RESEARCH ARTICLE Asian Journal of Dairy and Food Research, Volume 44 Special Issue: 62-68 (November 2025)

An Investigation Into the Traditional Processing of Camel Meat as *Khlii*: A Dried, Cooked and Fatty Meat from Southwestern Algeria

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10.18805/ajdfr.DRF-509

ABSTRACT

Background: In Southern Algeria, camel meat is the primary source of protein-rich animal products. To extend its shelf life, the people of the southwestern region prepare *Khlii*, a dried, cooked and fatty form of camel meat. This preservation technique, which involves drying, salting, seasoning and cooking the meat in fat, allows it to be stored at room temperature for several months, while also enhancing its nutritional value and sensory qualities, thus helping combat food insecurity.

Methods: This study investigates the processing methods involved in the production of *Khlii*. A quantitative ethno-nutritional survey was conducted with a sample of 100 households from the Bechar and Beni Abbes provinces in southwestern Algeria to examine the traditional methods used in preparing this meat product.

Result: The survey uncovered various *Khlii* recipes made with either fresh or dried, seasoned camel meat cooked in fat, reflecting the cultural diversity of the people in southwestern Algeria. The advantages of this traditional method of preparing and preserving meat, which include drying (*Kadid*) followed by cooking the meat in fat, present an opportunity for the industrialization of this product and the promotion of camel farming in southern Algeria. Processing camel meat into *Khlii* helps minimize spoilage and extend its shelf life. This valuable know-how and cultural tradition should be preserved as a rich and diverse part of our heritage.

Key words: Camel meat, *Khlii*, Processing techniques, Survey.

INTRODUCTION

The camel population in Algeria is estimated to exceed 418,000 across 17 provinces in the southern part of the country (Benyagoub, 2019; Boudalia *et al*., 2023; Benyagoub and Bessadet, 2023), ranking it 14th among camel-breeding nations (Moula, 2023).

The shelf life of meat and meat products is often compromised by enzymatic activity and microbial growth (Bendada *et al*., 2022; Benyagoub *et al*., 2022). To achieve optimal preservation, several traditional methods have been used by our ancestors to prevent or slow microbial spoilage and inhibit autolysis (Benyagoub and Bessadet, 2023). *Khlii* is a traditional processed meat product commonly prepared in the western regions of Algeria and is also widespread in Morocco (Codex Alimentarius, 2016; Boudechicha *et al*., 2018). In the southwestern Algerian region, this dried, cooked and fatty camel meat is renowned for its long shelf life, unique flavor and nutritive value (Ferjil, 2019), making it a vital food source in arid areas where camel meat is more readily available and less expensive than meat from other animal species (Brahimi *et al*., 2020; Benyagoub and Mammeri, 2023).

The preparation method used for *Khlii* not only prevents spoilage but also enriches the meat with fat, making it a valuable energy-dense food. Despite its cultural significance, the preparation and conservation techniques of *Khlii* in Algeria are not well-documented in the literature, highlighting the need for a comprehensive survey. This study aims to fill that gap by exploring the preparation, preservation and nutritional aspects of *Khlii*, with a focus

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How to cite this article: Benyagoub, E., Kerkoub, M., Bessadet, C., Alkhudhairy, M.K., Mammeri, A., Sebei, K. and Zouhir, K.A. (2025). An Investigation Into the Traditional Processing of Camel Meat as *Khlii*: A Dried, Cooked and Fatty Meat from Southwestern Algeria. *Asian Journal of Dairy and Food Research*. **44 (Special Issue):** 62-68. doi: 10.18805/ajdfr.DRF-509.

Submitted: 07-02-2025 **Accepted:** 17-06-2025 **Online:** 01-07-2025

on its ethnographic context in southwestern Algeria. Our previous study, which investigated traditional processing and storage methods of dried and salted camel meat (*Kadid*) through a survey of 60 households in southwestern Algeria, provided valuable insights into ethno-nutritional practices aimed at enhancing shelf life and food security. *Khlii*, a related traditional product, is prepared using techniques similar to those used for *Kadid*, making this study a natural extension of our earlier research.

Camel population in bechar and beni abbes provinces (Southwestern algeria)

In the new regional division, the province of Bechar ranked 8th, with an average of approximately 25,568 camels (Fig 1), primarily of the Sahraoui breed (Fig 2).

However, following the division implemented in 2021 (JORA, No.78, 2019) (Fig 3), the camel population was reduced, with more than half of the total population now recorded in the newly established province of Beni Abbes (Southwestern Algeria), which has an average of approximately 19,544 camels. According to the Agricultural Services Department (DAS) of Bechar (MADR, 2024), the province currently produces 27,726 quintals of camel meat and aims to double this production by the year 2030.

MATERIALS AND METHODS

The quantitative ethno-nutritional survey was conducted over a nine-month period, from January to September 2024. In the context of heritage and traditional knowledge, we carried out a quantitative ethno-nutritional survey following the methodology outlined by Cibois (2014). This method involves defining research goals, selecting a representative sample, designing questionnaires, collecting and analyzing data, interpreting results and reporting findings. It integrates ethnographic elements to understand cultural influences on dietary habits. The survey included a questionnaire with five questions focused on the preparation and cultural significance of *Khlii*, a dried and fatty camel meat. A total of 100 households from each village were surveyed across two provinces in Southwestern Algeria: Bechar province (which includes Bechar city, Abadla, Taghit, Kenadsa and Beni Ounif) and Beni Abbes province.

The five questions included in the survey were as follows (own elaboration):

Q1. How is *Khlii* prepared?

Q2. Is the preparation of *Khlii* associated with a particular occasion and how has the adherence to this tradition changed over time?

Q3. What is the maximum shelf life for this type of meat and where is it typically stored?

Q4. What are the advantages of *Khlii* compared to other modern methods of preserving meat?

Q5. How is *Khlii* consumed and in what dishes is it commonly used?

For the graphical presentations, OriginLab software (2018) was used to plot histograms and the survey results are presented as mean values±SD.

RESULTS AND DISCUSSION

The results obtained from the quantitative ethno-nutritional survey were as follows:

For Q.1

Q1. How is *Khlii* prepared?

The quantitative ethno-nutritional survey revealed three traditional recipes for preparing *Khlii* from fresh boneless camel meat. Despite slight variations, all three methods share the following key steps (Fig 4).

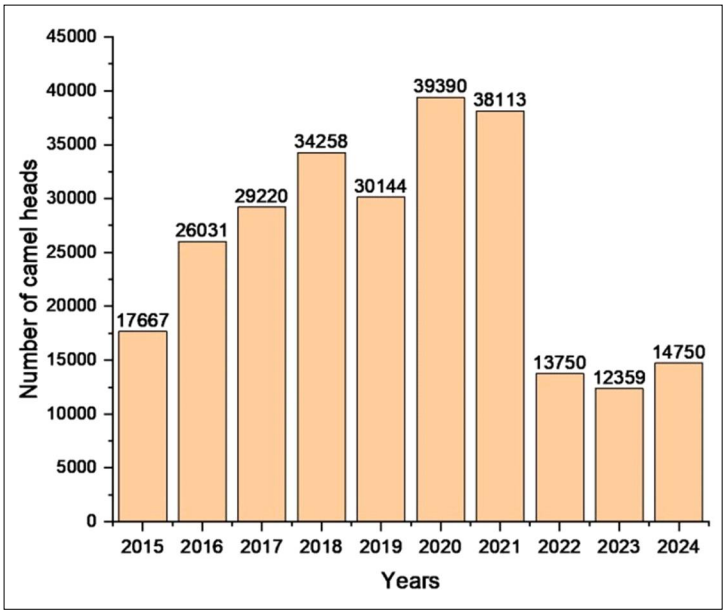


Fig 1: Camel population in Bechar province (Southwest Algeria) (Source: Benyagoub and Bessadet, 2023; MADR, 2024).

Recipe no.1

Raw material: fresh boneless camel meat.

- Preparation of dried and salted camel meat (*Kadid*) as follow:
- Cut and slice the camel meat
- Season primarily with a generous amount of salt, dried garlic and coriander. Additionally, use *Ras el Hanout*, a traditional Algerian spice blend that includes cloves, cubeb pepper, basil, cinnamon, black and white pepper, nutmeg, white ginger, cumin, galangal, bay leaf, cardamom, turmeric and dried onion. Add vinegar and olive oil or cooking oil.
- Leave the meat in a dry place, away from sunlight, for at least 48 hours, preferably at a low temperature, to allow it to absorb the spice mixture.
- Place the meat on a wire rack in a shaded area at room temperature, covering it with perforated fabric for ventilation and protection from insects. Turn the meat occasionally until fully dried (Fig 5).



Fig 2: Sahraoui camel breed from Bechar province (Algeria) (Original, 2024) - Photo by E. Benyagoub.

- Once the meat has dried, the mixture of camel hump fat and kidney fat (possibly seasoned with spices) is heated. Then, the dried meat slices (*Kadid*), which were previously immersed in water, along with cooking oil and olive oil, are added (Fig 6). The mixture is allowed to simmer on low heat for a sufficient period to ensure the meat is fully cooked, saturated with the fat and most importantly, any residual water has evaporated. Afterward, the mixture is transferred into clay or glass jars and stored at room temperature.

Recipe no.2

Raw material: fresh boneless camel meat.

- Cut the camel meat into small pieces.
- Leave the meat in a dry place, away from sunlight, for at least 48 hours, preferably at a low temperature, to allow it to absorb the spice mixture (salt, dried coriander and garlic).
- Fry the meat in oil in a pan, or cook the seasoned meat in the oven without oil. Once cooked, add the meat to the melted camel hump fat and kidney fat. Then, transfer the mixture into clay or glass jars and store it at room temperature.

Recipe no.3

Raw material: fresh boneless camel meat.

- Cut the camel meat into small pieces.
- Leave the meat in a dry place, away from sunlight, for at least 48 hours, preferably at a low temperature, to allow it to absorb the spice mixture (salt, black pepper, hot pepper, cumin and coriander).
- Heat the mixture of camel hump fat and kidney fat, then add the seasoned fresh meat.
- Cook on low heat, ensuring the meat is thoroughly cooked and well-saturated with the fat. Afterward, transfer the mixture into clay or glass jars and store it in a shaded area, away from sunlight, or in the refrigerator (cold storage).

Based on the survey data, we classified the recipes according to their frequency of use across the different regions studied. The results are presented in Fig 7.

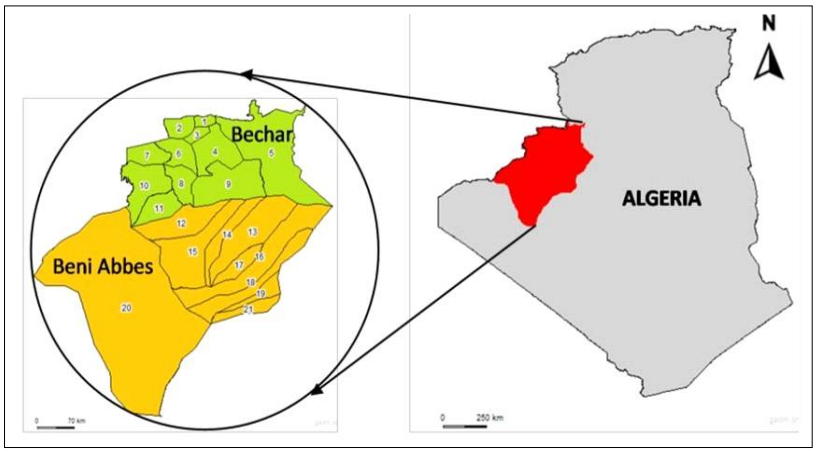


Fig 3: Geographical location of bechar and beni abbes provinces in southwestern Algeria, following the new regional division (GADM, 2024).

The results revealed that 70% of the surveyed households used the first recipe for preparing *Khlii*, while 18% opted for the second and 12% followed the third.

According to Ferjil (2019), the practice of preparing *Khlii* as a preserved meat (Codex Alimentarius, 2016) serves to extend its shelf life, enhance its flavor and improve its nutritional quality. *Khlii* is particularly rich in animal proteins and fats, containing 20.92g of protein and 57.1 g of fat per 100 g of product. From a microbiological perspective, *Khliaa Ezir*, a popular meat product in eastern Algeria made from beef and resembling the processed meat product studied, has been shown by Boudechicha *et al.* (2017) to have good microbiological quality. The preparation method allows it to be preserved for several months at room temperature. The high nutritional and microbiological qualities of *Kadid*, a major constituent of *Khlii*, have been confirmed in previous studies (Benyagoub *et al*., 2022; Benyagoub and Mammeri, 2023; Benyagoub *et al*., 2024; Zioud *et al*., 2024). The fat from the Sahraoui camel breed appears to have a higher content of unsaturated fatty acids, primarily oleic acid. However, palmitic acid, stearic acid and myristic acid, which are saturated fatty acids, are also considered important sources of fatty acids (Sbihi *et al*., 2013; Sahraoui *et al*., 2015). Therefore, the hump fat can be regarded as an important source of unsaturated fatty acids, which are known for their various health benefits, including improving heart health, reducing inflammation, providing antioxidant properties and energy (Fahmy, 2015; Al-Shafei *et al*., 2022).

Additionally, it is also important to note that the spices commonly used to season meat and fat in cuisines worldwide are renowned for their extraordinary biological activities, as extensively documented in various studies (Razni *et al*., 2019; Draoui *et al*., 2020; Benyagoub, 2022; Benyagoub and Bessadet, 2023; Mandal *et al*., 2023; Benyagoub, 2023a, 2023b). Among these, salt reduces the water activity of foods, creating an environment that is inhospitable to microorganisms (Bozoglu, 2016; Benlacheheb *et al*., 2019; Benyagoub and Mammeri, 2023).

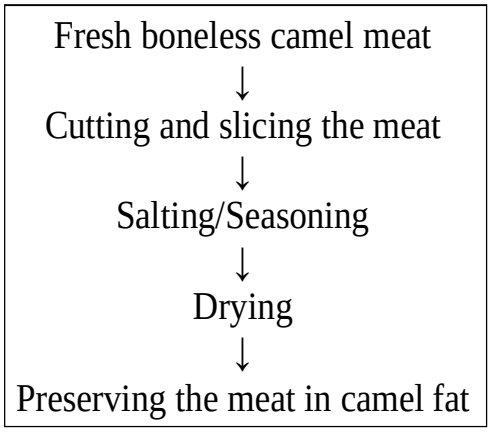


Fig 4: Traditional steps in *Khlii* preparation (Own elaboration).



Fig 5: Dired and salted camel meat (*Kadid*) (Original, 2024) - Photo by E. Benyagoub.



(A) (B) (C)

(A, B): Camel hump fat, (C): Mixture of *Kadid* and melted camel hump fat and kidney fat.

Fig 6: Mixture of *Kadid* and camel hump fat (Original, 2024) - Photo by *E. Benyagoub*.

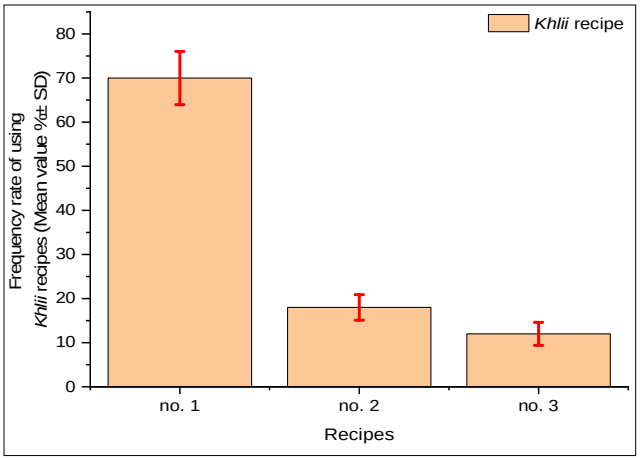


Fig 7: Frequency of recipe usage in *Khlii* preparation (Own elaboration).



Fig 8: *Khlii* product packaged in clay and glass jars (Original, 2024) - Photo by E. Benyagoub.

For Q.2

Q2. Is the preparation of *Khlii* associated with a particular occasion and how has the adherence to this tradition changed over time?

Based on the present study results, nearly all of the households under surveillance indicated that the preparation of *Khlii* and *Kadid* is linked to religious events of the Muslim community, such as the Feast of Sacrifice (*Eid al-Adha*), where meat is available in large quantities. These products are also prepared for pilgrims traveling to Mecca (for *Hajj* and *Umrah*), *Ashura* (the celebration on the 10th day of Muharram, the first month of the Islamic New Year), *Mawlid Nabawi* (the celebration of the Prophet Mohammed's birth) and January 12, the Amazigh New Year (*Yennayer*). However, *Kadid* is prepared more frequently than *Khlii*, which is less commonly made.

Moreover, the survey revealed that the older generation is more dedicated to preparing these products than the current generation. This is not only due to the lack of modern storage facilities in the past, but also because of their superior nutritive value and exceptional sensory qualities compared to fresh meat or meat stored using modern storage methods.

For Q3

Q3. What is the maximum shelf life for this type of meat and where is it typically stored?

According to the survey results, *Khlii* prepared from dried and salted camel meat (recipe no.1) and packaged in clay or glass jars can be preserved for up to 3 years at ambient temperature, provided it is kept away from sunlight and humidity (Fig 8). In contrast, *Khlii* made from fresh camel meat (recipe no. 3) is less durable and requires storage in a dry, shaded area or even in cool conditions.



(A): *Khlii* with fried eggs, **(B):** *Berkoukes* or *Mardoud* with *Khlii* and vegetables, **(C):** *Mkhala'a* with *Khlii.*

Fig 9: Traditional dishes based on *Khlii* (Original, 2024) - Photo by E. Benyagoub.

For Q.4

Q4. What are the advantages of *Khlii* compared to other modern methods of preserving meat?

The responses regarding the significance of *Khlii* compared to meat preserved using modern methods (such as freezing or chilling) highlighted the following advantages:

- *Khlii* offers high nutritional value and exceptional sensory qualities.
- Due to its preparation with dried and salted camel meat (*Kadid*), *Khlii* has a longer shelf life than other products in the same category.

For Q.5

Q5. How is *khlii* consumed and in what dishes is it commonly used?

According to the survey results, *Khlii* can be consumed on its own or served with fried eggs. It is also widely used as an ingredient in various traditional dishes (Fig 9), such as *couscous*, *berkoukes* (also known as *Mardoud,* made from durum wheat semolina) with fresh and dried vegetables, vegetable soup with *Khlii*, *Mkhala'a* (an Algerian stuffed bread) and other traditional preparations.

CONCLUSION

The study demonstrates that the traditional method of preserving camel meat is highly effective, particularly in enhancing both its nutritive value and sensory attributes, as seen in *Khlii* made from *Kadid*. Moreover, the research underscores the rich cultural and ethnographic knowledge embedded in the preparation of this product by the people of the Sahara. Expanding the production and distribution of *Kadid* and *Khlii*, could not only help preserve this cultural heritage but also contribute significantly to the development of the livestock-processing sector. The provinces under study possess the necessary resources and have great potential to make this vision a reality.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to all those who participated in the ethno-nutritional survey for their invaluable support. No financial support was received for this study.

Conflict of interest

The authors declare that they have no conflicts of interest.

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