour, which amounts to 2.5 to 3 hours per ton.

3.4.9. Packaging and Marketing Strategy

91% of dates are packaged in cardboard boxes and/or trays. However, the Tomour Wahat Aoufous EIG additionally provides packaging in plastic trays. As for the marketing strategy, some EIGs manage to secure contracts with large retailers like Marjane, Carrefour, or Aswak Assalam as well as with supermarkets in major cities. Markets and souks, mainly along the Casa-Rabat and Marrakech axis, are also

among the locations for date marketing.

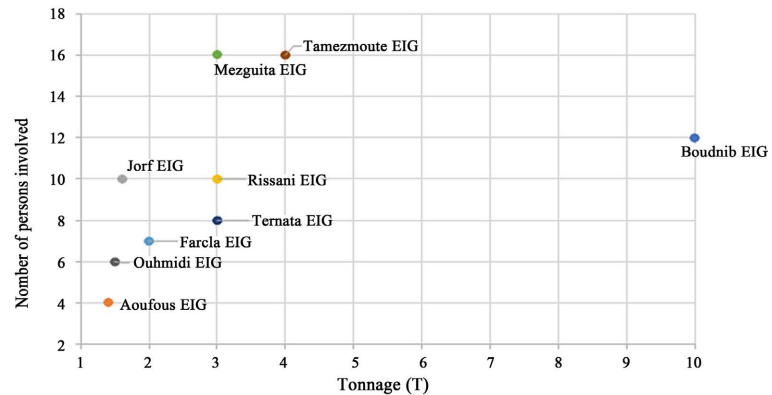


Figure 5. Number of people involved per tonnage sorted in each EIG for an 8-hour day.

3.5. Energy Consumption

The Drâa-Tafilalet region is a major center for producing and preserving dates, particularly the Majhoul and Boufeggous varieties. Refrigeration units in this area play a crucial role in preserving these dates. The energy consumption of these units is particularly high. The refrigeration systems that keep dates at temperatures between 0 and 4°C for long periods require substantial energy. Moreover, the average storage capacity of these units, around 400 tons for most EIGs, further amplifies this energy demand.

Table 2. Energy consumption of EIG Toumour wahat aoufous in 2018.

Month	Energy Consumed (KWh)			Total Energy (kWh)	Cost (Including Taxes Dhs)
	Peak	Normal	Off-peak		
January	1272	2644	1942	5858	10,449
February	1666	3219	2478	7363	12,218
March	1927	4559	3405	9891	12,213
April	2784	4625	3256	10,665	15,538
May	2156	4745	3045	9955	15,042
June	2176	5149	2808	10,133	16,025
July	3088	6540	3691	13,319	19,205
August	2338	5626	3174	11,138	16,074
September	1854	4289	2732	8875	13,466
October	1666	3219	2478	7363	13,600
November	1666	3219	2478	7363	13,180
December	1666	3219	2478	7363	13,200
Tot./Avg.	24,259	51,053	33,974	109,286	170,209

Table 3. Real price of a kilogram of date stored in different packaging units in 2018.

Units	Electric Bill (MAD)	Quantity of Dates Stored (T/Year)	Unit Price (MAD/kg)
Toumour Aoufous	170,209	239	0.71

Continued

Difat Ziz Erfoud	200,716	146	1.38
Mergouna Rissani	104,873	41.8	2.51
Wahat Guirr	34,445	61	0.56
Ghris Ferkla	83,522	69	1.21

Taking the Toumour wahat aoufous EIG as an example, **Table 2** illustrates its energy consumption in 2018. It was equal to 109,286 kWh per year, with a total cost of 170,209 MAD/year (including taxes), resulting in an average unit price of 1.56 MAD/kWh. However, significant variations exist between units of the same size. This is due to the quantities of dates processed, which remain below the capacities of these refrigeration units.

Table 3 presents the unit price of one Kilogram of dates stored in each refrigeration unit. This price varies from unit to unit, depending mainly on storage capacity, the quantity of dates to be stored, and the number of operational refrigeration chambers. However, our survey revealed that all refrigeration units in the Drâa-Tafilalet region apply a similar unit price, not exceeding 0.35 MAD per kilogram of stored dates. As a result, these units reported balance sheet deficits, as the unit price calculated in **Table 3** is significantly higher than the actual charged cost, which explains the observed financial losses.

Morocco's oases have considerable solar potential, with 365 days of sunshine and an average irradiation of over 5 kW/h/m²/d. As part of the PAGIE project, and in order to reduce their energy consumption, the government has equipped all the date packaging units from Group 1 and one from Group 2 in the Daraa Tafilalet region with photovoltaic energy, at an average cost of 900,000.00 MAD per unit. Each unit was equipped with 3 hybrid inverters, 64 batteries with a storage capacity of 150 kWh and a data acquisition system (**Figure 6**). This use of renewable energies led to a financial gain of around 200,000 dirhams/year/unit, while ensuring total coverage of the units' energy consumption and avoiding the equivalent of 70.27 tons of CO₂ per unit.

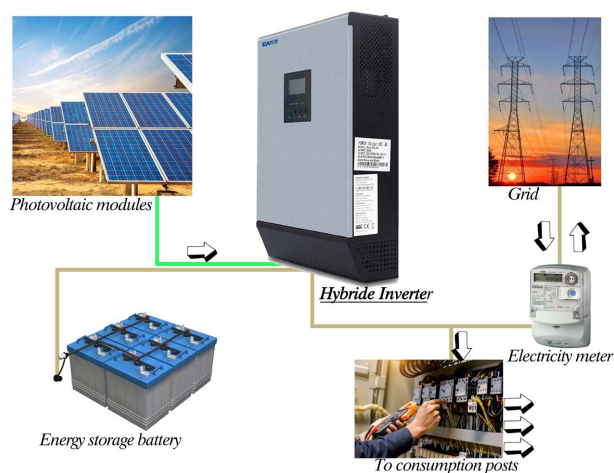


Figure 6. Schematic diagram of a hybrid photovoltaic system with storage.

4. Discussion

The diagnostic analysis of the studied packaging units reveals several noteworthy geographical and operational characteristics that influence their functionality and efficiency. Firstly, the geographic positioning of these units is significant, with all twelve units strategically located in areas not prone to flooding, devoid of standing water, and free from offensive smells. This geographical consideration is essential as it ensures a conducive environment for manufacturing operations, minimizing the risk of water damage and unpleasant odors that could compromise product quality [10]. Moreover, the majority of these units (67%) are situated away from residential areas, which reduces potential conflicts with local communities and mitigates noise and traffic disturbances.

In terms of infrastructure, the presence of 380V electrical currents in each unit facilitates a robust power supply, essential for operating modern packaging machinery efficiently [11]. Additionally, the design features such as gutters with inspection traps and appropriately angled floors demonstrate a proactive approach to liquid waste management, preventing stagnant water accumulation and facilitating easy cleaning processes [12]. Adequate ventilation systems further contribute to maintaining hygienic conditions by controlling dust, moisture, and heat levels within the units [13].

Furthermore, the high percentage of units (92%) connected to sanitation networks underscores a commitment to wastewater management and environmental sustainability [14]. Adherence to hygiene protocols, including stringent cleanliness standards for workers and equipment, along with pest control measures, reflects a dedication to maintaining product quality and safety [15]. The authorization by ONSSA and participation in training sessions facilitated by agricultural institutes highlight regulatory compliance and continuous professional development within the industry.

Regarding investment costs, the disparity between Group 1 and Group 2 reflects differences in storage capacities and operational requirements. Group 2's lower construction expenses can be attributed to its smaller scale and possibly less complex infrastructure needs compared to Group 1. However, both groups allocate a significant portion of their budgets to infrastructure and basic equipment, emphasizing the importance of robust foundational elements in packaging unit operations.

The evolution of date stocks from 2017 to 2020 reveals significant fluctuations among EIGs, reflecting diverse factors shaping supply conditions. In Group 1, a substantial increase in stored quantities, highlighted by a 127% rise from 2019 and a remarkable 477% escalation from 2017, underscores evolving procurement and storage strategies. Spatial distribution within this group shows nuanced trends, with the Aoufous station experiencing a notable uptick while the Ternata station sees a slight decline, accentuating the complexity of supply dynamics. Meanwhile, Group 2 faces operational challenges, with one EIG unit ceasing operations due to irrigation and palm grove vitality issues, emphasizing the vulnerability of

supply chains to environmental factors.

Diverse quality control standards among EIGs for receiving and weighing dates highlight varying priorities. While some, like Rissani, have comprehensive criteria covering variety, impurity, maturity, health, and water content, others, like Tamezmoute and Ouhmidi, focus solely on health conditions. This reflects tailored quality control measures in agricultural supply chains, as noted in studies [16].

Most EIGs maintain meticulous record-keeping, including entry date, supplier details, variety, batch number, weight, and packaging, aligning with supply chain best practices for transparency and accountability (Group 1). This echoes research emphasizing the role of traceability in ensuring product integrity and consumer trust [17].

The results regarding insect disinfestation and sorting processes in date processing operations offer insights into the diversity of practices and challenges faced within the industry. While 10 out of 11 EIGs operate insect disinfestation chambers, the absence of this practice in some EIGs due to sealing issues or infrastructural limitations highlights barriers to implementing standardized pest control measures (Group 1). This finding resonates with research by Rajendran [18], which emphasizes the importance of pest management strategies in preserving agricultural produce quality and minimizing post-harvest losses.

Sorting procedures, prevalent across all EIGs, demonstrate standardized classification into four levels, with additional specifications for certain varieties (Group 1). The variation in sorting reject disposal methods, including returning to the client, livestock feed, or transformation cooperatives, underscores the need for sustainable waste management practices within the processing chain (Group 1). This observation aligns with findings from studies on agricultural waste management [19], emphasizing the significance of efficient utilization of by-products to minimize environmental impact and enhance resource efficiency.

Furthermore, the wide divergence in tonnage sorted relative to workforce mobilization among EIGs underscores variations in operational efficiency and resource utilization (Group 1). This highlights the potential for operational optimization and standardization to improve productivity and reduce labor costs, as suggested by Taşkın & Bilgen [19] in their study on agricultural supply chain resilience.

In contrast, utilizing drying and hydration processes by a subset of operational units reflects diverse approaches to product preservation and quality enhancement (Group 1). The cited reasons for not employing drying methods, such as cost constraints, echo findings from studies on cost-benefit analysis in agricultural processing [20], highlighting the economic considerations influencing processing decisions.

5. Conclusion

The established infrastructure serves as a means of valorizing Moroccan dates and improving the income of small-scale agriculture by bringing to market dates that meet quality standards, both for local and export markets. These packaging units

have led to an enhancement in packaging quality to an acceptable level, as well as the creation of new jobs and opportunities for value-added products. The organization into EIGs presents an opportunity for the distribution of palm date production with a reasonable margin benefiting producers and the population of oasis areas. Despite their satisfactory technical level, compared to the average operational lifespan of units not exceeding 5 years, the existing activity volumes fall below the desired capacity to meet the demand for high-quality palm date varieties annually. Additionally, the mastery of operationalization and optimal utilization of equipment remains insufficient. Indeed, apart from cold rooms, over 50% of EIGs do not utilize the equipment provided for operations such as drying, humidification, date hydration, glucose soaking, fumigation, or date washing.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Sedra, M.H. (2013) Guide du phoeniculteur: Mise en place et conduite des vergers phoenicoles. INRA.
<https://www.inra.org.ma/sites/default/files/publications/ouvrages/guidephoenicole1212.pdf>
- [2] Bakouri, Z.E., Meziani, R., Mazri, M.A., Chitt, M.A., Bouamri, R. and Jaiti, F. (2021) Estimation of the Production Cost of Date Fruits of Cultivar Majhoul (*Phoenix dactylifera* L.) and Evaluation of the Moroccan Competitiveness towards the Major Exporting Regions in the World. *Agricultural Sciences*, **12**, 1342-1351.
<https://doi.org/10.4236/as.2021.1211086>
- [3] MAPMDREF (2019) Filiere Palmier Dattier.
<https://www.agriculture.gov.ma/fr/filiere/palmier-dattier>
- [4] ANDZOA (2018) Rapport d'activité 2017. Direction de Développement des Zones Oasiennes. 92 p.
- [5] Bouhlali, E.D.T., Bammou, M., Sellam, K., Benlyas, M., Alem, C. and Filali-Zegzouti, Y. (2016) Evaluation of Antioxidant, Antihemolytic and Antibacterial Potential of Six Moroccan Date Fruit (*Phoenix dactylifera* L.) Varieties. *Journal of King Saud University—Science*, **28**, 136-142. <https://doi.org/10.1016/j.jksus.2016.01.002>
- [6] Djaoud, K., Muñoz-Almagro, N., Benítez, V., Martín-Cabrejas, M.Á., Madani, K., Boulekbache-Makhlouf, L., *et al.* (2022) New Valorization Approach of Algerian Dates (*Phoenix dactylifera* L.) by Ultrasound Pectin Extraction: Physicochemical, Techno-Functional, Antioxidant and Antidiabetic Properties. *International Journal of Biological Macromolecules*, **212**, 337-347.
<https://doi.org/10.1016/j.ijbiomac.2022.05.115>
- [7] Johnson, D., Al-Khayri, J.M. and Jain, S.M. (2015) Date Palm Genetic Resources and Utilization, Volume 1: Africa and the Americas. Springer.
- [8] Spurgeon, S. (2019) Morocco's Date Palms Bring in MAD 2 Million per Year. Morocco World News.
<https://www.moroccoworldnews.com/2019/10/285334/morocco-date-palms-2-million-year>
- [9] Zahidi, M. and Ayegou, J. (2022) The Organization of the Date Sector in Morocco: A Lever for Valorization and Local Development. The Case of the Ziz Valley in the

- Tafila-Let Region of Morocco. *Regional and Sectoral Economic Studies*, **22**, 37-60.
- [10] Chumaidiyah, E., Dewantoro, M.D.R., Fauzi, P.M. and Kamil, A.A. (2023) Selection of Industrial Sites Using a Web-Based Geographical Information System to Minimize Risks: A Case Study in West Java, Indonesia. *Sustainability*, **15**, Article No. 16034. <https://doi.org/10.3390/su152216034>
- [11] de Oliveira Costa, L.F. and de Carvalho Filho, J.M. (2016) Electrical Power Quality and the Challenges Faced by Power Assemblies Applications in Petrochemical Industry. *IEEE Transactions on Industry Applications*, **52**, 4495-4502. <https://doi.org/10.1109/tia.2016.2573258>
- [12] Vanatta, B. (2000) Guide for Industrial Waste Management. DIANE Publishing.
- [13] Chan, W.R., Kim, Y.S., Less, B.D., Singer, B.C. and Walker, I.S. (2019) Ventilation and Indoor Air Quality in New California Homes with Gas Appliances and Mechanical Ventilation. USDOE Office of Energy Efficiency and Renewable Energy (EERE), Energy Efficiency Office. Building Technologies Office. <https://doi.org/10.2172/1509678>
- [14] Kumar, A., Thakur, A. and Panesar, P.S. (2023) A Review on the Industrial Wastewater with the Efficient Treatment Techniques. *Chemical Papers*, **77**, 4131-4163. <https://doi.org/10.1007/s11696-023-02779-3>
- [15] Aarnisalo, K., Tallavaara, K., Wirtanen, G., Maijala, R. and Raaska, L. (2006) The Hygienic Working Practices of Maintenance Personnel and Equipment Hygiene in the Finnish Food Industry. *Food Control*, **17**, 1001-1011. <https://doi.org/10.1016/j.foodcont.2005.07.006>
- [16] Bian, Y., Yan, S., Yi, Z., Guan, X. and Chen, Y. (2022) Quality Certification in Agricultural Supply Chains: Implications from Government Information Provision. *Production and Operations Management*, **31**, 1456-1472. <https://doi.org/10.1111/poms.13623>
- [17] Anastasiadis, F., Apostolidou, I. and Michailidis, A. (2021) Food Traceability: A Consumer-Centric Supply Chain Approach on Sustainable Tomato. *Foods*, **10**, Article No. 543. <https://doi.org/10.3390/foods10030543>
- [18] Rajendran, S. (2020) Insect Pest Management in Stored Products. *Outlooks on Pest Management*, **31**, 24-35. https://doi.org/10.1564/v31_feb_05
- [19] Taşkıner, T. and Bilgen, B. (2021) Optimization Models for Harvest and Production Planning in Agri-Food Supply Chain: A Systematic Review. *Logistics*, **5**, Article No. 52. <https://doi.org/10.3390/logistics5030052>
- [20] Hsu, E. (2021) Cost-Benefit Analysis for Recycling of Agricultural Wastes in Taiwan Region. *Waste Management*, **120**, 424-432. <https://doi.org/10.1016/j.wasman.2020.09.051>