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Technical Production System of *lebol*: A Local Dairy Product in Cameroon with Higher Potential

D. F. R. Dazeck[1, 2*], H. C. Edima[2] and Nso E. Jong[2]

[1]Institute for Agricultural Research for Development, Cameroon
[2]National School of Agro-Industrial Sciences, Cameroon

**Corresponding author*

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A B S T R A C T

This work is carried out to describe the technical production system of *lebol* with the aim to diagnose the constraint which affect the valorization of this product and recommend the correctives measures to be implemented to allow the improvement of the producers. To meet the goal, a survey was carried out among dairy processing units in the North Region of Cameroon, which is one of the main milk production zones in the country. For this purpose, a questionnaire and a check list, were used to collect data to evaluate the application of Good Hygienic Practices and Good Manufacturing Practices in relation with the requirement of *Codex Alimentarius*. The main result shows that 96% of the producers are women. There is only one process type in the production of *lebol* with a spontaneous fermentation. 80% of producers use *pendidam* (sour fermented milk) and 20% *kindirmou*(fermented milk). In addition, Good Hygienic Practices are not applied by all the operator. However, *lebol* is tasty, and used as flavors enhancer. It is also used in traditional therapies and in cosmetics. Definitively, *lebol* is a local dairy product with a higher economic, culinary and therapeutic potentials, but the main critical point which limit his valorization is the formulation of starter.

Introduction

Cameroon is milk producer country with many local dairy products with varied organoletptic properties that are *pendidam* (skimmed fermented milk); *kindirmou* (fermented whole milk) and *lebol* (dehydrated fats from milk). However, the production system for these local dairy products remain traditional (Essomba *et al.*, 2005; Libouga *et al.*, 2005; Edima *et al.*, 2013).

Although appreciated by consumers, thanks to their atypical aromas and textures they pose a problem quality conformity of the final product as they vary from operator to operator. However, these products for the most part (*pendidam, kindirmou, biradam*), require a

cold chain which is conspicuously absent in the production systems of villages and countryside that do not always have electricity for their preservation. *Lebol* does not need to be cold for preservation. It is *appreciated* by consumers for his flavor and widely used for its therapeutic, organoleptic and cosmetic properties. However, this local dairy product is not valorized and does not allow empowerment of producers who are the main consumers of their products (Edima *et al.,* 2014).

In the Fulani language, l*ebol* refers to the dehydrated fat of milk obtained after churning a fermented cream of cow milk(Essomba *et al.,* 2005; Edima *et al.,* 2014). It remains low income product because it is not wholesome.

This is a consequence of inappropriate processing and preservation methods (Edima *et al.,* 2014). In order to upgrade his economic status, an appropriate technical system of production of *lebol* has to be developed. Knowledge of all components of the system would allow to identify flaws, permitting the corrective actions to be carried out. This work is carried out to describe the different components of the local technological system of *lebol* production in North Region of Cameroon.

Materials and Methods

Zone of Study

The study was conducted in the North Region of Cameroon. It is one of the main milk production zones in Cameroon. This region has four administrative divisions: Bénoué, Mayo-louti, Mayo-Rey and Faro; and 21 sub divisions. This administrative distribution has been reconfigured into 51 Zootechnical Veterinary Centers (MINEPIA, 2015), each of which included the dairy units in which this study was conducted.

Analysis of the Production System of *Lebol*

A survey was carried out in order to describe the various components of the technical system of *lebol* production in North Region of Cameroon. It took into account the accessibility of the production unit and the availability of operators to answer the questions asked. A questionnaire was used in which the following topics are assessed : the identification of the operator's, the working environment, the supply and storage of the raw material, packaging and preservation, quality criteria and the use of final product. The informations were collected through interviews (in Fulfuldé and French) and visual observations done.

Manufacturing Process Analysis

To evaluate the local method of processing *lebol,* a checklist (*Codex Alimentarius,* 2011) was established to collect information on inputs (nature and quantity) and unit operations (designations, parameters and materials used). Information was collected by observing the transformation of milk into *lebol.* A stopwatch and thermometer (HANNA brand) were used to measure parameters (time and temperature).

Results and Discussion

Characterization of operators operating in the *lebol* manufacturing chain

In order to characterize the different actors involved in the *lebol* processing chain, informations about operators were collected (Table 1). It appears that out of a total of 106 operators surveyed, 96% of the people involved in this sector are women.

These results are justified insofar as the woman in the northern regions of Cameroon is in charge of the production and marketing

operations of dairy products that are similar to domestic work because it usually takes place in the kitchen. Similar observations have been reported by Edima *et al.,* (2014) which showed that domestic work is generally reserved for women in these parts of the country. Men represent 4% in the value chain of *lebol* are the owners of the dairy bars and are involved in the marketing link. The high representation of the Peulhs at 86% reflects the fact that they are a people animal breeding. The other ethnic groups represented in this production chain of *lebol* can be explained by the influence of the environment, the blending of cultures and the adaptation of ethnicities (Edima *et al.,* 2014). With regard to the level of education of operators involved in the processing of *lebol* in the North Region of Cameroon, it was observed that 84.90% attend the Koranic school following the rules as perceived by the Islam religion which is the major religion among the Peulhs. With regards to education, only 15.09% have primary level. Similar trends were also observed by Edima *et al.,* (2012) which showed that in most cases, people working in the dairy sector have little education.

Working environment for *lebol production*

The working environment remains an important element in agro-food processing chains. The evaluation of the *lebol* production environment show that 96% have no specific site allocated for *lebol* production. It is done in the family environment like any other domestic activity. The remaining 4% are production sites close to the markets. These production sites are generally non-compliant with the requirements of the Food Codex.

Material used to process *lebol*

Material in contact with food can be a source of contamination. This hypothesis motivated the evaluation of the compliance of the processing equipment of *lebol.* This survey shows that the material used in the three essential units in the value chain is made of stainless steel, wood, aluminum and plastic (Table 2).

Stainless steel is recommended for processing of dairy products (FAO, 2012). This material must be washable, easy to disinfect and should not interact with milk. The use of non-standard material can compromise the sanitary and organoleptic qualities of the finished products.

Plastic bottles are recovered for use after consumption of mineral water, cooking oil and fuel cans. The immediate consequences would be biological contamination of milk due to the fact that these containers are difficult to wash and disinfect and chemical contamination because of the primary use of this material (Edima *et al.,* 2014).

In addition, wood material is an auspicious medium for the development of microorganisms because after washing and disinfection it does not dry quickly thus encourage the proliferation of microorganisms (Gran *et al.,* 2002). Although Aluminum is widely used in the design of several products including containers, it remains harmful to human health. It is believed to provoke several cancers such as lung and bladder (InVS, 2003).

The inputs used in processing *lebol*

In order to identify and quantify everything that goes into the production of *lebol*, the have been analyzed. It is observed that there is only one input, the starter. The starter used for seeding milk for *lebol* production is *pendidam* (80% skimmed curd) or *kindirmou* (whole curdled milk). They are artisanal sourdoughs obtained from spontaneous and uncontrolled fermentations (Libouga *et al.,* 2005).

Pendidam is an acid fermented milk with a pH of between 3.55 and 3.95 pH, pH that promotes the development of acidophilic microorganisms such as *lactobacillus* (*L. fermentum, L. acidophilus*) (Jiwoua *et al.*, 1990).

Their metabolism will be oriented towards the production of lactic acid in larger parts and the product will tend to be more acidic. In addition, acidification of milk fats causes loss of its aroma, while diacetyl transformed into acetone exposes the product to oxidation (Tamime *et al.*, 1997).

The pH of *kindirmou* fluctuates between 4.2 and 4.7. Germs such as *Streptococcus thermophilus* found there during their metabolism, will produce lactic acid and other aromatic compounds as diacetyl. The *lebol* from this fermentation is thought to be highly flavored (Libouga *et al.*, 2005; Edima *et al.*, 2014). The analysis of the two starters suggests a variation in the microorganism profile contained in them, which could eventually result in a variation the aromatic profile and texture of the *lebol* resulting from these two types of fermentation.

Method of milk processing into *lebol*

Raw material supply

The operators (74%) have farms and thus produce milk. The remaining 26% are actors in the *lebol* value chain who get supplies from breeders. It shows that the majority of actors (74%) are milk producers and processors. They have the advantage of not being subject to fluctuations in the milk market in this region. Indeed, during the long dry season (of 8 months) milk production drops from 1.5 L to 1L /cow (Awono *et al.*, 2014), depriving actors who do not have farms of raw material which compromises their activity during this period.

Lebol production process

The description of the *lebol* processing reveals that there is only one process. After receiving the milk, it is sieved, heated, cooled, seeded, fermented and skimmed. The resulting cream is churned out to give *lebol*, which is washed, kneaded and then packaged (Figure 1).

Delivered milk is sieved to remove foreign bodies. It is then heated over wood fire until boiling. The parameters (time and temperature) of the heating are not controlled. This would affect the effectiveness of this treatment on the inactivation of microorganisms and milk enzymes.

The fragility of its physical-chemical balances (fat emulsion, colloidal protein suspension) can easily lead to physical destabilization, especially under the action of mechanical and thermal shocks (Sboui *et al.*, 2009). Also, a fairly long thermal treatment would lead to the denaturation of the macromolecules of milk, especially caseins (Walstra *et al.*, 1984) and the loss of nutrients such as vitamins (Kessler, 1996). Another consequence of uncontrolled thermal treatment would be the formation of new compounds such as furfural Hydroxy-methyl following Maillard's reaction, a reaction between lactose and milk proteins (Brands, 2002; Burton, 1988).

Milk after boiling is left at room temperature to be cooled or in a double boiler. The cooling time and temperature are not controlled and cooling is not done quickly. Indeed, the rapid drop in temperature during cooling makes it possible to make up for the errors of pasteurization.

The cooled milk is seeded and fermented for 18 to 72 hours at room temperature. During fermentation, the time, temperature and concentration parameters of the starter are not defined and controlled.

Uncontrolled temperature could promote the development of unwanted microorganisms in the product and therefore affect the sanitary and organoleptic qualities of the finished product (Edima *et al.,* 2014). The fermentation temperature should correspond to the optimal temperature range of growth of lactic fermentation (Tamime *et al.,* 1997). Also, fermentation time is not fixed and varies from operator to operator and can thus have an impact on the quality of *lebol.*

After fermentation, whole milk is skimmed. However, cream yield remains low because skimming is done manually. The recovered cream is churned for about ten minutes by hand. As soon as the *lebol* forms, the buttermilk is collected and cold water added to it to allow for a firm *lebol*. The *lebol* is washed several times for the complete elimination of buttermilk. Unlike the work of Edima *et al.,* (2014) which determined two types of processes, the hot and cold in Adamawa Region, in the North Region, a single type of process, the hot one is observed.

Marketing

After production, *lebol* is marketed in locally closest to processing sites. It is sold fresh (in the form of a small ball) or dehydrated and packaged in bottles (0.35; 0.5; 1L). To obtain it, the consumers of *lebol* can place orders from the operators. In 47% of cases, clients express satisfaction with of the product.

Lebol Preservation

Lebol is mainly composed of milk fat, and as a consequence, prone to oxidation reactions of its unsaturated fatty acids. Because of preservation difficulties of *lebol*, it is customary for it to be consumed or sold immediately after production. This raises the need for the investigation of better preservation methods. It was found that there were three preservation methods, dehydration, pH decrease and room temperature (Figure 2).

Water activity is reduced by dehydration during heating. Dehydration by wood-fired heating of the *lebol* allows for a product called *Kainadam*, equivalent to clarified butter. This reduces the free water in the matrix. The microorganisms in the environment are destroyed by heat. The fat from this dehydration is collected and cooled to room temperature away from the light. However, the fact that the temperature and time of this thermal treatment are not controlled, compromises the nutritional and organoleptic quality of the *lebol.* Temperatures above 100 or even 150 degrees Celsius will lead to the formation of polymers, cyclical or isomerized compounds. The effect of heat on *lebol* fatty acids could lead to their oxidation and the formation of free radicals, which are carcinogenic compounds. Similarly, the oxidation of these unsaturated fatty acids can produce the rancid smell of the product.

Lebol can also be preserved by using an acidic medium. Indeed, lebol is soaked in Pendidam, fermented milk at a pH included in 3.55 and 3.9. These acidic conditions will slow or stop the multiplication of non-acidophilic germs and enzyme reactions (Tamime, 2006; Panesar 2011).

However, this pH would promote the proliferation of microorganisms capable of developing in extreme conditions such as moulds and yeasts as well as all acidophilic microorganisms (Jiwoua *et al.,* 1990). Also, this mode of preservation in *pendidam* could affect the taste of *lebol* because of the accumulation of lactic acid in the medium. It is therefore advisable to wash the product before use. The shelf life of *lebol* in *pendidam* is limited to 7 days at the moment.

Table.1 Operators involved in the *lebol* production chain in the North Cameroon Region

Observations	Variations	Percentages (%)
Gender	Male	4
	Female	96
Ethnicity	Peulh	86
	Fali	7
	Guidar	7
Level of Education	Non	85
	Primary	15
Religion	Muslim	100

Table.2 Materials used for the production of *lebol* in Northern Region of Cameroon

Material	Natures	Use
Calabash	wood	Milk supply and processing
Plate	Stainless steel, plastic	Milk supply, transformation and Conditioning
Can	Plastic	Milk supply
Seals		
Bottle		Supply and packaging
Packaging		Packaging
Pot	Aluminium	Transformation
Ladle	Wood, plastic, Aluminium	
Bourgal (wooden cross-shaped thresher)	Wood	
Djoulorou (calabash in the shape of a bottle)		

Fig.1 The production process of lebol used by operators in the North Region of Cameroon

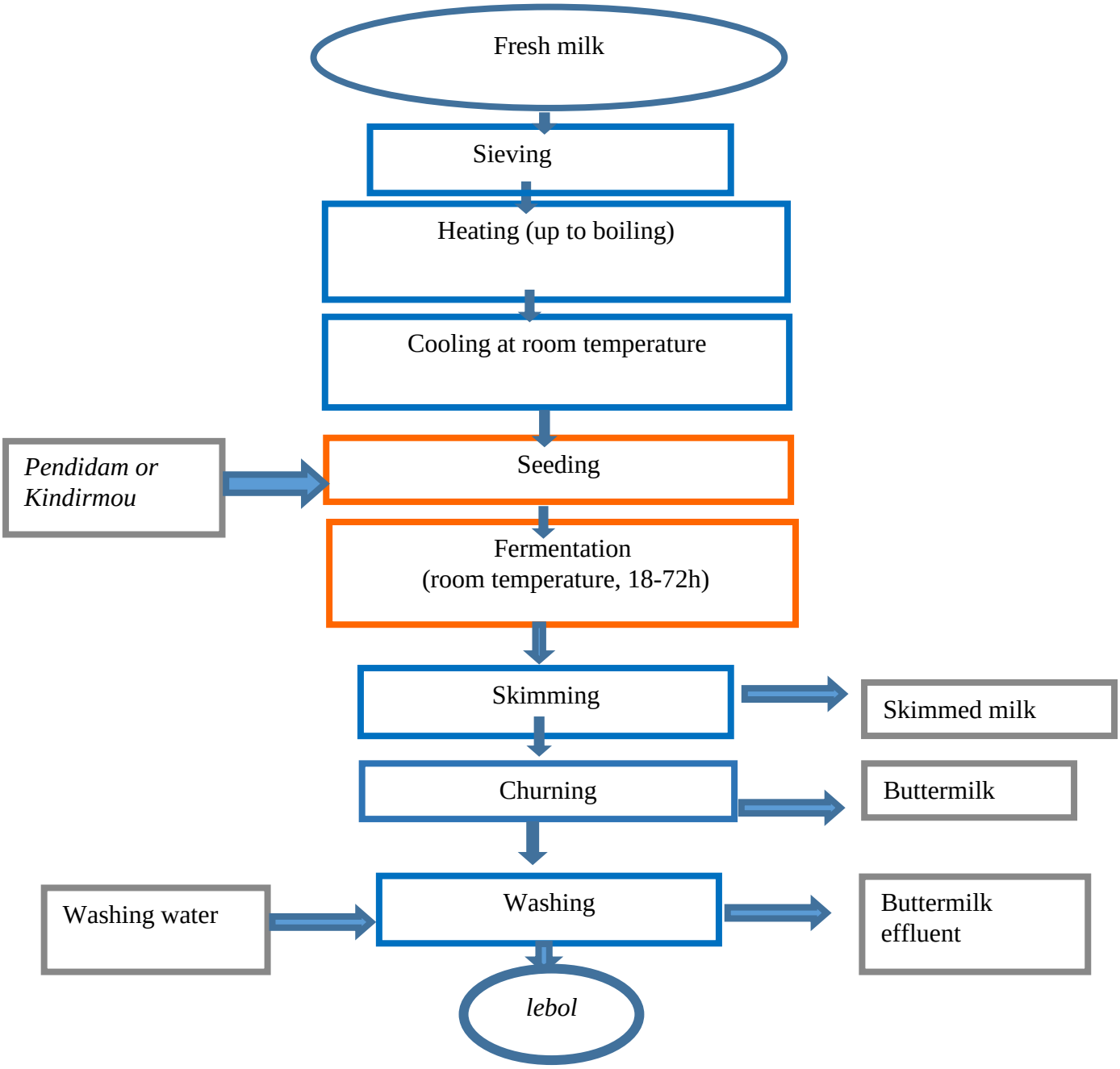


Fig.2 Ways to preserving *lebol* after manufacture in the North Region of Cameroon

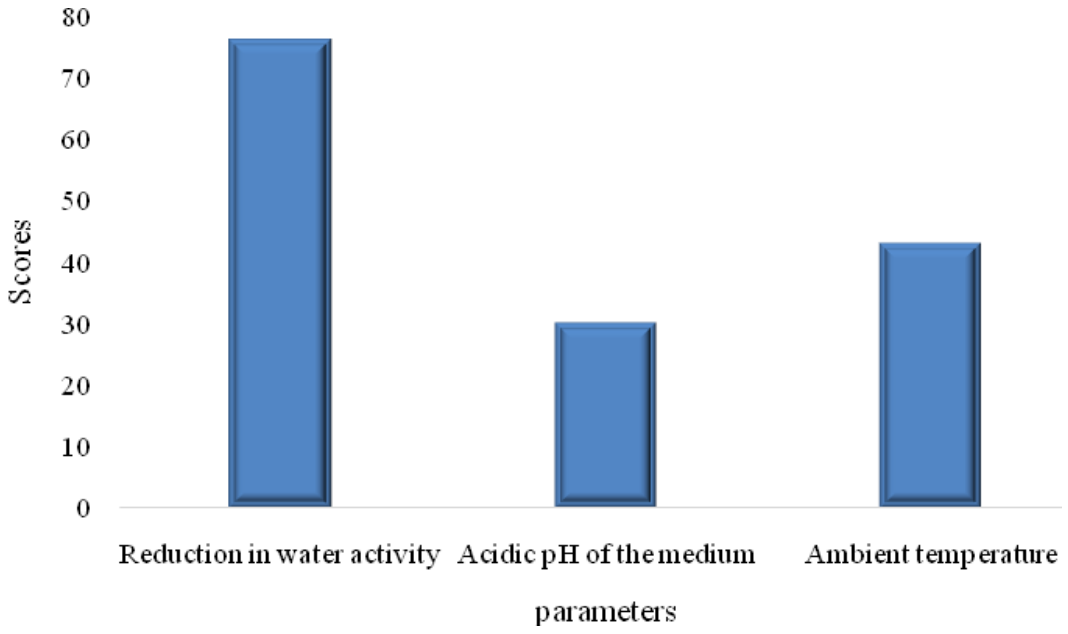


Fig.3 Uses of *lebol* in Human Food in the Northern Region of Cameroon

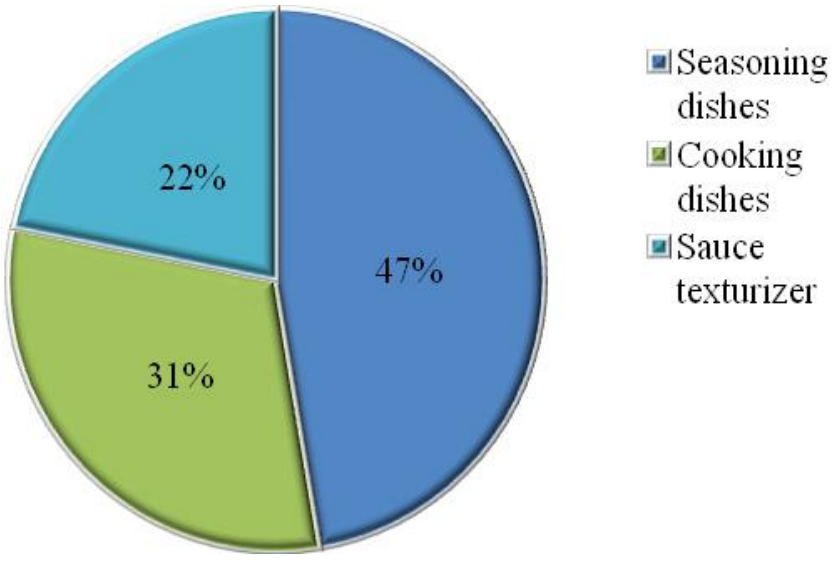
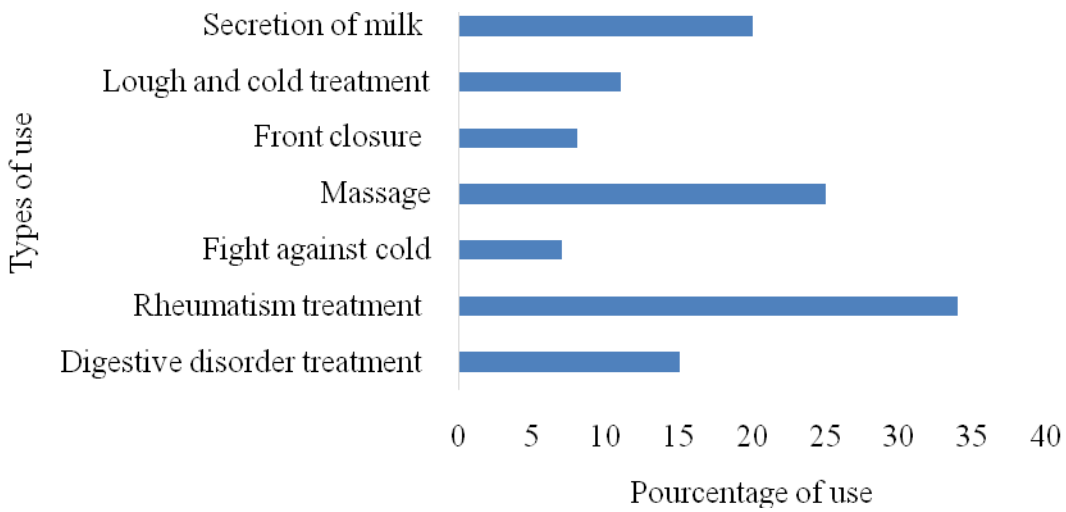


Fig.4 Uses of *lebol* as therapeutics



Uses of *lebol*

Lebol, which is a local dairy product, is a food that is consumed but is also used in cosmetics and traditional therapy.

Uses of *lebol* in Food

In the food field, *lebol* is used for seasoning of meals at the time of tasting, it is used in the preparation of sauces and vegetables, and also as a taste enhancer etc. (Figure 3). *Lebol*, a partially dehydrated fatty milk, indeed would consist of 16% water, 82% fat, 2% nitrogen, minerals, and carbohydrates (lactose). It has a high nutritional value and is highly digestible even when consumed in reasonable quantities. It is therefore a source of energy that is assimilated faster by the body. On the other hand, from the point of view of processors, dairy fat is principally responsible for the sensory characteristics of dairy products (Alais, 1984).

Uses of *lebol* as cosmetics

Lebol is used for skin (44%) and hair (56%) maintenance. According to the accounts of the interviewees, the admirable posture and length of the hair of Peulh women is due to the exclusive use of *lebol* as a hair cream free of rinsing. Indeed, the saturated and mono-unsaturated fats contained in *lebol* play an encapsulating role of, which helps to protect the hair from breakage and retain more hydration of the hair after shampoos. *Lebol* also makes skin soft and hydrated. Indeed, triglycerides and phospholipids contained in *lebol* have moisturizing and softening properties (Cotte, 1991).

Uses of *lebol* in traditional medicine

Lebol is used in the treatment of several ailments. Figure 4 shows the different percentages of it's use in therapeutic care.

The therapeutic attributes of *lebol* are thought to be due to the effect of fermentation that results in the synthesis of different health-promoting metabolites and the decomposition of milk macromolecules into simpler elements that could be bioactive, easy to digest and providing thus all nutritional properties (Shiby and Mishra, 2013). *Lebol* is used for massage of fractures or sprains and in cases of rheumatism. *Lebol* also fights against digestive disorders, constipation or diarrhea

and equally accelerates closure of the fontanelle in babies. It also fights against intestinal ailments and can be inhaled against sinusitis and used for eyes care.

This efficacy in therapeutics can be explained by the presence of sphingolipids, butyric acid, linoleic fatty acid, which play a role in cell differentiation (Shiby and Mishra, 2013). Fermented foods as *lebol* are potent detoxifers, capable of drawing out a wide range of heavy metals from the body. Additionally, fermented foods supplemented with probiotics are rich in essential nutrients like vitamins B12, B6, K2, biotin, protein, essential amino acids, and fatty acids that fulfill the body needs. Many of the probiotics produce wide variety of antimicrobial substances, for instance, lactic acid, acetic acid, formic acid, propionic acid, ethanol, diacetyl, acetaldehyde, reutericycline, reuterin, fatty acids, and bacteriocins that are inhibitory to pathogens (Jain *et al.*, 2009).

The objective of this study was to analyze the production system of *lebol.* At the end of this investigation, it is observed that 96% of the 106 producers surveyed are women. The ethnic groups involved in the production of *lebol* are the Peulhs, the Guidars and the Fali. The survey revealed only one process type in the production of *lebol*.

The starter is said to be used as *pendidam* by 80% or as *kindirmou by* 20% of the producers. However, these starters are not standardized and therefore do not guarantee the quality of the product. In addition to being a culinary ingredient for the seasoning of dishes, *lebol* is used in traditional medicine and cosmetics. However, the fermentation operation is not yet standardized. Indeed, it requires the development of a starter under controlled conditions. Hence the need to isolate and identify the microorganisms of technological interest that go into the processing of this local dairy product much appreciated by consumers.

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