

# A survey on dried and salted camel meat (Kadid): A traditional meat by-product of southern Algeria

## Abstract

Algeria ranks 14th among camel-breeding countries in the world, with more than 417,322 camels, according to data from the Agricultural Services Department of Bechar (DSA). However, camel meat represents just 3% of red meat production in Algeria. Camel meat is the most protein-rich animal product consumed in arid regions. To preserve this perishable product, the inhabitants of southern Algeria prepare dried and salted camel meat (Kadid). This practice of drying and salting camel meat could safely and successfully extend the product's shelf life for several months at room temperature as well as improve its nutritional and sensory qualities, thereby helping to ease food insecurity. This study investigates the preparation and storage techniques used in the production of Kadid. A quantitative ethno-nutritional survey was conducted on a sample of 60 households from different regions of southwestern Algeria to investigate traditional practices used in the preparation of dried and salted camel meat. The survey revealed several recipes for Kadid based on adding salt, spices and drying in the open air, which reflects the level of cultural diversity of the inhabitants of southern Algeria. The benefits of this ancient preservation method, combined with an increasing consumer demand for products that preserve health and the environment, raises the potential for a camel meat drying industry and the promotion of camel breeding. This know-how and tradition should therefore be preserved as a rich and diversified cultural heritage.

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## Introduction

The camel population is estimated to be more than 35 million heads worldwide <sup>[1]</sup> – a treasure that could be a potential driver in the livestock economy. Camel meat is a protein-rich, low-fat food product that contains all essential amino acids and is rich in many other nutrients. As such, it meets the strong trend towards foods with multiple health claims <sup>[2, 3, 4]</sup>.

However, the shelf life of meat and meat products is limited by enzymatic and microbial deterioration <sup>[5-7]</sup>. To extend the shelf life of meat and meat products, traditional preservation methods using sun-drying and salting techniques have been used to prevent or delay microbial spoilage, avoiding autolysis. Dry products made by different processes (drying in the open air or by industrial drying techniques, namely dryers powered by solar energy or other energy sources) remain of interest as they do not require a refrigeration system during distribution and storage. The drying technology is mostly based on preserving the properties of the meat by reducing water activity <sup>[5, 8, 9]</sup>.

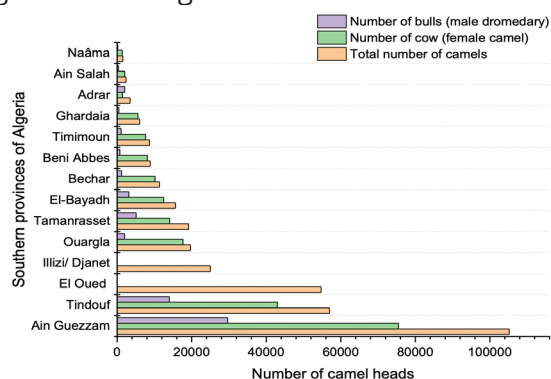
Several research studies have focused on fresh camel meat. However, the current study investigates methods of preparation in the production of dried and salted camel meat (Kadid), also known as El Guedid. Through a quantitative ethno-nutritional survey addressed to several households, we assessed this important food preserving tradition of southern Algeria. To the best of our knowledge, this is the first time that camel meat by-products and traditional food preservation practices in the southern regions of Algeria have been highlighted to the level of looking at recipes and storage conditions.

### Distribution of camels in Southern Algeria

The camel population in Algeria was estimated to be about 417,322 in 2020, including

10 camel breeds distributed across 17 provinces, of which 83% is confined to eight Saharan provinces: Ouargla, Ghardaia, El Oued, Tamanrasset, Illizi, Adrar, Tindouf and Bechar <sup>[10-13]</sup>. Algeria ranked 14th among camel-breeding countries <sup>[14]</sup>.

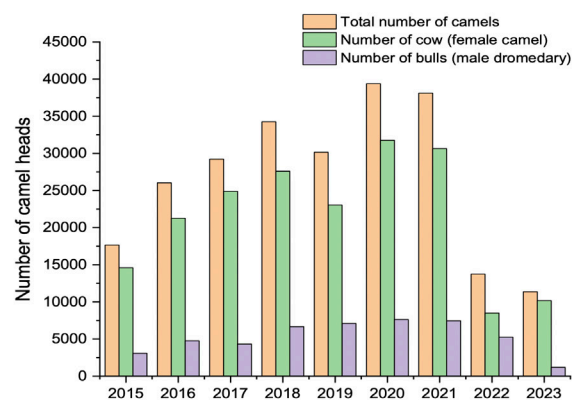
Given the absence of official statistics on camels, it was necessary to collect official data from the Agricultural Services Department in each province. **Fig. 1** below shows the number and distribution of camel herds in southern Algeria according to the new territorial division.



**Figure 1:** Number of camels in the Southern provinces of Algeria (2022) <sup>[15-17]</sup> (Own elaboration)

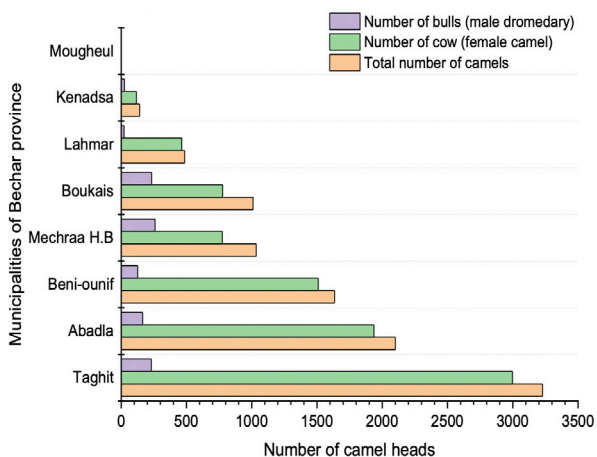
Note: No recent official data is available on the number of male dromedary (bulls) and female camel (cow) in El Oued, Illizi, Djanet provinces, nor the total number of camels in Biskra, and Djelfa provinces.

After the implementation of the new territorial division in 2021 <sup>[18]</sup>, the following provinces had the largest number of camels in southern Algeria: Ain Guezzam, Tindouf, El Oued, Illizi/Djanet, Ouargla and Tamanrasset. The province of Bechar ranked 8th in this new distribution, with an average of 26,660 camel heads (**Fig. 2**).



**Figure 2:** Number of camels in the province of Bechar (Southwest of Algeria) (2015-2023) <sup>[15]</sup> (Own elaboration)

Taghit, Abadla, and Beni-Ounif being the municipalities of Bechar province, have the largest number of camels compared to the other municipalities, as shown in Fig. 3 below.

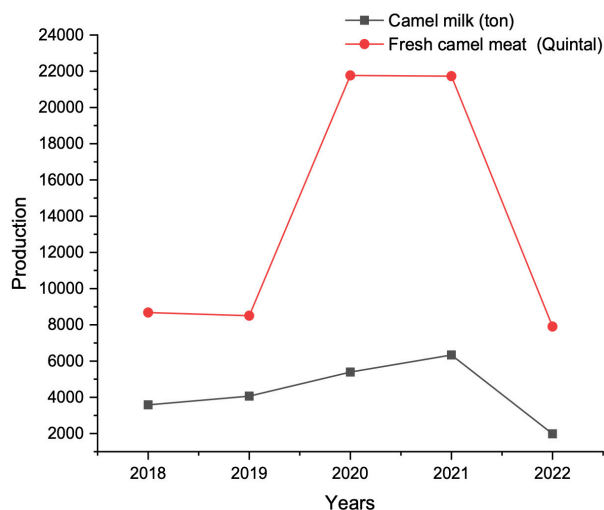


**Figure 3:** Number of camels in the municipalities of the province of Bechar (2023)<sup>[15]</sup> (Own elaboration)  
**Machraa H.B** = Municipality of Mechraa Houari Boumediene (Bechar province).

### Milk and camel meat production

The exploitation of the camel breeding sector is not limited to meat, it also includes milk and its derivatives<sup>[19]</sup>. The hair and skin of the dromedary also have a very good market value<sup>[20, 21]</sup>. Camel milk represents the complete food of the indigenous populations of the desert. It has a low-fat content, is rich in vitamin C and linoleic acid and has a light laxative effect; it contains less lactose than cow's milk, making it easy to digest and more tolerable for people with lactose sensitivity<sup>[6, 13, 22, 23]</sup>. Camel meat represents 3% of red meat production in Algeria. Although camel meat consumption is low at the national level, it is important in the Saharan regions, where camels represent one third of the animals slaughtered in southern Algeria<sup>[14, 24]</sup>. It is possible that camel meat production is underestimated due to the large number of camels that are slaughtered outside official circuits, such figures would consequently not be included in the official statistics<sup>[2]</sup>. In Algeria, a total of 15,080 tons of camel milk was produced in 2020<sup>[13]</sup>.

Fig. 4 shows the evolution of camel meat and camel milk production in Bechar province.



**Figure 4:** Evolution of camel meat and camel milk production in the province of Bechar (2018-2022)<sup>[15]</sup> (Own elaboration)

Figure 4 above shows an increase in the production of milk and camel meat in Bechar until 2021, after which the production rate decreased due to the new regional division, where more than half of the production was recorded for the new province of Beni Abbes. The goal set by the Agricultural Services Department of Bechar province in 2023 is to achieve a production exceeding 100,000 quintals of camel meat and to increase camel milk production to 2,700 tons. This is a legitimate objective as several factors favourable to camel breeding, such as the country's climatic diversity, culture/religion, economic factors and genetic diversity, can help improve red meat and milk production in Algeria<sup>[25]</sup>.

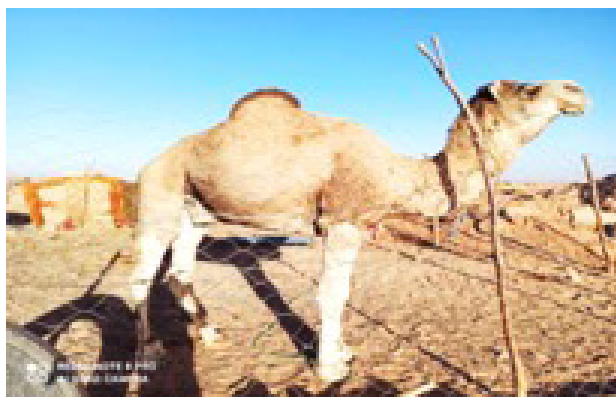
## Material and methods

In the context of heritage and know-how, we conducted a quantitative ethno-nutritional survey according to the method described by Cibois<sup>[26]</sup>, in which a survey sheet consisting of eight questions about the preparation and importance of dried and salted camel meat was

proposed to a representative sample of 60 households from several regions in southwestern Algeria, namely: Bechar city, Abadla, Timou-di, Igli, Mazer, Tindouf city, and Oued Khoudir.

The eight questions asked in this survey were as follows (own elaboration):

- Q1.** How is dried and salted camel meat prepared?
- Q2.** Does the animal species affect the duration and drying process of the meat, and what is the preferred part for drying?
- Q3.** Is the preparation of dried and salted camel meat linked to a particular occasion, and to what extent do people adhere to it now compared to in the past?
- Q4.** How do you dry fresh salted camel meat?
- Q5.** How long does it take to dry the meat?
- Q6.** What is the maximum shelf life for this type of meat, and where is it done?
- Q7.** What is the benefit of dried and salted camel meat compared to storing meat by other means (frozen or chilled)?



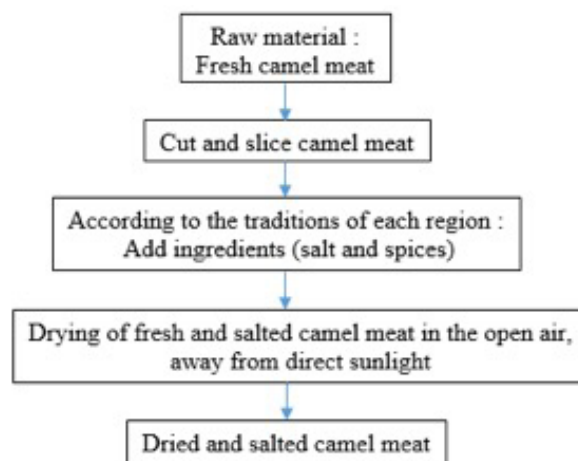
**Figure 5:** Sahraoui camel breed (*Camelus dromedarius*) (Ph. E. Benyagoub)

**Q8.** Which areas are known to prepare this type of meat and is its preparation linked to specific tribes?

## Results and discussion

### Ethno-nutritional survey results

Given that the western part of Algeria is known for its important distribution of the Rguibi and Sahraoui camel breeds <sup>[27]</sup> (Fig. 5), lean meat as a raw material from 6–8 month-old camels is generally used in the preparation of dried and salted camel meat. In Algeria, it is prepared by adding salt and spices to thinly sliced pieces of meat, which are then hung on a string in the open air until completely dry. The dried meat is then stored at room temperature <sup>[28, 29]</sup> (Fig. 6 and 7).



**Figure 6:** Diagram of the preparation of dried and salted camel meat (Kadid) (Own elaboration)



**(a)** Fresh camel meat, salt and spices

**(b)** Drying of fresh, salted and flavoured camel meat in the open air

**(c)** Dried meat, salted, and flavoured with spices

**Figure 7:** Steps for preparing dried and salted camel meat (Ph. E. Benyagoub)

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

#### For Q.1 and Q.4:

**Q1.** How is dried and salted camel meat prepared?

**Q4.** How do you dry fresh salted camel meat?

The survey data enabled us to identify four recipes for preparing dried and salted camel meat:

#### Recipe 1

Raw material: fresh camel meat

- Cut and slice camel meat.
- Season with a mixture of spices (known locally as Ras el hanout). This can either be bought (which includes a few ingredients), or a rich homemade one consisting of cloves, cubeb (tailed pepper), basil, cinnamon, black pepper, nutmeg, white pepper, white ginger, cumin, galangal (*Alpinia*), bay leaf (*Laurus nobilis* L. leaves), cardamom (*Elettaria cardamomum*), turmeric, coriander, dried garlic peels, dried onion peels, dried onion, and salts. In some cases, thyme, rosemary, garlic and *Anacyclus valentinus* are added to the camel meat.
- Leave the meat in the refrigerator for 1-3 days to absorb the spice mixture.
- Spread the meat out on a wire rack in a shaded place at room temperature and cover the meat with a piece of perforated fabric to ensure good ventilation and to protect the meat from insects. Turn the meat from time to time until it dries completely.
- Place the dried and salted camel meat in a canvas bag and store in a dry place at room temperature.

#### Recipe 2

Raw material: fresh camel meat.

- Cut and slice camel meat.
- Season with salts; pepper; dried onions; and dried coriander.
- Spread the meat out on a wire rack in a shaded place at room temperature and cover with perforated fabric until completely dry.
- Place the dried and salted camel meat in a canvas bag and store in a dry place at room temperature.

#### Recipe 3

Raw material: fresh camel meat.

- Cut and slice camel meat into thin layers.

- Season with salt.

- Spread the meat out on a wire rack in a shaded place at room temperature and cover the meat with perforated fabric until completely dry.

- Place the dried and salted camel meat in a canvas bag and store in a dry place at room temperature.

#### Recipe 4

Raw material: fresh camel meat.

- Cut and slice camel meat into thin layers.

- Season with salt.

- Spread the meat out on a wire rack in a shaded place at room temperature and cover with perforated fabric until completely dry.

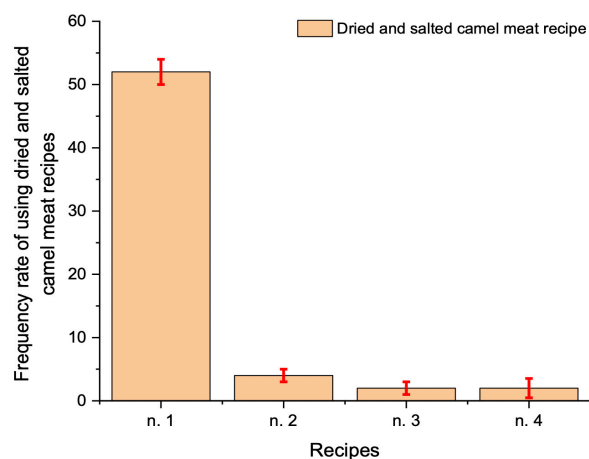
- Grind the dried and salted camel meat in a mortar.

- Add Dhane butter to the ground camel meat.

- Place dried and salted camel meat into plastic storage boxes and store in the refrigerator.

It is worth noting that before using dried and salted camel meat in cooking, it must be immersed in water and left for more than six hours to remove excess salt.

Through the different regions surveyed, we were able to classify the recipes according to their frequency of use. The results obtained are shown in Fig. 8.



**Figure 8:** Frequency rate of recipes used in the preparation of dried and salted camel meat

The obtained results showed that 86.7% (52±2.0 out of 60) of the surveyed households



followed the first recipe for preparing dried and salted camel meat. A rate of 6.7% ( $4 \pm 1.0$  out of 60), 3.3% ( $2 \pm 1.0$  out of 60) and 3.3% ( $2 \pm 1.53$  out of 60) was obtained for the second, third and fourth recipes, respectively.

Algeria and the Maghreb countries use spice mixtures (Ras el hanout) in several food preparations. This looks like Indian Masala and is a mixture of 20–70 spices consisting mainly of ginger, coriander, cardamom, cumin, cinnamon, turmeric, black pepper, fennel, garlic, onion, fenugreek, cubeb, clove, mustard<sup>[30]</sup>.

The spices used are not simple aromatic agents but extraordinary plants with multiple virtues. They contain a complex biochemistry, bringing together several bioactive compounds that have bactericidal, antiseptic, anti-inflammatory, anti-infective, antioxidant, and other biological properties<sup>[31, 32]</sup>.

Given their medicinal and preservative properties, spices are included in cuisines around the world and are consistently linked to health<sup>[33]</sup>.

It should be noted that salting extends the shelf life of food. Salts increase osmotic pressure by absorbing a large amount of water and are used to reduce water activity of foods. The drying procedure, which reduces the moisture content, combined with the acidic medium of dried and salted camel meat (pH values ranging from 5.14 to 5.59<sup>[29]</sup>), creates an environment that makes it difficult for microorganisms to survive<sup>[5, 8, 9, 34]</sup>.

The study conducted by Chaouch *et al*<sup>[35]</sup> on drying camel meat without salting using a solar dryer confirms the effectiveness of this technology in providing consumers with a guaranteed dry product that meets hygiene standards and has high nutritional quality.

#### For Q.2:

**Q2.** Does the animal species affect the duration and drying process of the meat, and what is the preferred part for drying?

More than 90% of the families surveyed report-

ed that the animal species influences the drying process of the meat, which is confirmed by the difference in drying time. The rest considered it a marginal factor. Since the price of camel meat is less expensive compared to other red meats, most families buy it and it can be used in the preparation of dried meat, which allows low-income families in particular to have access to red meat at a lower price<sup>[2, 36]</sup>.

The leanest parts of camel meat are the most suitable for drying and salting. Some families prepare it with meat that contains bones (bone-in meat) (**Fig. 9**), but only after steam cooking it as the bones can be a source of microbial spoilage.



**Figure 9:** Dried and salted camel meat including bones (Ph. E. Benyagoub)

#### For Q.3:

**Q3.** Is the preparation of dried and salted camel meat linked to a particular occasion, and to what extent do people adhere to it now compared to in the past?

According to the survey results, almost all the households surveyed reported that preparing dried meat according to local customs and traditions is linked to religious occasions, such as the feast of sacrifice (Eid al-Adha for Muslims). The survey showed that the older generation is more committed to preparing this product than the current generation, not only because of the lack of modern storage facilities in the past but also because of its nutritional and exceptional sensory quality compared to fresh meat and meat stored in the freezer or refrigerator.

#### For Q.5:

**Q5.** How long does it take to dry the meat?

According to the survey results, the time re-

quired to achieve fully dried meat ranges from 7 to 15 days depending on the season, with the majority of respondents claiming that it does not exceed two weeks.

**For Q.6:**

**Q6.** What is the maximum shelf life for this type of meat, and where is it done?

According to the survey results, dried meat can be kept for a few months to a year or longer, depending on the storage conditions (freezer/refrigerator). Usually, the dried and salted camel meat is placed in a canvas bag and stored in a dry place (away from moisture) at room temperature.

**For Q.7:**

**Q7.** What is the benefit of dried and salted camel meat compared to storing meat by other means (frozen or chilled)?

The answers obtained about the importance of dried and salted camel meat compared to meat stored by other means (frozen or chilled meat) were as follows:

- Due to its high nutritional value and exceptional sensory quality, dried meat is preferred over fresh, chilled, or frozen meat.
- Dried and salted camel meat can be stored under conditions that do not require modern means of preservation.
- The drying process reduces the weight and volume of fresh meat.
- Dried meat has a long shelf life compared to other products in the same range.
- Dried and salted camel meat is a healthy product with many medicinal benefits for human health and is used in the preparation of delicious dishes (Fig. 10).



**Figure 10:** Traditional dish of dried and salted camel meat with fries (Ph. E. Benyagoub)

**For Q.8:**

**Q8.** Which areas are known to prepare this type of meat and is its preparation linked to specific tribes?

The preparation of dried meat is popular among inhabitants of desert regions, especially by indigenous people, because camel meat is an ethnic food consumed in arid regions<sup>[37]</sup>.

## Conclusion

Since ancient times, people have sought out ways to preserve food. In the absence of research on the preparation, preservation, and consumer preference, the current study looked at different recipes for the preparation of dried and salted camel meat through a quantitative ethno-nutritional survey conducted in different regions of Southwestern Algeria. The data collected confirms that this traditional technique can preserve camel meat and improve its nutritional and sensory qualities. Consumers can enjoy the wonderful taste of dried meat, salted and flavoured with spices and aromatic herbs from desert regions. A sensory analysis study of this product is therefore recommended.

Our study also highlights the traditional and ethnic knowledge involved in the preparation of this product among the people of the Sahara. The production and marketing of this product on an industrial scale would not only preserve and enhance this cultural heritage, it would also contribute to the development of the agricultural and agri-food sectors.

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## Conflict of interests

The authors declare they have no conflict of interest.

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