

## Traditional Fermented Butter *Smen/Dhan*: Current Knowledge, Production and Consumption in Algeria

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### Abstract

Algerian *Smen/Dhan* is an ethnic dairy product which is a traditional fermented butter made from whole raw milk by empirical methods. This product constitutes a significant part of the Algerian diet and represents a gastronomic heritage that needs to be preserved and protected. The aim of the present study was to investigate the place and use of this product in the Algerian culture as well as to identify the traditional methods used for its preparation. A survey was conducted on 880 households in the South and East of Algeria. The results revealed that 96.47% of the surveyed population knew what *Smen/Dhan* was, 75.22% consumed it and 47.61% prepared it at home. Concerning the production method, raw milk (cow, goat and/or sheep milk) is spontaneously fermented until coagulation. Then, the obtained coagulum (*Raib*) is churned with different tools to obtain the butter used for *Smen/Dhan* preparation. Then, two different preparation modes are used depending on the surveyed regions. Households from Batna, Khenchela and Setif proceed directly with butter salting while in the Biskra, Jijel, El Oued and Ouargla regions, a different process is used which first involves a heat-treatment of the butter followed by the addition of one or more ingredients. After packing in a traditional ceramic container (*Ezzir*) and other containers, a maturation step is applied with a long duration varying from one month to several years. This product is consumed as an additive to enhance the taste and aroma of some traditional dishes (*couscous*/other) and is also used in traditional medicine.

**Keywords:** *Smen/Dhan*, Algeria, survey, traditional preparation, consumption

### 1. Introduction

Nowadays, there is an increasing interest for foods that are linked with specific places or territories. Indeed, consumers are more and more attracted to local foods with a traditional character or image, and such local foods are often perceived as to be of higher quality, freshness, more sustainable and contributing to support the local economy (Pieniak, Verbeke, Vanhonacker, Guerrero, & Hersleth, 2009). Among traditional foods, fermented foods have been consumed since antiquity and still constitute a main food source in the population's diet throughout the world. They also represent an important part of human dietary and culinary culture and most of these products are produced at household level or in small enterprise using spontaneous fermentation (El Sheikha, & Hu, 2018; Johansen, Owusu-Kwarteng, Parkouda, Paonou, & Jesperen, 2020).

Among fermented foods, dairy products are very popular due to their simple formulation. Milk as a raw material is well suited to support the growth of microorganisms because it is rich in carbon and nitrogen sources as well as micronutrients. Indeed, the ability to maintain it in a fresh state is limited, especially in warm environments and in the absence of a cold chain (Hutkins, 2006; Puniya, 2015), as these latter conditions will rapidly lead to its spoilage; that is the reason why different methods have been developed to allow its preservation for longer

periods. Among these methods, milk fermentation is one of the most ancient practices to ensure milk preservation as it guarantees the availability of safe and nutritious foods throughout the year, and prevents the risk of shortage of dairy products to consumers (Abd-El Salam, & Benkerroum, 2006).

Many types of fermented milk products exist throughout the world. Their organoleptic properties depend on different factors such as the animal species from which milk it is obtained, milk pre-treatment, conditions of fermentation and associated microbiota, and subsequent processing (Zamfir et al., 2006).

In Algeria, a large variety of dairy products are prepared with naturally fermented milk. They have played and still play a major role in people's diet, especially those from rural areas. Among them, *Lben*, *Raib*, *Zebda*, *Dhan* or *Smen* and *Jben* are the most common and are mostly marketed throughout informal circuits (Idoui, Benhamada, & Leghouchi, 2010).

*Smen* or *Dhan* is a traditional fermented butter which is made from raw milk, cream or butter originating from several animal species (Rajorhia, 1993; Guessas, Adjoudj, Hadadji, & Kihal, 2012; Iradukunda, Aida, Ouafi, Barkouch, & Boussaid, 2018). Its fermentation can last from a few months to several years, depending on the moisture, humidity and room temperature of the storage place (Kacem, & Karam, 2006). It is produced in many countries around the world, in Asia, the Middle-East and Africa (Afsaneh, Hosseinpour, & Mina, 2016) and its name and preparation methods differ from one region to another. In Algeria, it is known as *Dhan* or *Smen* (Bensalah, Labtar, Delorme, & Renault, 2011; Guessas, Adjoudj, Hadadji, & Kihal, 2012), *Smen* in Morocco (Tantaoui-Elaraki, & El Marrakchi, 1987; Benkerroum, & Tamime, 2004; Faid et al., 1993; Sakili, & Isoual, 2003; Iradukunda, Ouafi, Barkouch, & Boussaid, 2018), *Ghee* in India and Ethiopia (Dhurvey, Kawtikwar, & Sakarkar, 2012; Mortensen, 2016; Alganesh, & Yetenayet, 2017), *Samna* in Egypt and *Samin* in Sudan (Sserunjogi, Abrahamsen, & Narvhus, 1998).

This fermented butter is mostly used as a flavouring ingredient to improve the taste and aroma of many traditional dishes (Iradukunda, Aida, Ouafi, Barkouch, & Boussaid, 2018). It is also used in traditional medicine for reducing pain associated with the cold feeling that accompanies coughs, rheumatism and bone trauma (Sakili, & Isoual, 2003).

In Algeria, *Smen/Dhan* represents an ethnic heritage. It is manufactured according to an artisanal process, which is far from being perfectly known. A better knowledge of this product presents a scientific interest. In this context, the aim of the present study was thus to investigate the use and consumption of this traditional product as well as to identify how it is manufactured and stored in the Northeastern and Southeastern parts of Algeria.

## 2. Material and Methods

### 2.1 Survey Study

A field survey was conducted between May 2017 and March 2018 in different regions of the Southeast (Biskra, El Oued and Ouargla) and the Northeast of Algeria (Batna, Khenchela, Jijel and Setif) as shown in **Figure 1**. These regions were chosen based on a preliminary survey showing that *Smen/Dhan* preparation and consumption is quite common in these areas.

Families were asked about their practices and utilization of *Smen/Dhan* and the overall sample surveyed consisted of 880 households distributed in 71 towns from and nearby different localities, i.e., Batna, Biskra, El Oued, Jijel, Khenchela, Ouargla and Setif. The survey was mostly directed towards elder people especially women, dairy farmers, and farmers who are used to prepare *Smen/Dhan* and possibly market it in informal circuits in order to have a view as precise as possible on the practices associated with this traditional product.

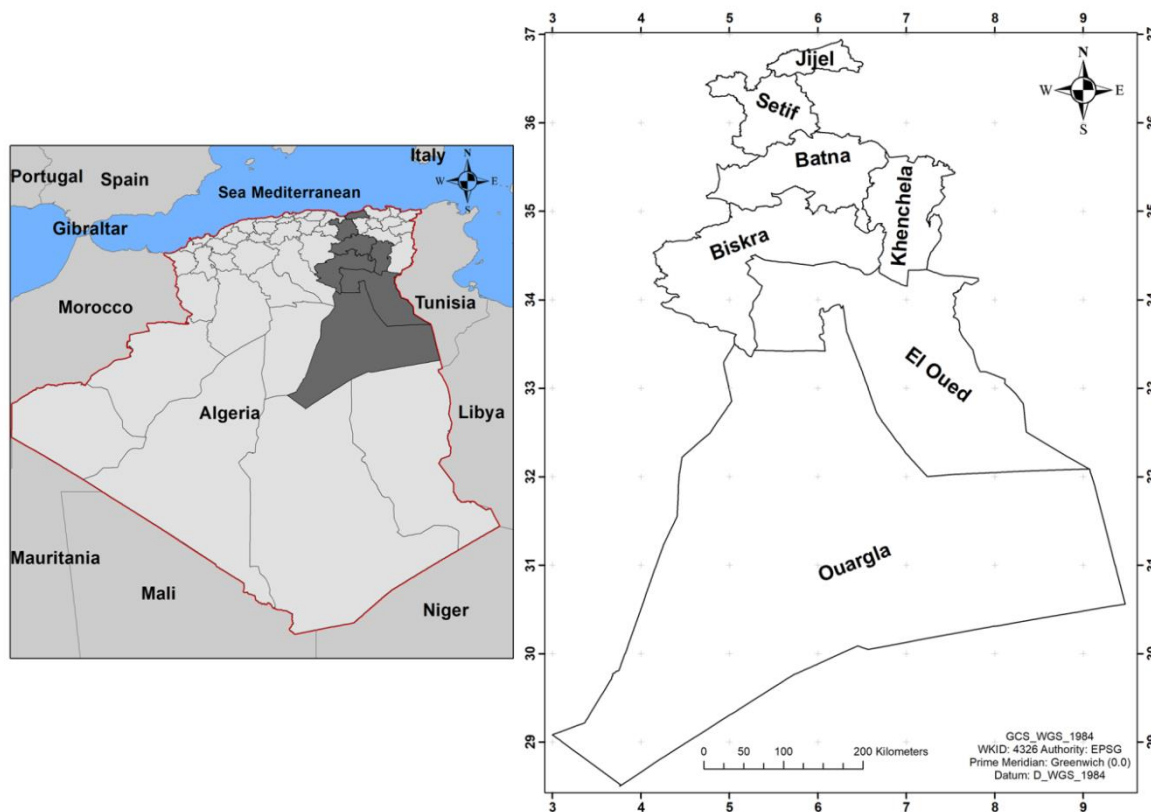


Figure 1. Detailed maps highlighting the surveyed regions of Algeria

## 2.2 Data Collection

Data were collected using a questionnaire and completed by face-to-face interviews. Before the beginning of the survey, the questionnaire framework and purpose was explained followed by the interview, which lasted about 15 to 20 minutes. Questions were read and if necessary, explained before collection of the answers.

## 2.3 General Content of the Questionnaire

The survey questionnaire contained forty-eight questions (**supplementary file 1**). It was divided into five parts. The first part of the questionnaire contained questions about the identity of the interviewed person (gender, age, education degree, professional activity and residence). The second part dealt with the profile of the business/enterprise where the product was produced. The third part allowed to gather information on the fermented product itself, i.e. the place of the fermented product in the local culture, its local name, the geographical production area, the mode and period of consumption as well as the product use. The fourth part included questions about the product organoleptic properties (texture, color, smell, taste...) and the fifth part concerned the description of the production process, the raw materials used and their origins, as well as the equipment used.

## 2.4 Statistical Analysis

Statistical analysis was performed using XL STAT, version 2014. The results of this study are presented using descriptive statistics and expressed as percentage of response to each question in the survey. ANOVA test was used to analyze the variance between modalities of each surveyed variables ( $p < 0.05$ ). Correlation analysis was used to explore the relationship between the different parameters.

## 3. Results and Discussion

### 3.1 Characteristics of the Studied Population and Link with Smen/Dhan Preparation

Our study group consisted of 880 households and the interviewed persons were aged between 19 and 99 years old. As shown in **Table 1**, the surveyed population was overwhelmingly composed of adults over 38 years of age. The average and median age of the surveyed population was 49.47 and 50 years old, respectively. Over 55% of

respondents lived in urban areas.

After subdividing the surveyed persons into 20 year age-groups, we did not observe any relationship between age groups and preparation of *Smen/Dhan* in households, which indicates that *Smen/Dhan* preparation was performed indistinctively by all age groups. This result may be explained by the fact that *Smen/Dhan* preparation relies on a simple method of preparation in contrast to other traditional foods, such as couscous, which need much more effort and experience in their preparation. As an example, (Bekhouché, Merabti, & Bailly, 2013) reported that couscous *lemzeiet* was mainly prepared by women that are aged between 40 and 60 years. On the other hand, we did not find any relationship between professional activity and *Smen/Dhan* preparation, this can be explained by the fact that the product preparation does not require a great effort, and its preparation is quick and easy.

The percentage of the surveyed females was higher than that of males, as 84.54% of the interviewed persons were females while only 15.45% were males. This observation is not surprising given the women's role in the manufacture of traditional products, including *Smen/Dhan*, and the fact that *Smen/Dhan* preparation is an activity exclusively realized by women. For all these women, the expertise or the art of *Smen/Dhan* making was passed on by their mothers, grandmothers or mothers-in-law as previously reported by Gagaoua and Boudchicha (2018) for ethnic meat products of the North African and Mediterranean countries. While keeping and preserving the same eating habits, the *Smen/Dhan* making process was considered by the interviewed persons as a precious legacy transmitted from one generation to another. In contrast, men play a relatively insignificant role in the *Smen/Dhan* preparation but are involved in selling tasks.

Table 1. Socio-demographic structure of the 880 surveyed persons

Surveyed population	Number	Percentage (%)
<b>Age (years)</b>		
19-38	202	22.95
38-58	424	48.18
59-78	226	25.68
79-99	28	3.18
<b>Gender</b>		
Female	744	84.54
Male	136	15.45
<b>Region</b>		
Urban	489	55.56
Rural	391	44.43
<b>Professional Activity</b>		
Housewives	701	79.65
Students	29	3.29
Civil servant	133	14.77
Retired	17	1.93

### 3.2 Place of the Product in Local Culture

*Smen/Dhan* is a traditional product very appreciated by the Algerian population. This product is part of the eating habits in different regions of Algeria. The results revealed that 96.47% of the surveyed population knew what *Smen/Dhan* was because of its importance in the Algerian kitchen (**Table 2**). Even if the product was not prepared by all Algerian families (47.6% of households), its recognition by most families confirmed that this product is a traditional product of Algeria, which knowledge and utilization are transmitted from one generation to another. It is worth noting that the name used for this product, i.e. *Smen* or *Dhan* varied according to the surveyed region. Indeed, we found out that the majority of respondents used the name *Dhan* in all the surveyed regions (Batna, Biskra, El Oued, Khenchela, Setif, Ouargla), except for Jijel in which the name *Smen* was used.

*Smen/Dhan* is widely used by Algerian families. Indeed, 75.22% of the surveyed population consumed it on a regular basis. The interviewed persons also indicated that they consumed *Smen/Dhan* for its taste, i.e., as flavouring agent in traditional dishes, but also for the health benefits associated with its consumption.

Concerning people that did not prepare themselves *Smen/Dhan*, the purchase of *Smen/Dhan* was done in formal circuits if available on the market or informally through other households producing their own product. We noted that the price of one Kg of *Dhan* was 2000 DA in southern areas of Algeria (Biskra, El Oued, Ouargla) while it

was 800 DA in Eastern areas. This price difference can be explained by the nature of the raw material used for its preparation in these two areas. Indeed, *Smen/Dhan* is prepared with goat's milk in the South and cow's milk in the East and goat's milk is more expensive than cow's milk.

Table 2. Distribution of the surveyed population according to knowledge, manufacture, consumption and purchase of *Smen/Dhan* in different regions of Algeria

Regions ( <i>Wilayas</i> )	Number of respondents	Knowledge (n)	Preparation (n)	Purchase (n)	Consumption (n)
Batna	100	100	46	38	77
Biskra	100	100	21	50	67
El Oued	100	100	53	42	73
Jijel	100	69	42	21	68
Khenchela	276	276	158	114	221
S áif	104	104	48	33	79
Ouargla	100	100	51	31	77
Total	880	849	419	329	662
%	100	96.47	47.61	37.38	75.22

### 3.3 Traditional Preparation Steps of *Smen/Dhan*

Based on the survey results, we could define the different steps used for the preparation of traditional “*Smen/Dhan*” (Figure 2, 3). These steps are described below.

#### 3.3.1 Raw Material Used

Raw milk of different animal species can be used in order to make butter, which is then further processed to *Smen/Dhan*. Based on the survey results, it was found that, cow, goat and sheep milk or mixture of two milk types (goat and sheep milk) could be used to produce butter, and the milk type differed significantly between eastern and southern regions. Indeed, cow's milk is the most widely used milk in the eastern regions with 73.97, 100, 70% and 100% of interviewed households using cow's milk in Batna, Jijel, Khenchela and Setif localities, respectively. In contrast, in the Southern regions, goat's milk is mostly used for the preparation of *Dhan*, with 92.75%, 98.68% and 100% of interviewed households preparing *Smen/Dhan* with goat milk in Biskra, Ouargla and El Oued localities, respectively. Concerning sheep milk, its utilization is scarce and most of the time, it is used in mixture with goat milk. It is not surprising that the milk type differs between Eastern and Southern regions as it reflects the most prevalent bred animals in these two regions.

##### 3.3.1.1 Milk Coagulation

After milk collection, raw milk is spontaneously fermented at room temperature until coagulation with a duration time varying from 12 to 120 h depending on the season at which this fermentation is performed. Indeed, in the summer season, because of higher temperatures, the fermentation time varies between 12 to 24 h while in the winter, it can last up to 120 h. In order to accelerate the fermentation process in the winter season, some people add ingredients to the milk, such as lemon juice, vinegar, *Raib* (fermented milk), yogurt, klila (cheese) and/or hot water, or leave the milk to coagulate in front of heat or the fireplace. The obtained coagulum is called *Raib* and it may be consumed as it is or processed further as described below.

##### 3.3.1.2 Butter Making

For butter making, *Raib* is then churned. Churning can be performed with several tools either manually using the traditional *Chekoua* which is a goatskin bag, an electric churn equipped with wood, metal, paddles or a plastic bottle (Figure 4).

In the past, *Chekoua* was the mostly used churning tool, but due to its decreasing availability as well as the better ease and speed of use of other tools, it disappeared gradually. Benkerroum and Tammim (2004) stated that the decreasing use of traditional churning tools was due to the fact that electric churns are faster and do not require much labour. In addition, these tools are easier to clean while *Chekoua* cleaning is more fastidious and laborious, and it can be easily contaminated by undesirable microorganisms including spoilage and pathogenic ones. On the other hand, this tool can be a source of beneficial microorganisms which could play a significant role in *Smen/Dhan* organoleptic properties, but this aspect has not been studied in detail so far.

Nevertheless, in Algeria, people still use the traditional *Chekoua*, especially people living in rural areas. Indeed, 21% of the surveyed population still used *Chekoua* for churning, while 41% and 38% use electric churns and

plastic bottles or cans, respectively. With regard to churning duration, it varied depending on the churning tool used as well as the ambient temperature, quantity of *Raib* to be processed and its fat content which is also dependent on the animal species from which milk is derived. According to the surveyed population, it can last between 1 to 2 h using a traditional *Chekoua* or a bottle and between 30 min to 1 h using an electric tool. At the end of churning, a quantity of cold or hot water can be added in the mixture according to the ambient temperature, in order to favor the agglomeration of butter grains. This trick is also used by the Moroccans (Tantaoui-Elaraki, & El Marrakchi, 1987). At the end of this process, two phases appear, a solid one called *zebda* i.e., butter and a liquid one called *Lben*, i.e., buttermilk. After that, the butter is collected by hand or using a strainer or a perforated ladle.

Concerning butter yield, 30 L of milk yield between 0.8 and 1 kg of butter, which is slightly lower than that reported by Alganesh and Yetenayet (2018) with 20 to 25 L of milk for 1 kg of butter. After churning, the butter is washed several times to remove *Lben* traces which constitute the aqueous phase.

### 3.3.2 *Smen/Dhan* Preparation

According to the surveyed households from East and South of Algeria, *Smen/Dhan* preparation is transmitted by identical method from generations. Its production is related to two main factors. First, *Smen/Dhan* is produced because it is an important ingredient in traditional foods, but also for its possible use in traditional medicine. The second reason is that *Smen/Dhan* production allows keeping the butter for longer time period. Indeed, butter transformation into *Smen/Dhan* leads to a more stable product from an organoleptic and microbiological point of view and thus prevent food losses. Benkerroum and Tamim (2004) also reported that the raw butter surplus exceeding the domestic demand, was transformed into Moroccan *Smen* for longer preservation.

It is also worth mentioning that among households preparing *Smen/Dhan* at home, 61.3 % prepared the butter themselves at home starting from raw milk as described above, while the others did not and purchased butter directly from milkmen. These milkmen are traders who collect milk from farms, and sell milk and traditional dairy products to people in the area. These traders own large churns which are used for the preparation of *Lben* and butter. This was also true for households living in urban areas of the Eastern regions (Batna, Jijel, Setif and Khenchela), which did not transform themselves the raw milk into butter, but bought directly the latter from milkmen, in contrast to households from rural areas and those from the Southern regions. These traders also manufacture and sell *Smen/Dhan* but, in general, *Smen/Dhan* preparation is performed by their mother or wife following the traditional process.

After churning, the obtained butter can be processed immediately into *Smen/Dhan*, or the latter is only produced after the accumulation of a large butter quantity in the household. Indeed, we noted that 31.6% of households used to prepare *Smen/Dhan*, immediately processed the butter, while the remaining households only prepared *Smen/Dhan* after accumulation of large butter quantities. In the latter case, butter is kept in the refrigerator or at room temperature with a small amount of salt which allows storing butter for a longer time period as salt addition reduces food water activity and thus prevents the growth of non-halotolerant undesirable microorganisms. Interestingly, we observed that *Smen/Dhan* preparation method is different according to the surveyed region. This difference was observed between the regions of Batna, Khenchela, Setif on one hand and the regions of Biskra, El oued, Jijel, Ouargla. Indeed, following butter washing, households from regions of Batna, Khenchela, Setif proceed directly with butter salting (Figure 2, see section 3.3.2.1) while in others regions of Biskra, El Oued, Jijel, Ouargla, a different process is used which first involves a heat treatment of the butter (Figure 2, see section 3.3.2.2) followed by the addition of one or more ingredients. Both methods, together with the butter acidic pH, relatively high salt (NaCl) content, and its low moisture and water activity, contribute to the microbiological stability of the obtained products, which in turn increases butter shelf life (Sserunjogi, Abrahamsen, & Narvhus, 1998; Afsaneh, Hosseinpour, & Mina, 2016; Alganesh, & Yetenayet, 2017).

#### 3.3.2.1 Butter Salting

As mentioned above, in certain localities, i.e., Batna, Khenchela, and Setif, people proceed directly to butter salting with a process similar to that of Moroccan *Smen* (Tantaoui-Elaraki & El Marrakchi, 1987; Benkerroum & Tamime, 2004). In the present study, 94% of households preparing *Smen/Dhan* with this method add directly salt to the butter and this quantity varies from one household to another. The answers of the surveyed population were very diversified, and the interviewed people did not know exactly the salt concentration used, only the fact that the butter must be well salted. According to 60% of surveyed population and based on our estimation, the salt concentration varies between 50 and 80 g/ kg of butter. It is worth mentioning that certain households (2.20%) add a quantity of matured *Smen/Dhan* (period of maturation between 2 years to 10 years) with recently prepared *Smen/Dhan* in order to minimize the maturation time and gives a result in a short time. Benkerroum and Tamim

(2004) also reported that the ripening period of Moroccan *Smen* could be shortened to 30 days after mixing a portion (ca.5–8%) of matured *Smen* with freshly made product.

After salt addition, butter is well kneaded allowing a homogeneous distribution of salt in the butter. People stated that the salt addition was necessary for better preservation and for taste improvement.

After salting, the salted butter is left for a certain time to get the water out, which is then removed, allowing a shelf-life extension of *Smen/Dhan* during storage. Salted butter can then be directly packaged for further maturation.

### 3.3.2.2 Heat Treatment

The use of heat treatment was adopted in Biskra, Jijel, El Oued and Ouargla localities. For this, the butter is heated at slow fire until melting. The melting temperature could not be defined precisely by the respondents, but they indicated that butter had to be slowly melted to avoid fatty degradation and for a better separation of *Lben* residues and impurities. This method is similar to that of *Samna* making in Egypt and to a smaller extent to Ethiopian and Indian *Ghee*. Indeed, for *Samna*, butter is heated under continuous stirring at 50 to 60 °C while for Ethiopian and Indian *Ghee*, temperature can reach to 110 °C at 120 °C, allowing the removal of more moisture and development of specific flavour (Sserunjogi, Abrahamsen, & Narvhus, 1998; Chaudhary et al., 2019). According to (Illingworth, Patil, & Tamime, 2009), *Ghee* can be defined as a clarified pure fat which is obtained exclusively from milk, cream or butter by application of heat treatment leading to an almost complete elimination of moisture and solid fats.

At boiling point, white froth, which corresponds to residual *Lben* as indicated by the interviewed persons, appears on the melted butter surface. This froth is then skimmed off with a soup spoon, followed by the addition of different ingredients, the basic one being coarse semolina called *Dchicha*. Indeed, 92.5% of the population who prepared *Smen/Dhan* using this method, declared that they added *Dchicha* to butter during boiling under continuous agitation. The quantity of added *Dchicha* was usually approximate but the majority of respondents added ~ 160 g of *Dchicha* per Kg of butter, the purpose of this addition being residual *Lben* and water absorption during cooking to obtain *Smen/Dhan* of good quality. According to (Sserunjogi, Abrahamsen, & Narvhus, 1998) who focused on *Ghee*, after separation, the fat phase is further boiled together with a piece of bread and the boiling step is stopped when the bread becomes crispy and light brown in colour.

Besides *Dchicha*, 88.75% of them also added a small quantity of salt, ~ 8 g/Kg of butter. Moreover, 41.66% of respondents were adding herbs to flavor the product. These herbs were added by people of Biska, El Oued and Ouargla while those of Jijel did not use them. The different herbs, *i.e.*, rosemary (*Salvia rosmarinus*), thyme (*Thymus spp.*), juniper (*Junipirus spp.*) and fenugreek (*Trigonella foenum-graecum*) mixtures, are added in small quantities (a pinch) to butter during cooking. Finally, 7.90% of respondents were also adding a small onion piece to the mixture. Hazra and Parmar (2014) reported that the addition of herbs can prevent oxidative rancidity of *Ghee*.

The cooking duration differed from one respondent to another with duration between 30 min and 1.5 h. This variation was justified by the time needed for cooking and decanting the *Dchicha* semolina grains. At the end of cooking, the cooked butter is clarified with the semolina at the bottom of the pan. After this heat treatment phase, the product is filtered through using a sieve or a piece of a stamen to eliminate any trace of impurities and additives followed by packaging as described below.

The cooked semolina removed of melted butter is consumed by 35% of the respondents using this method. Nowadays, cooked semolina is considered as a traditional dish and is consumed for pleasure while in the past, it was also consumed to avoid food losses in a context of food shortage.

### 3.3.3 Packaging, Maturation and Storage

The packaging of salted or cooked butter is then carried out in containers made of glass (53.45% of the surveyed population preparing *Smen/Dhan*), plastic (34.04%), or a traditional ceramic container called *Ezzir* (12.5%). The latter type of container was mainly preferred by people from rural areas. The butter must be well compacted to remove air, so the pot must be fully filled to minimize free space. Some people declared that they covered the top a paste of semolina to completely prevent air entry. The ripening process was conducted in a dry place, in the dark and, at room temperature. In some cases, the product was left in the refrigerator, especially in the Southern regions of Algeria, because these regions are hot areas, especially in the summer. We noted that 53.45%, 41.48% and 3.45% of the population producing *Smen/Dhan* let it to mature at room temperature, in the refrigerator, or both depending on the season while 1.59% bury the *Smen/Dhan* underground. As previously reported by Benkerroum and Tamime (2004) for *Smen* made in several Morocco regions, the pot is buried underground to ensure darkness,

anaerobiosis and to minimize temperature variations.

The maturation duration was different from one person to another, varying from one month to several years, according to the consumer preferences. As indicated by the respondents, *Smen/Dhan* has a strong characteristic taste which strength depends on the maturation time.

After *Smen/Dhan* maturation, most people utilize it as it is (90.42% of the population consuming *Smen/Dhan*) while 9.57% heated *Smen/Dhan* at a slow fire until melting, before filtration and storage at room temperature, to stop the *Smen/Dhan* maturation process.

As for all other dairy products, *Smen/Dhan* may undergo physico-chemical or microbiological alterations. These phenomena can take place during storage and affect its organoleptic properties (texture, taste). According to the surveyed population, most people (70%) stated that they never experienced *Smen/Dhan* spoilage during storage. The others stated that they had observed mould spoilage on the *Smen/Dhan* surface which, according to the answers of some elderly people, was due to a default encountered during *Smen/Dhan* preparation and the remaining presence of *Lben* in the butter before packaging. Other spoilage encountered by consumers included rancidity defects, colour defect due to mould growth and unpleasant flavour development.

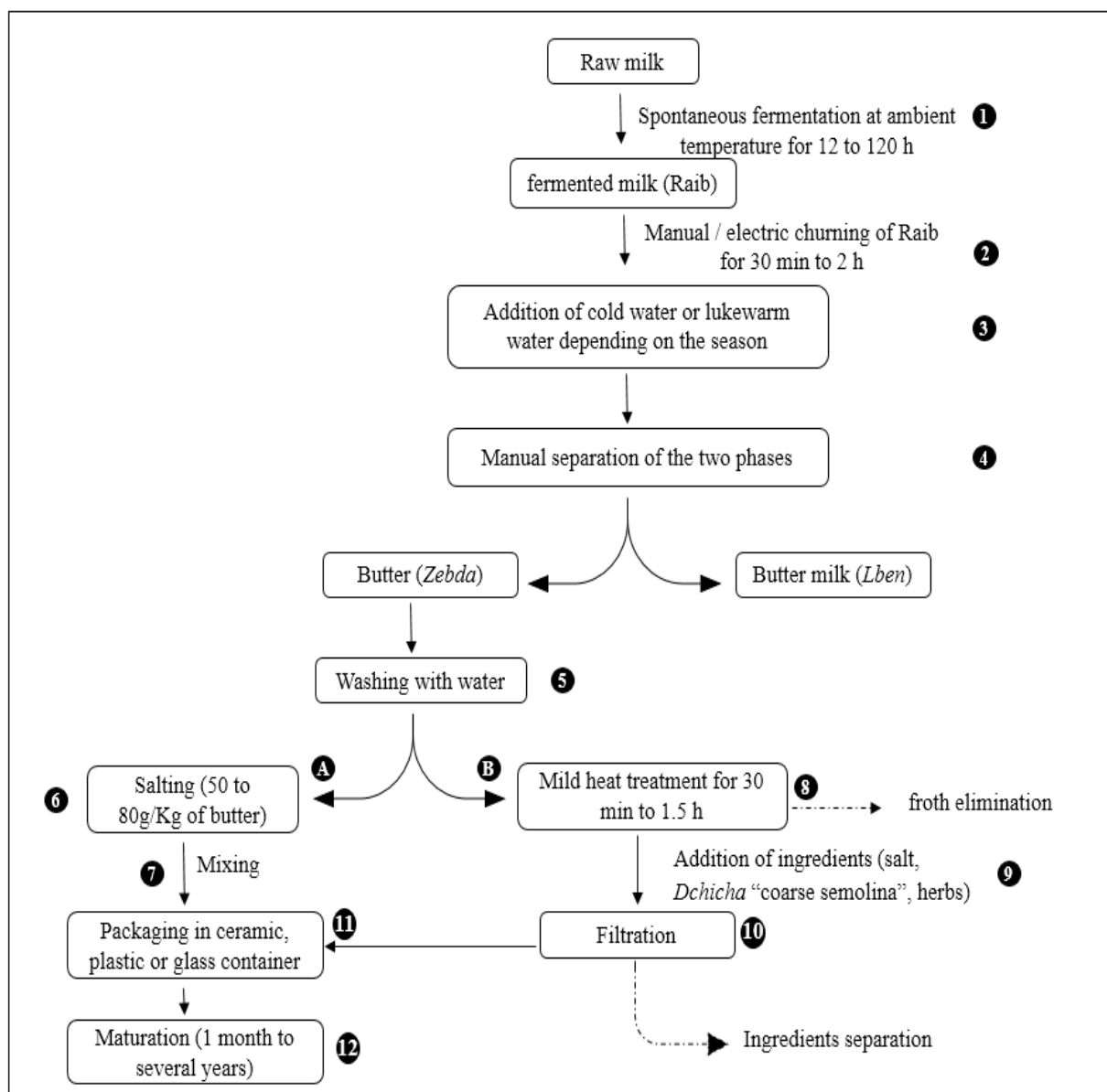


Figure 2. Diagram showing the different steps of traditional *Smen/Dhan* manufacturing



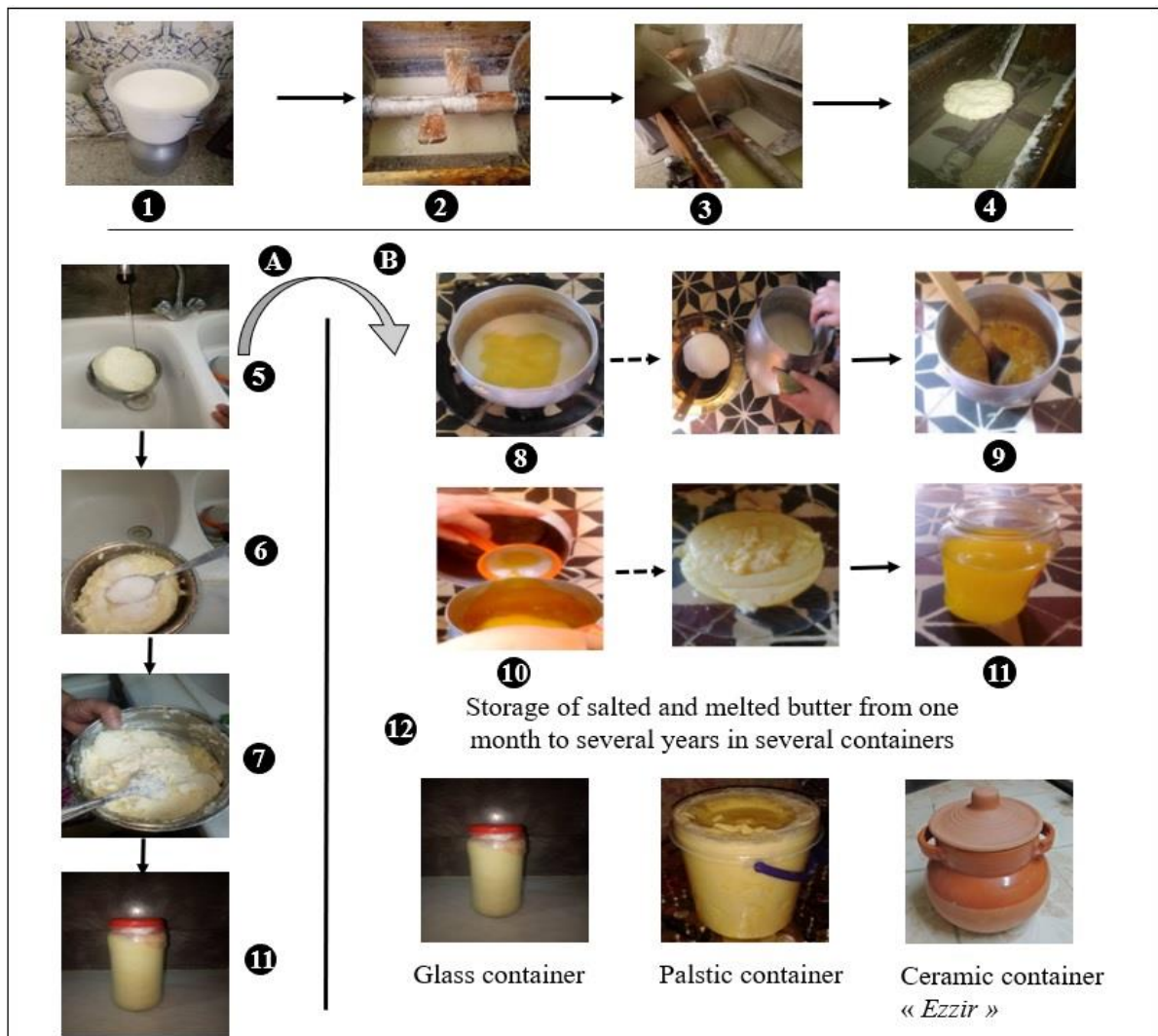


Figure 3. Photographs showing the different steps of traditional *Smen/Dhan* manufacturing



Figure 4. Different tools used for Rayeb churning (a: traditional *Chekoua* made from goat skin, b<sub>1</sub>-b<sub>2</sub>: traditional churn in wood, c: electric churn)

### 3.4 *Smen/Dhan* Consumption

Regarding the use of *Smen/Dhan* in the local culture, and based on the answers of the surveyed population, the majority of the respondents used it for meal preparation and also consumed it alone. The consumption has different objectives, *i.e.*, improving the taste and aroma of some traditional dishes or therapeutic purposes. Regarding culinary usage, people use *Smen/Dhan* with maturation age between 1 month to 2 years. Its characteristic taste depends on maturation time and this taste is stronger with a long maturation period. It is usually used at the end of cooking as a flavoring agent in some traditional dishes such as *couscous*,

*chekhchoukha* and *trida*, for cooking meat, and for preparation of traditional cakes such as *makrout*, *baklawa*, *mberdja*, and *rfis*. This is in agreement with previous work that stated that ripened *Smen*, because it has a strong rancid and salty characteristic taste, is mostly used as a condiment to enhance the flavor of some traditional Moroccan dishes (Benkerroum, & Tamime, 2004).

According to the results of this study, traditional *Smen/Dhan* ripened for more than two years is used for therapeutic purposes. This practice is much more observed in southern regions of Algeria, where it is occasionally drunk with coffee to treat cough. This practice was also reported for *Ghee* by Alganesh and Yetenayet (2017) who indicated that traditionally made *Ghee* stored for more than a year was recommended to treat chronic coughs. *Smen/Dhan* is also used to treat injuries, burns, migraine, headache, injury, hemorrhoids, flu and eczema with a superficial application. We also noted that some farmers use *Smen/Dhan* to treat trauma and injuries of their cows and other animals. The same applications in traditional medicine are also seen with Indian *Ghee* (Gandhi, & Lal, 2015). The therapeutic effects of *Smen/Dhan* have not been studied so far but concerning *Ghee*, Ahmad and Saleem (2020) showed that it has a high concentration of conjugated linoleic acid which possess antioxidant, anticarcinogenic, antidiabetic and antiatherogenic properties (Chinnadurai, Kanwl, Tyagi, Stanton & Ross, 2013).



Figure 5. Photographs of some traditional foods (A, B, C, D) and pastries (E, F, G, H) prepared with *Smen/Dhan* matured for 1 to 24 months

#### 4. Conclusion

Through this study, it was found that *Smen/Dhan* is an important product in the Eastern and Southern Algerian culture. It represents an ethnic food with a specific know-how and is part of Algerian eating habits. *Smen/Dhan* is prepared by housewives and takes an important place at the family level. This product is used for self-consumption, and it can be commercialized to provide an income for the family. Unfortunately, its marketing is generally in informal circuits because *Smen/Dhan* has not yet received any quality label despite its importance in traditional cooking and medicine. Therefore, it would be of great interest to create cooperatives that could market this product in a formal way while guaranteeing a better quality with a specific quality label. It could help local producers improving overall product quality and safety as well as to promote the gastronomic heritage of Algeria. Because the Algerian *Smen/Dhan* is a fermented food, it would be of great interest to study its microbial diversity and identify the key microorganisms involved in its sensory characteristics to better control fermentation processes and, thus, its quality attributes.

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## Conflict of interest

The authors declare no conflict of interest.

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