

# CAMEL GELATIN PRODUCTION IN ALGERIA: FROM BIOLOGICAL POTENTIAL TO INSTITUTIONAL AND ECONOMIC CONSTRAINTS

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**Abstract:** Gelatin is a strategic material for food, pharmaceutical, cosmetics, and biotechnology industries. Despite substantial camel resources, Algeria remains dependent on gelatin imports, causing significant hard currency drainage. This study analyzes the potential for valorizing camel slaughter by-products for gelatin extraction and identifies constraints hindering establishment of a sustainable national production project. Official data from the Ministry of Trade and Export Promotion revealed that Algeria's gelatin imports in 2021 reached 1.26 million \$ (6,057 tons), while exports represented only 1% of trade. Primary demand concentrated in food industries (>1,000 tons annually), pharmaceutical sectors (60 tons), and electronics. Camel meat production in 2021 generated approximately 22,500 tons of bones annually, theoretically enabling production of 5,175 tons of gelatin at 22% extraction rate, alongside 794 tons of hides nationally. Critical constraints preventing project implementation include absence of proper collection and preservation protocols, lack of cold chain infrastructure, inadequate sanitary quality controls, and minimal coordination among value chain stakeholders. A comprehensive national strategy integrating industrial security and bioeconomy principles is required, with coordinated involvement of Agriculture, Industry, and Higher Education ministries, supported by pilot projects to transform biological potential into sustainable economic development in arid regions.

**Keywords:** camel gelatin, slaughter by-products, circular economy, value chain, bioeconomy

## Introduction

Gelatin is a vital material of strategic importance in many industrial sectors, particularly the food, pharmaceutical, and cosmetics industries, as well as in its growing applications in medicine and biotechnology [1; 2; 3; 4; 5]. Despite this pivotal role, Algeria remains almost entirely dependent on gelatin imports to meet its national needs [6], resulting in a significant drain on hard currency, at a time when local animal resources are available that could be exploited within a circular economy and sustainable development approach.

In this context, camels stand out as a strategic resource in arid and semi-arid regions, not only in terms of meat and milk production, but also in terms of slaughter by-products, primarily bones and hides, which are promising raw materials for the extraction of gelatin and collagen derivatives with high added value [7; 8]. Camel meat production in Algeria saw a significant increase in 2021, reaching approximately 255,151 tons, which leaves an estimated 22,500 tons of bones annually. which could theoretically enable the production of around 5,175 tons of gelatin [9] with an estimated extraction rate of 22% from bones [7].

Field data confirms the availability of significant quantities of other slaughter residues, particularly hides. Statistics indicate that in the province of Ouargla alone, approximately 277 camels were slaughtered, resulting in an estimated production of 59.47 tons of hides. Extrapolating these results to the national level, the annual quantity of hides produced from camel slaughter could reach approximately 794.2 tons, as recorded in 2018 [8], reflecting the untapped potential for the valorization of camel waste.

Despite this promising quantitative and biological potential, the valorization of camel waste, particularly gelatin extraction, has not been translated into a self-sustaining national economic project, raising fundamental questions about the nature of obstacles preventing its implementation.

Based on these facts, this article aims to provide a comprehensive analytical reading of the potential for valorizing camel waste in Algeria, with a focus on gelatin extraction, by linking quantitative data to regulatory and institutional issues, and proposing an integrated vision for reorganizing the value chain and transforming this vital resource into a real lever for sustainable economic development in arid regions. In addition, the study aims to identify and analyze the main structural, organizational, and institutional constraints that hinder the establishment of a genuine and sustainable investment project in the field of camel-derived gelatin.

## **Materials and methods**

This study was conducted using a combination of tracking, investigation, analytical, and verification approaches, based on official data obtained from the Algerian Ministry of Trade and Export Promotion. The objective was to provide a comprehensive overview of gelatin production and marketing in Algeria, assess its position within the local investment landscape, and evaluate its potential contribution to economic development.

### **1. Data collection**

The Ministry of Commerce and Export Promotion data was collected through questionnaires in the form of ready-to-fill statistical tables, which included the following:

- Gelatin import movements in terms of quantity, market prices, and fields of use in 2021.
- Local exports abroad in terms of quantity, market prices, and destination in 2021.

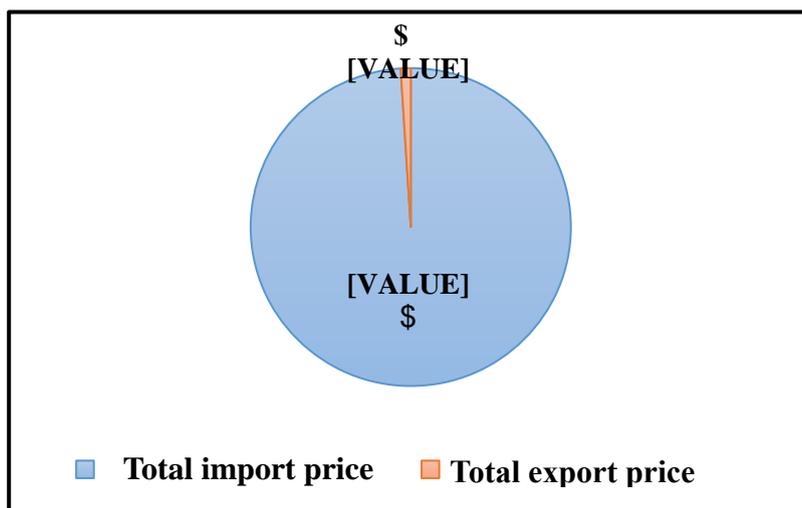
### **2. Data output**

The data were output in the form of graphs using Microsoft Excel 2013 and XLSTAT, Perpetual version 2019.2.2, 59614 for Microsoft Excel 16.0 17231 (64 bit).

## **Results and Discussion**

### **1. Commercial dynamics and international trade in gelatin in Algeria**

This refers to import and export movements at the national level and their respective levels in terms of quantity and international prices. Figure 1 shows this interaction in import and export dynamics.



**Figure 1.** Proportion of gelatin exports and imports in Algeria in 2021

Algeria's imports of gelatin in 2021 were estimated at more than 1 million \$ (1,266,234.67 \$), equivalent to 1 billion Algerian dinars, with an estimated quantity of 60,575,632.64 kg (6,057.56 tons). This quantity represents the national annual demand for gelatin, and achieving self-sufficiency in this material is necessary to reduce costs and eliminate dependence on foreign imports.

Algeria's exports of gelatin are negligible, accounting for only 1% of the trade in this vital material, which means that the lack of local production of the material creates a huge gap in the Algerian economy, making it permanently dependent on foreign imports, which will always result in heavy losses in hard currency. This dependence on foreign imports can be attributed to several reasons:

- A lack of specialized technical knowledge and social and industrial ignorance of the material's uses. In addition, ignorance of its economic weight, linked to its huge financial cost, estimated at over a million dollars in hard currency, leads people to underestimate its

value and consider it a cheap material, and therefore there is no thought of producing it in the first place.

- Gelatin manufacturing is complex and relatively time-consuming. Even when raw materials are abundant, it requires special chemicals in large quantities [10], as well as advanced equipment and technology [11], which are lacking locally and must be imported from abroad if a production project for the material is to be established.

- Finally, the administrative restrictions imposed on those wishing to establish a gelatin manufacturing project take time to overcome, which prolongs the process of laying the foundations. In addition, the concept of entrepreneurship and business leadership is lacking in certain social groups and requires lengthy training before individuals are ready to implement it.

Usually, low supply and demand in the market are key reasons for the lack of a certain product, but in the case of the gelatin market in Algeria, we find that there are many areas of demand and in large quantities, so this cannot be considered a fundamental reason for the

lack of local production of the material. The multifunctional properties of gelatin, derived from its unique protein composition and structural characteristics, support its widespread application and use in various sectors, including food, medicine, cosmetics, and biotechnology [12]. In Algeria, gelatin is an essential ingredient in the formulation and production of many consumer and non-consumer products, including confectionery, dairy products, meat products, pharmaceutical capsules, photographic films, and medical dressings, due to its exceptional properties in fermentation, stabilization, emulsification, and film formation. Gelatin is a crucial ingredient for achieving the structural and sensory properties desired in a wide range of consumer goods [13].

Figure 2 shows the distribution of gelatin demand across various industries in Algeria in 2021.

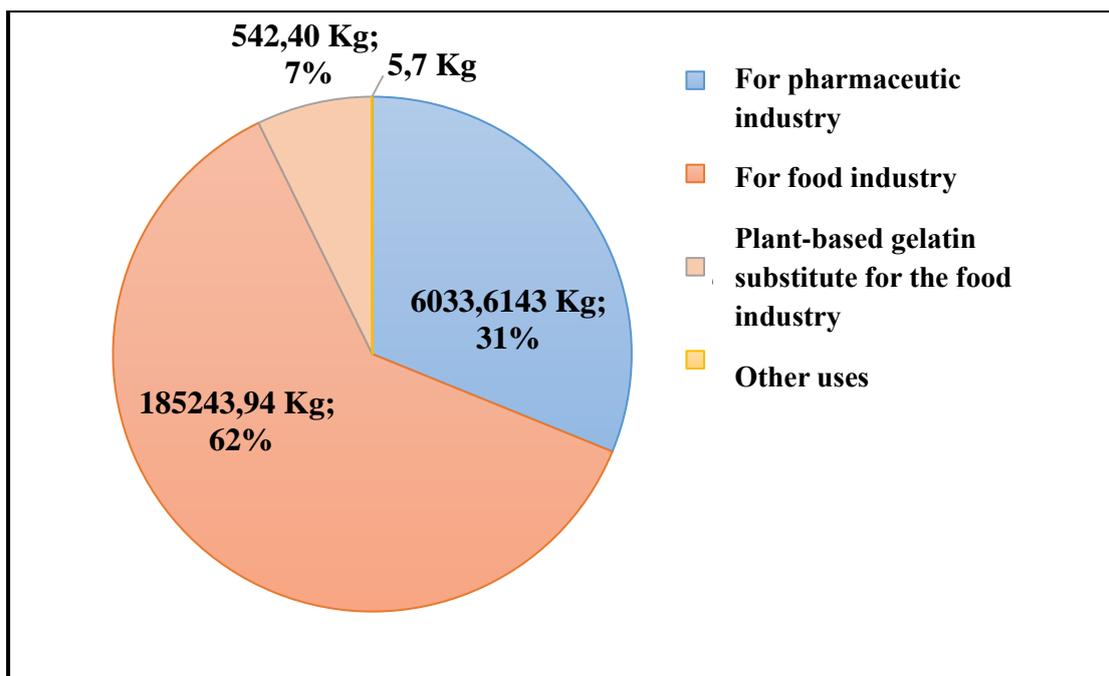
The food industry ranks first in gelatin consumption, using more than 1,000 tons annually. The Algerian people consume a wide range of foods that rely on gelatin as an ingredient, such as jelly desserts, yogurt, cheese, and chocolate, in addition to raw gelatin sold directly in stores, which

is imported and packaged by companies specializing in the food industry.

Given the questionable sources of animal gelatin associated with pig gelatin and illegally slaughtered animals, some import companies have resorted to plant-based gelatin alternatives to meet the needs of the food industry. However, this type of import does not exceed 7% and does not actually cover the needs of the local market.

In the pharmaceutical industry, the nanostructure of gelatin makes it an ideal functional material for the manufacture of medical capsules and an effective supplement as a natural ingredient in medicines. Gelatin for medical products ranks second with 60 tons per year.

In Algeria, the electronics industry has grown in recent years at a microscopic rate of no more than 2%. This industry needs gelatin as part of its components due to its ability to form films and nanofibers and its cohesive strength. Consequently, some imports are directed to these industries in very small quantities (5.7 kg). The percentages are almost negligible, but we should not ignore them because of their importance in the economic sector.



**Figure 2.** Main destinations for gelatin imports in Algeria in 2021

The way to solve the problem of dependence on imports to meet national demand for gelatin is to promote local manufacturing and overcome the constraints associated with production by investing available domestic resources. However, it is not possible to speak of an independent and sustainable investment project without clearly defining the structural, organizational, and institutional prerequisites that govern its feasibility. Indeed, beyond the availability of raw materials, the success of such a project requires an integrated framework encompassing resource organization, quality control, logistics, coordination among stakeholders, and a coherent national vision for the development of the camel sector and the value of its by-products.

## **2. Why a National Economic Project Cannot Currently Be Considered?**

Despite the quantitative and biological potential offered by the camel sector in

Algeria, it is currently not feasible to speak of a fully integrated national economic project for camel gelatin production. This is due to a range of structural and organizational constraints. One of the main challenges is the difficulty of obtaining slaughter by-products, particularly bones and hides, in an acceptable sanitary quality, due to the absence of proper collection and preservation protocols and the prevalence of unregulated practices that contribute to contamination and deterioration of their physical and microbiological properties.

In addition, there is a near-total lack of cooling and preservation chains, both at the slaughterhouse level and during transportation and storage, making a significant portion of these by-products unsuitable for industrial use. There is also a marked lack of coordination among the various actors in the value chain, from breeders, through slaughterhouses, to researchers and industrialists, with each

working in isolation in the absence of an organized, collaborative framework.

These imbalances collectively reflect the absence of a coherent national vision for the organization of the camel sector and the valorization of its by-products, preventing the transition from isolated individual or research initiatives to a sustainable national economic project.

### **3. Major Milestones Required to Build a Camel Gelatin Project**

Upgrading camel gelatin production to a fully functional economic project requires passing through a set of major milestones, none of which can be overlooked without disrupting the balance of the entire system. The issue is not merely about establishing a production unit but about building a fully integrated value chain that begins with camel husbandry and ends with a product that meets industrial standards.

#### **3.1 Strengthening the Camel Sector**

Strengthening the camel sector is the foundational pillar for any sustainable valorization project. This includes organizing traditional husbandry practices, improving feeding programs to positively affect animal health and the quality of by-products, and controlling reproduction to ensure herd stability and renewal. Limiting unregulated slaughter is also essential, given its direct negative impact on sector sustainability and the availability of raw materials in the medium and long term.

#### **3.2 Organizing Camel Slaughter**

Slaughter is a pivotal stage in the value chain and requires specialized or appropriately equipped slaughterhouses that follow strict health protocols to ensure the safety of both meat and by-products.

Mechanisms should be established to track by-products from the moment of slaughter, ensuring their origin, quality, and suitability for industrial use, particularly in sensitive industries such as gelatin extraction.

#### **3.3 Organizing the Collection and Preservation of Bones and Hides**

The organization of by-product collection and preservation is as crucial as the breeding and slaughter stages. Structured collection chains must be established, supported by proper storage conditions regarding temperature, humidity, and duration, to minimize bacterial contamination and preserve the structural properties of collagen. This organization is an essential prerequisite for ensuring the efficiency of the extraction process and the quality of the resulting gelatin.

#### **4. The Role of Specialized Incubators in Building the Value Chain**

Analysis of the value chain indicates that a camel gelatin project cannot rely on a single actor but requires an integrated system of expertise and competencies. In this context, specialized incubators play a central role in guiding and coordinating the various stages of the project. This can include an incubator for camel husbandry focused on improving production practices, a nutrition-focused incubator, a technical incubator for gelatin extraction, and another dedicated to quality control and ensuring the final product meets national and international standards.

This framework emphasizes that a gelatin project is not merely an industrial production unit but a fully integrated system requiring continuous coordination

among biological, technical, organizational, and marketing components.

### **5. The University: Between Scientific Role and Economic Limitations**

Although university is not an economic institution in a strict sense, it represents a key pillar in the development of knowledge and technology related to gelatin extraction. However, its contribution to implementing tangible economic projects remains limited due to the isolation of research within university walls, the rejection of interdisciplinary approaches, and relative disconnect from industrial needs.

In this context, the university can act as a knowledge partner and technology incubator by directing research toward applied problems and engaging with economic institutions. Startups and patents, within the framework of the Ministry of Higher Education's policies, represent promising mechanisms to link research with the market, and laboratories with factories, thus enabling the translation of scientific results into actionable industrial solutions.

### **Conclusion and Recommendations**

Based on the analysis presented, camel-derived gelatin is not merely a scientific dream or theoretical concept, but rather a deferred project hindered by a range of organizational and structural imbalances that prevent the transformation of biological potential into a sustainable national economic venture. Success in this field depends critically on three key elements: sound planning, prudent management, and the integration of

scientific knowledge with practical production and industrial requirements.

To overcome these challenges, the extraction of gelatin should be integrated into a comprehensive national strategy encompassing industrial security and the bioeconomy, with the active involvement of key stakeholders at the governmental and research levels, including:

- The Ministry of Agriculture, to secure raw materials and improve camel sector management,
- The Ministry of Industry, to support the development of production units and infrastructure,
- The Ministry of Higher Education and Scientific Research, to guide research toward applied solutions and bridge the gap between laboratories and factories.

It is also recommended to support pilot projects, aiming to test replicable production, technical, and economic models, and to establish a gradual economic framework that begins at the local level, expands to the regional level, and ultimately culminates in a fully integrated national project, while ensuring quality standards, resource preservation, and production sustainability.

Implementing these recommendations will transform the camel gelatin project from a deferred idea into a strategic lever for sustainable economic development in arid regions, enabling Algeria to reduce import dependency, efficiently utilize local resources, and open new avenues for innovation in the food, pharmaceutical, and biotechnological industries.

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