

Article de recherche

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Problematic of premature harvesting of the carob

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ملخص

تركز هذه الدراسة على حصاد الخروب المبكر، ضمن مشروع INRF لتطوير وتسويق شجرة الخروب. تشمل منهجية العمل استطلاعًا اجتماعيًا واقتصاديًا عبر الإنترنت ومراقبة نضج القرون في الحقل والمختبر. تشير النتائج إلى أن معظم عمليات الحصاد تحدث قبل أن تجف القرون تمامًا، مما يؤثر على جودتها. يشجع التخزين قبل التسليم على العمليات اللاهوائية، مما يؤثر سلبًا على الإنتاج. يشكل ضرب الأغصان أثناء الحصاد خطرًا على العائدات المستقبلية، نظرًا لتزامن فترة الحصاد الحالية مع زهور السنة التالية. وبالتالي، فإن التوعية وإجراءات مراقبة الجودة ضرورية.

الكلمات الرئيسية: الخروب، طريقة الحصاد، الحصاد المبكر، التسويق.

Abstract

The focus of this work is on the premature harvesting of carob, integrated into the INRF project for the development and valorization of the carob tree. The methodology includes an online socio-economic survey and monitoring of pod maturation in the field and laboratory. Findings indicate that most harvests occur before the pods fully dry, compromising their quality. Pre-delivery storage encourages anaerobic processes, detrimental to production. Branch beating during harvesting poses a risk to future yields, as the current harvesting period coincides with the flowering of the following year. Thus, awareness and quality control procedures are necessary.

Keywords: Carob, Harvesting method, Premature harvesting, Valorization.

Résumé

Le travail se focalise sur la récolte prématurée de la caroube, intégré au projet de l'INRF pour le développement et la valorisation du caroubier. La méthodologie comprend une enquête socio-économique en ligne et un suivi de la maturation des gousses sur le terrain et en laboratoire. Les résultats indiquent que la plupart des récoltes sont faites avant le dessèchement complet des gousses, compromettant leur qualité. Le stockage pré-livraison favorise les processus anaérobies, nuisant à la production. Le battage des branches lors de la récolte présente un risque pour le rendement futur, car la période de récolte actuelle coïncide avec la floraison de l'année suivante. Ainsi, une sensibilisation et des procédures de contrôle de la qualité sont nécessaires.

Mots clés : Caroube, Méthode de récolte, Récolte prématurée, Valorisation.

1. Introduction

Mediterranean ecosystems, particularly forested areas, face significant challenges due to climatic constraints such as irregular precipitation and prolonged summer droughts, coupled with mounting anthropogenic pressures (Ramón-Laca et al. 2004; Gadoum, 2020). These factors contribute to vegetation decline and rapid soil erosion, necessitating the use of species adapted to such conditions in reforestation programs. Among the diverse Mediterranean flora, the Carob tree stands out as a promising solution. Thriving in arid regions with poor, rocky soils, this species exhibits remarkable resilience to temperature fluctuations ranging from ≤ 6 to ≥ 50 °C. Moreover, the Carob tree holds considerable economic importance, with all its parts—roots, wood, bark, leaves, flowers, and fruits—yielding valuable resources for various purposes including food, industry, and medicine.

Research by Batlle et al. (1997) underscores the Carob tree's low agronomic demands compared to other species and its capacity to thrive in dry, calcareous soils (Antonio et al. 2019; Benmahiou et al. 2011; Ait Chitt et al. 2007; Correia, 2005; Tous, 1984). The economic significance of the Carob tree is particularly evident in its pods and seeds, which are sought after for human and animal consumption as well as in the food industry. The flour derived from crushed pods and the carob gum extracted from seeds' endosperm are highly valued commodities, finding extensive applications as stabilizers and thickening agents in pharmaceutical and cosmetic sectors (Goulas et al. 2016; Benković et al. 2016; Stavrou et al. 2018; Durazzo et al. 2014; Batlle et al. 1997).

Global statistics from FAOSTAT (2020) indicate an annual carob production of approximately 49,690 tonnes, predominantly concentrated in the Mediterranean region, with Morocco leading production at 21,800 tonnes and Algeria ranking fourth with an estimated 3,280 tonnes, constituting 6.6% of the global yield. This highlights the species' potential for national and international development (Sbay, 2008). Although historically overlooked in Algerian reforestation and development initiatives, the Carob tree has garnered significant attention in recent years from policymakers, stake-

holders, and researchers alike (Lemradji et al. 2019). Research efforts have explored various facets and values of Carob products, with studies focusing on aspects such as nutritional content and pod maturity levels (Tsatsaragkou et al. 2014; Arribas et al. 2019; Farag et al. 2019; Kyratzis et al. 2020; Antoniou et al. 2021).

The cultivation of Carob trees in accessible rural areas has led to increasing demand and prices, prompting a surge of interest in certain segments of society. However, despite these trends, the issue of premature harvesting remains understudied, despite its potential impact on product quality and value. The present study addresses this gap within the framework of a socio-economic impact project at the INRF in collaboration with ENSA, examining the problem of premature carob harvesting.

2. Methods and Materials

2.1. Objective and methodology

The current study focuses on the valorization of carob production by examining harvesting periods relative to pod maturity and drying. Its objective is to conduct a socio-economic survey among harvesters to determine harvesting periods and methods, alongside monitoring pod drying both in the field and laboratory. By comparing the results of these aspects—harvest periods utilized by collectors and pod drying times—the study aims to provide recommendations and measures to enhance harvesting practices and consequently improve production value.

2.2. Study sites

The first part of the study, involving a survey about harvest periods conducted with collectors, covered various regions of Algeria and was administered online via a Google Form (Figure 1). The second part, focusing on determining pod drying time, was conducted in the region of Bougara, situated in the eastern part of the Mitidja plain (Blida department). The climate in this region ranges from sub-

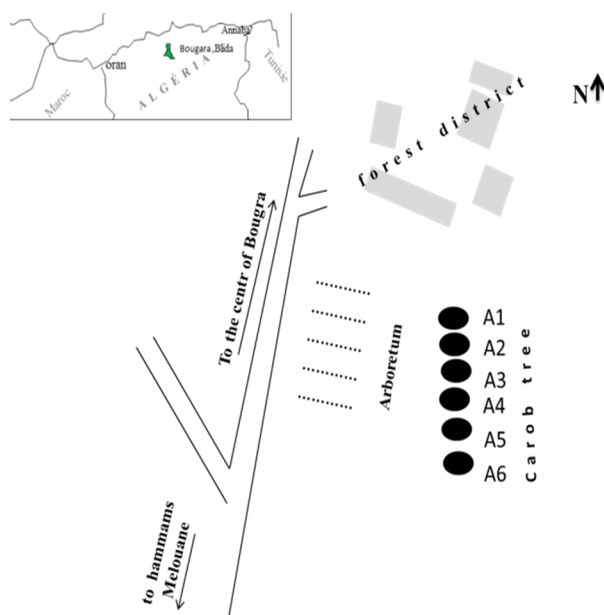


Figure 1. Study sites.

humid to humid, with an average precipitation of approximately 600 mm and temperatures ranging from 11,5°C in winter to 34°C in summer. The soil composition is clayey-sandy. Six trees located within the forest administration yard of Bougara forest district were sampled. These trees are mature, with extensive branches and crown heights exceeding 8 m. The selection of these trees was primarily based on considerations of protection and accessibility.

2.3. Tracking method of pod ripening

Pod ripening was tracked through periodic sampling. During each collection, 60 pods (10 from each tree) were randomly selected from different parts of the tree crown. These sampled pods were then monitored in the laboratory, with measurements taken for both browning rate and drying rate.

2.3.1. Browning rate

The browning rate, serving as an indicator of maturity, was calculated for each pod as the ratio between the browned surface area and the total surface area (% browning rate = $\frac{\text{Browned surface area}}{\text{Total surface area}} \times 100$). The "MESURIM" soft-

ware was utilized for estimating the browning surface.

2.3.2. Drying rate

The drying rate was assessed by periodically weighing samples spread out in the laboratory for air-drying. Initially, sampling occurred weekly during the early stages of maturity (May, June, and the first half of July). Subsequently, as the harvesting season approached, the sampling frequency increased, shifting from weekly to every three days by the second half of July.

2.4. Methods of describing harvest dates and practices

The determination of harvesting periods was achieved through an online questionnaire survey, supplemented by direct field observations to corroborate and expand upon the collected information. This encompassed aspects such as harvesting periods, practices, indications used by collectors, and methods and duration of field storage.

2.5. Statistical analysis

Survey results were analyzed using Sphinx Plus2 Software. Multiple correspondence analyses were conducted using XL STAT 2016 software to analyze survey data. Additionally, the correlation between browning rate and drying rate was assessed using the same software.

3. Results

3.1. Description of harvesting practices

Analysis of survey responses reveals that several harvesters use browning as an indicator of pod maturity and commencement of harvest (Figure 2A). The predominant method of storage involves closed woven bags (Figure 2B; Figure 3A et B), while the duration of field storage—spanning from harvest to delivery to processors—varies significantly among collectors, ranging from one week to one year (Figure 2C).

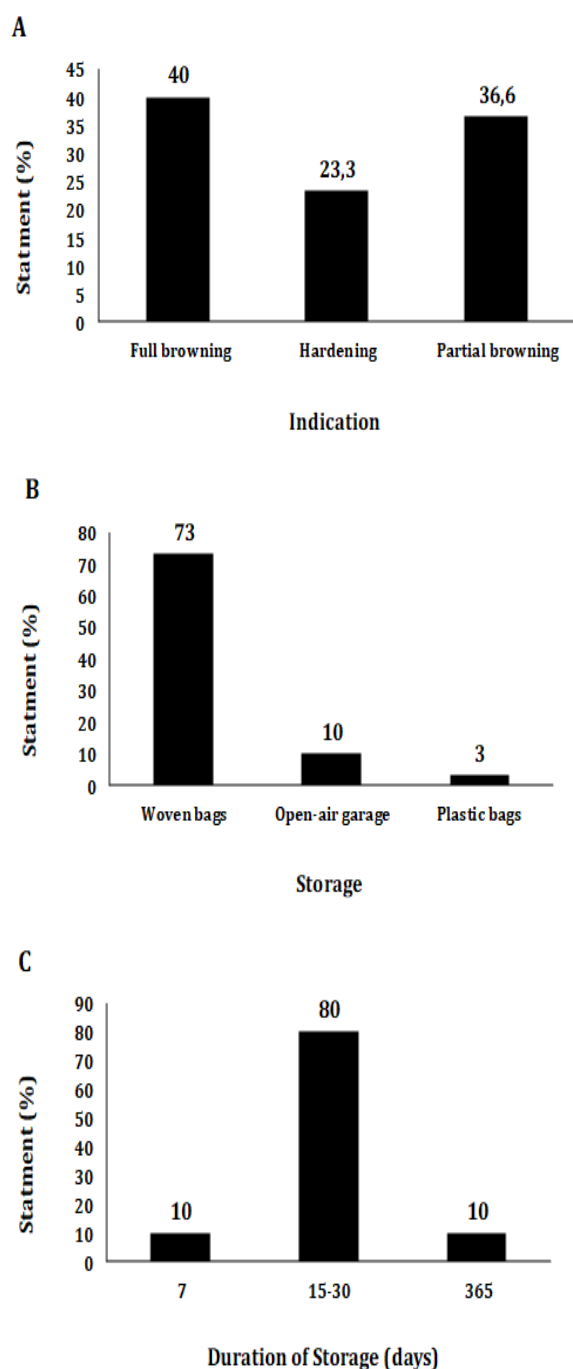


Figure 2. Harvest period according to pods appearance (A), methods harvesting (B) and duration of storage in field (C).



Figure 3 . Storage in closed bags (A) ; Quality affected (harvesting prematurely)(B).

3.2. Relationship between collectors and harvesting practices

A total of 30 individuals participated in the survey, with the majority falling within the 30-50 age group. The consensus among respondents was that harvesting commenced upon the onset of pod browning. Notably, the survey indicated that the harvesting period typically extends over 40 days, from June 30th to August 10th (Figure 4). Further analysis revealed three distinct groups of harvesters:

The first group comprises individuals aged 16 to 29 with university degrees, initiating harvest between July 20th and 30th. They rely on total browning as a cue for harvest initiation and employ pod pulling and branch shaking techniques.

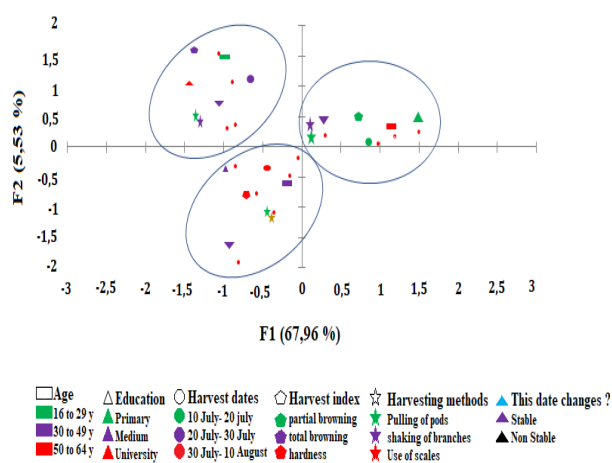


Figure 4. Multiple Correspondence Analyses (axes F1 and F2: 73.49%).



Figure 5. Browning pods (A, B), pods that are totally brown but not yet dried (C), and dried pods (D).

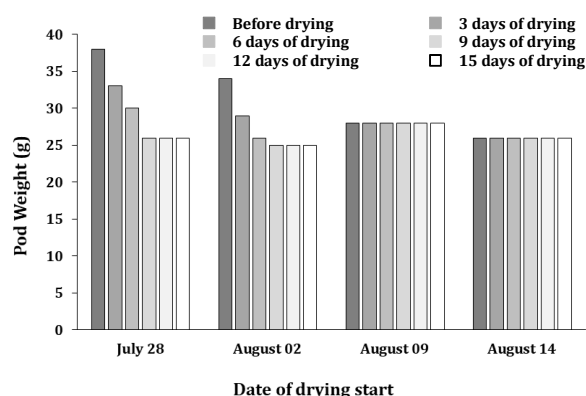


Figure 6. Evolution of pod sample weights according to date and duration of drying

The second group consists of harvesters aged 50 to 64 with moderate education levels. They harvest between July 30th and August 10th, relying on pod hardness as an indicator. Similar to the first group, they utilize pod pulling and branch shaking methods.

The third group includes harvesters aged 30 to 49 with primary school education, commencing harvest between July 10th and 20th. They utilize brown spots (partial browning) as a reference for pod ripening and employ pod pulling and branch shaking techniques.

3.3. Evolution of browning and drying rates of pods

Browning typically initiates in the fourth week of June, gradually increasing from 20-50% in the first half of July to 80-97% by the third week, reaching full browning by month-end (Figure 5). Observation indicates a progressive color change, beginning with dark spots in the stigma area and spreading across the entire fruit surface, with the peduncle showing browning last. Browning intensity varies across trees and is heterogeneous among pods within the crown, with sunny areas exhibiting greater intensity. Periodic weighing of samples spread out in the laboratory for drying on various dates (Figure 6) indicates that total pod drying was achieved by August 9th. Samples collected on July 28th and August 2nd showed weight reduction, while those collected on August 09th and 14th displayed no change in weight.

3.4. Comparison of maturity stage and harvest date

A graphical overlay of three parameters—browning rate, drying rate, and frequency of harvest beginning dates—reveals that a substantial proportion (69%) of harvests commence before total browning, and hence, before the drying rate date. Notably, harvesting in June remains significant, indicating that harvesting of green pods is prevalent. All harvests initiated before drying out, with 69% commencing before total browning (Figure 7).

4. Discussion

Carob holds significant potential for development and valorization, owing to its ecological resilience, economic viability, and increasing demand in the food industry (Karababa et al. 2013). Its attributes, including drought resistance and soil erosion control, make it particularly valuable amidst concerns of global warming. Commercial interest in carob has surged, with its price doubling over the past three years, fueled by extensive advertising on social media platforms like Facebook and Instagram. However, this surge in demand has led to fierce competition among traders and collectors, resulting in price inflation and chaotic harvesting practices.

Despite the relatively small sample size of 30 individuals, our findings reveal a common occurrence of premature harvesting of pods. All reported harvest dates preceded August 10, when pods typically reach full dryness. This observation aligns with discussions with SARL Boublenza, indicating a significant portion of this year's production being harvested prematurely.

The majority of harvesters (70%) rely on browning rates to determine harvest timing, often initiating harvest as soon as pods begin to turn brown around early July. However, laboratory monitoring indicates that total browning precedes drying by approximately 15 days, with some harvesters (36.6%) commencing harvest even before complete browning, exacerbating the issue of premature harvesting.

Inter-annual variations in harvest dates are acknowledged, with most harvesters stating a stable start date, although climate fluctuations may influence this. Similar issues of premature harvest have been noted in Spain, where harvests in the carob region commence a month before maturity, resulting in a 30% decline in carob product production.

Harvesting methods also pose challenges, with all harvesters (100%) utilizing techniques like shaking branches and hitting them with sticks, potentially harming future production by affecting flowering phases. Notably, alternative methods such as ladder use, which minimizes tree damage, were not mentioned.

Furthermore, the storage method significantly impacts product quality before delivery to industry

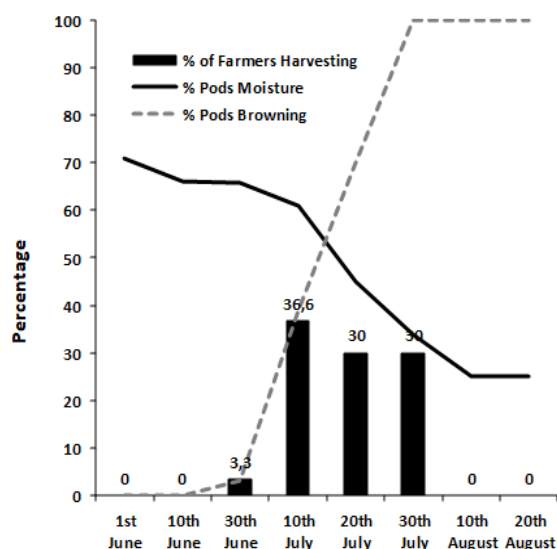


Figure 7. Evolution of farmers harvesting rates launched compared to pod browning and desiccation.

units. The majority of harvesters (75%) store pods in woven plastic bags, which can create anaerobic environments favoring premature pod fermentation. Closed plastic bags, used by 15% of harvesters, pose even greater risks of production destruction due to fermentation and fungal growth.

The varying time intervals of storage before delivery, ranging from one week to one year, are driven by market speculation and price fluctuations. Some harvesters prolong storage periods to await price increases, sometimes extending storage for an entire year.

Overall, the carob harvesting process is riddled with anomalies that devalue the product before delivery, from premature harvesting to inadequate storage methods. According to SARL Boublenza, the unit's operations in 2022 relied heavily on imported carob due to the inaccessibility of local produce resulting from premature harvesting practices. Addressing these issues is crucial for the sustainable development and valorization of the carob sector.

5. Conclusion

The carob tree, a species with a rich history dating back to the Middle Ages, continues to play a significant role in various ecological and economic endeavors (Evreinoff, 1947). Its rising prominence globally is attributed to an enhanced understanding of its nutritional value among consumers, with increasing international demand linked to the substitution of carob products for cocoa (Antoniou et al. 2021).

The findings of this study offer valuable insights into stand and crop management practices. Notably, a substantial portion of harvests occurs before pod drying, highlighting the need for measures to enhance product quality. Moreover, information on harvesting techniques, storage methods, and the duration between harvest and delivery is essential for enhancing both the quantity and quality of carob production.

In light of these findings, several recommendations can be made to improve the practical aspects of carob production:

Strengthening training and awareness initiatives aimed at educating stakeholders about the intricacies of the harvesting process and its implications for the economy.

Implementing quality control measures to ensure consistency and adherence to standards throughout the production process.

By adhering to these recommendations, stakeholders can contribute to the sustainable growth and valorization of the carob industry, thereby maximizing its potential as a valuable commodity in the global market.

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