

Full Length Research Paper

Identification of lactic acid bacteria in traditional curd in the Sudanian zone of Chad

^{1,4}Doutoum AA, ^{2*}Tidjani A, ⁴Sylla KSB, ³Tidjani SMT, ³Alamedji RB, ³Balde M, ³Abdelaziz Arada I, ⁴Seydi MG and ⁵Toguebaye BS

¹Graduate Institute of Science and Technology of Abeche (IUSTA) Abeche-Chad

²Faculty of Human Health, University of N'Djamena-Chad

³Laboratory of Microbiology, Immunology and Infectious Pathology (MIPI). EISMV, Dakar-Senegal

⁴Laboratory of Hygiene and Industry Foodstuffs of Animal Origin (HIDAOA), EISMV, Dakar, Senegal

⁵Department of Animal Biology, Faculty of Science and Technology – UCAD, Dakar-Senegal

Abstract

In Chad, milk and its products are consumed by many people including the curd in its various forms. This product still called "Laban Rayib" has also an important role in the labor market. In fact, these different types of curds are made without real respect basic standards of technology and hygiene. This situation will be improved if lactic ferments are well identified and taking into account their synergy. The Scientists can propose to the producers the formulas to improve the curds. However the studies in this field are rare to have reliable scientific information. It is in this context that this study was conducted to identify lactic acid bacteria in milk curd to provide scientific data needed for improve the fermented product. Thus, one hundred samples of 100 ml were collected from producers due to 10 samples / producer. The analyses were performed in the laboratory of Hygiene and Industry of Food of Origin Animal (HIDAOA) of the Inter-States School of Sciences and Veterinary Diseases (EISMV) of Dakar in Senegal and at the Veterinary and Zoo Technical Research Laboratory of Farcha (LRVZ) in Chad. The culture media used are M17 broth and agar, broth and de Man, Rogosa and Sharpe (MRS) for the search of these lactic acid bacteria. The identification of bacteria isolated and purified was made using the API 50 CH galleries biochemical, 20 STREP and software WEB API galleries. The lactic species identified are *Lactococcus diacetylactis*, *Streptococcus thermophilus*, and *Lactococcus lactis* subsp *lactis*. Isolated Lactobacilli are *Lactobacillus plantarum*, *Lactobacillus helveticus*, *Lactobacillus fermentum*, *Lactobacillus brevis* and *Lactobacillus acidophilus*. The results of this work could be a good tool for information and awareness to improve the characteristics of the curd.

Keywords: Lactic acid bacteria, Sudan zone, Moundou, Chad.

INTRODUCTION

Milk is a staple food for humans. It is highly nutritious for its richness in carbohydrates, lipids, vitamins and minerals (Ahmed et al., 2010). In addition to their nutritional values the consumption of dairy products is also associated with beneficial effects on health (Takahiro et al., 2007). Rastall et al. (2005) stresses that fermented dairy products are used as lactic ferments to remedy the gastrointestinal disorders. Fermented dairy products in particular are very popular with consumers

because their tastes and flavors. The preparation of such milk curd is to let the milk at room temperature for one to two days until its coagulation. Then the milk is churning followed by addition of water at the end. In the process of fermentation, lactic acid bacteria play an important role. Own different fermented milks characteristics are due to the specific changes in certain factors such as the composition of the milk, the incubation temperature or the seeds used (Luquet and Corrieu, 2005). The characteristics of various fermented milks are due to the particular variation of certain factors, such as the composition of the milk, the incubation temperature or

*Corresponding Author E-mail: abdelti@yahoo.fr

used enzymes (Luquet and Corrieu, 2005). The fermentation of milk involves primarily bacteria lactic acid (Zamfir et al., 2006). Lactic acid bacteria are a very interesting group of microorganisms, which are characterized by the ability to ferment carbohydrates into lactic acid, a weak acid conducive to the conservation and improvement of the organoleptic quality of food (Zadi-Karam and Karam, 2007). The interest of lactic acid bacteria in the food industry lies mainly in their ability to convert some sugars into lactate and so to acidify the surrounding environment (Raynaud, 2006). Lactic acid can be depending on the group of only product of bacterial fermentation in homofermentative bacteria or with other excreted metabolites such as acetic acid, ethanol, CO₂, among heterofermentative bacteria. The first group follows the Embden Meyerhoff and the second the way of Dickens Horecker and Entner Doudoroff (Kandler and Weiss, 1986). Leveau and Bouix (1993) indicate that the lactic acid bacteria produced as commercial starter cultures are pure cultures or a mix belonging to the genera *Lactococcus*, *Streptococcus*, *Lactobacillus*, *Leuconostoc*, *Pediococcus* and *Bifidobacterium*. Also, throughout the world, there are a variety of milk products (FAO, 1995). Moreover, many studies (Savadogo et al., 2004; Chammas et al., 2006; Zamfir et al., 2006; El-Baradei et al., 2008; Ouadghiri et al., 2009) were conducted on dairy products fermented. In Chad, little information exists on the strains that may have desirable characteristics in fermented dairy products. The present work which is to identify lactic acid bacteria in traditional curd "Laban Rayib" consumed in Chad is part of a quality approach to improve the technology scale processing of milk. In addition this research work complements the studies that we have made in other areas of Chad (Doutoum et al., 2013).

MATERIALS AND METHODS

The samples were collected in the periurban area of "Moundou". The town of "Moundou" is the second city of Chad after N'Djamena. This economic capital has grown from the right bank of the river "logone". We collected from each producer, 10 samples of 250 ml, which all come from different containers of 40 liters. . The indelible ink used to mark bottles to avoid the mixing of samples. Then the samples are quickly placed in an ice containing cooling elements to prevent microbial growth. Thus the chain is maintained until the place of storage. In total, we collected at random from the sampling requirements 100 samples of curd. Each sample is a plastic jar containing 250 ml of curd. The samples were then quickly transferred to LRVZ and HIDAOA which were conducted analyzes. All samples studied were treated to obtain preliminary dilutions according to standard NF V08-010

(March 1996). To form the stock solution, 10 ml of the sample are introduced in a bag STOMACHERND which are added 90 ml of MRS broth or M17 broth. And then one ml of each milk sample was homogenized in 9 ml of sterile saline. Lactic acid bacteria were enumerated by serial dilutions in sterile saline that were placed on the appropriate agar medium. The incubation was carried out at 37 °C for 48 hours.

Regarding the different identifications and confirmations of lactic acid bacteria, we first used two types of galleries: API 20 STREP (Biomerieux, France) gallery and Gallery 50 API CH-L with their boxes of reagents. Then, we used the identification catalogs for confirmation and then the software API Web TM (Biomerieux, France).

RESULTS

Table 1 shows the digital profile and identification of lactococcal strains by API 20 STREP Galleries. The digital profile and identification of *Lactobacillus* strains by API 50 CH galleries are presented in the table 2.

DISCUSSION

In this study, we worked on ten (10) isolates of *Lactococcus* and ten (10) isolates of *Lactobacilli*. In the light of our research, we have identified from the broth and agar M17 and then using the API 20 STREP gallery, strains of lactic acid bacteria following: three (3) strains of *Lactococcus diacetylactis*, four (4) *Lactococcus lactis* subsp *lactis*, two (2) strains of *Streptococcus thermophilus* and finally a strain of *Streptococcus bovis*. These bacteria were isolated from the curds collected in cold dry season. This could explain the rarity of isolated thermophilic strains (one strain of ten isolates). Bacteria of the genus *Lactococcus* are dominant in the traditional curds of Chad. This confirms the results we have obtained in four (4) other areas during the same period (Doutoum et al., 2013). Indeed, in the suburban area of Abeche (Chad), we identified six (6) strains of *Lactococcus lactis* subsp *lactis*, two (2) strains of *Lactococcus lactis* subsp *cremoris* and a strains of contamination: *Enterococcus faecium* and *Enterococcus durans*. Jiwoua and Milliere (1990) in Cameroon have reported similar results in the curds dominated by *Streptococcus thermophilus* and *Leuconostoc*, and other *Enterococcus*. Our results differ from those of Badis et al. (2005) who obtained a significant percentage of *Lactobacilli*. It is clear from the results that the thermophilic flora is rare only met eugenic conditions to be found in large numbers in the curds. In their studies, the authors did not isolate flora contamination. Indeed, according to their investigations, the habits of making curds differ. We also

Table 1. Digital profile and identification of lactococcal strains

Lactococcal strains	Code	Identification			Identification %	Appreciation
		Genus	Species	Subspecies		
SM1	1050400	<i>Streptococcus</i>	<i>thermophilus</i>	-	99.7	good identification
SM2	7167711	<i>Streptococcus</i>	<i>thermophilus</i>	-	66.4	low identification
SM3	1054411	<i>Streptococcus</i>	<i>thermophilus</i>	-	98.9	proper identification
SM4	1053411	<i>Streptococcus</i>	<i>thermophilus</i>	-	98.9	proper identification
SM5	1050400	<i>Streptococcus</i>	<i>thermophilus</i>	-	99.7	good identification
SM6	1052453	<i>Streptococcus</i>	<i>thermophilus</i>	-	99.6	proper identification
SM7	1053411	<i>Streptococcus</i>	<i>thermophilus</i>	-	98.6	proper identification
SM8	3050400	<i>Streptococcus</i>	<i>thermophilus</i>	-	99.9	excellent identification
SM9	7167711	<i>Streptococcus</i>	<i>thermophilus</i>	-	66.4	proper identification
SM10	2050400	<i>Streptococcus</i>	<i>thermophilus</i>	-	94.0	proper identification
SM11	1252400	<i>Streptococcus</i>	<i>thermophilus</i>	-	99.9	excellent identification
SM12	1250410	<i>Streptococcus</i>	<i>thermophilus</i>	-	87.4	identification acceptable
SM13	1250400	<i>Streptococcus</i>	<i>thermophilus</i>	-	99.4	good identification
SM14	1242400	<i>Streptococcus</i>	<i>thermophilus</i>	-	99.9	excellent identification
SM15	1240410	<i>Streptococcus</i>	<i>thermophilus</i>	-	81.9	identification acceptable
SM16	1240400	<i>Streptococcus</i>	<i>thermophilus</i>	-	99.2	good identification
SM17	1072400	<i>Streptococcus</i>	<i>thermophilus</i>	-	95.5	proper identification
SM18	1070400	<i>Streptococcus</i>	<i>thermophilus</i>	-	89.1	identification acceptable
SM19	1062400	<i>Streptococcus</i>	<i>thermophilus</i>	-	93.0	proper identification
SM20	1060400	<i>Streptococcus</i>	<i>thermophilus</i>	-	85.1	identification acceptable
SM21	1050440	<i>Streptococcus</i>	<i>thermophilus</i>	-	96.8	proper identification
SM22	1050411	<i>Streptococcus</i>	<i>thermophilus</i>	-	81.0	identification acceptable
SM23	1050410	<i>Streptococcus</i>	<i>thermophilus</i>	-	98.9	proper identification
SM24	1050401	<i>Streptococcus</i>	<i>thermophilus</i>	-	91.7	low identification
SM25	1050000	<i>Streptococcus</i>	<i>thermophilus</i>	-	45.7	proper identification
SM26	2050400	<i>Streptococcus</i>	<i>thermophilus</i>	-	94.0	excellent identification
SM27	1252400	<i>Streptococcus</i>	<i>thermophilus</i>	-	99.9	identification acceptable
SM28	1250410	<i>Streptococcus</i>	<i>thermophilus</i>	-	87.4	good identification
SM29	1250400	<i>Streptococcus</i>	<i>thermophilus</i>	-	99.4	excellent identification
SM30	1242400	<i>Streptococcus</i>	<i>thermophilus</i>	-	99.9	identification acceptable
SM31	1240410	<i>Streptococcus</i>	<i>thermophilus</i>	-	81.9	good identification
SM32	1240400	<i>Streptococcus</i>	<i>thermophilus</i>	-	99.2	proper identification
SM33	1072400	<i>Streptococcus</i>	<i>thermophilus</i>	-	95.5	identification acceptable
SM34	1070400	<i>Streptococcus</i>	<i>thermophilus</i>	-	89.1	proper identification
SM35	1062400	<i>Streptococcus</i>	<i>thermophilus</i>	-	93.0	identification acceptable
SM36	1060400	<i>Streptococcus</i>	<i>thermophilus</i>	-	85.1	proper identification
SM37	7043010	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	98.7	identification acceptable
SM38	7043410	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	88.9	proper identification
SM39	7043511	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	98.9	proper identification
SM40	7043510	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	97.6	excellent identification
SM41	7043401	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	99.9	excellent identification
SM42	7043151	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	99.9	excellent identification
SM43	5053011	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	99.9	proper identification
SM44	5053401	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	93.6	excellent identification
SM45	5053011	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	99.9	proper identification
SM46	5053411	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	98.9	proper identification
SM47	5057511	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	91.1	good identification
SM48	5057411	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	99.6	good identification

Table 1. Continue

Lactococcal strains	Code	Identification			Identification %	Appreciation
		Genus	Species	Subspecies		
SM49	5507111	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	99.7	excellent identification
SM50	5057011	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	99.9	proper identification
SM51	5053551	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	98.0	proper identification
SM52	7043010	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	98.7	identification acceptable
SM53	7043410	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	88.9	proper identification
SM54	7043511	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	98.9	proper identification
SM55	7043510	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	97.6	excellent identification
SM56	7043401	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	99.9	excellent identification
SM57	7043151	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	99.9	excellent identification
SM58	5053011	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	99.9	proper identification
SM59	5053401	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	93.6	excellent identification
SM60	5053011	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	99.9	proper identification
SM61	5053411	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	98.9	proper identification
SM62	5057511	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	91.1	good identification
SM63	5057411	<i>Lactococcus</i>	<i>lactis</i>	<i>diacetylactis</i>	99.6	excellent identification
SM64	7007411	<i>Lactococcus</i>	<i>lactis</i>	<i>lactis</i>	99.9	excellent identification
SM65	7007411	<i>Lactococcus</i>	<i>lactis</i>	<i>lactis</i>	99.9	good identification
SM66	7003511	<i>Lactococcus</i>	<i>lactis</i>	<i>lactis</i>	99.7	excellent identification
SM67	7007411	<i>Lactococcus</i>	<i>lactis</i>	<i>lactis</i>	99.9	excellent identification
SM68	7007410	<i>Lactococcus</i>	<i>lactis</i>	<i>lactis</i>	99.9	good identification
SM69	7003510	<i>Lactococcus</i>	<i>lactis</i>	<i>lactis</i>	99.5	proper identification
SM70	5353411	<i>Lactococcus</i>	<i>lactis</i>	<i>cremoris</i>	91.1	proper identification
SM71	5210440	<i>Lactococcus</i>	<i>lactis</i>	<i>cremoris</i>	99.6	proper identification
SM72	1040473	<i>Lactococcus</i>	<i>lactis</i>	<i>cremoris</i>	94.0	proper identification
SM73	5353411	<i>Lactococcus</i>	<i>lactis</i>	<i>cremoris</i>	91.1	proper identification
SM74	5353411	<i>Lactococcus</i>	<i>lactis</i>	<i>cremoris</i>	91.1	proper identification
SM75	5210440	<i>Lactococcus</i>	<i>lactis</i>	<i>cremoris</i>	99.6	proper identification
SM76	1040473	<i>Lactococcus</i>	<i>lactis</i>	<i>cremoris</i>	94.0	proper identificat
SM77	5353411	<i>Lactococcus</i>	<i>lactis</i>	<i>cremoris</i>	91.1	

Lactic streptococci identified in curd show that there is a predominance of *Lactococcus lactis* subsp *lactis* and *Lactococcus lactis* subsp *cremoris*.

Table 2. Digital profile and identification of *Lactobacillus* strains

lactococcal strains	Identification		Identification %	Tests against
	Genus	Species		
SLM1	<i>Lactobacillus</i>	<i>Plantarum</i>	99.9	0
SLM2	<i>Lactobacillus</i>	<i>plantarum</i>	99.6	1
SLM3	<i>Lactobacillus</i>	<i>plantarum</i>	99.9	0
SLM4	<i>Lactobacillus</i>	<i>helveticus</i>	99.9	2
SLM5	<i>Lactobacillus</i>	<i>fermentum</i>	99.6	2
SLM6	<i>Lactobacillus</i>	<i>plantarum</i>	98.4	2
SLM7	<i>Lactobacillus</i>	<i>brevis</i>	99.9	0
SLM8	<i>Lactobacillus</i>	<i>fermentum</i>	99.9	1
SLM9	<i>Lactobacillus</i>	<i>brevis</i>	99.9	0
SLM10	<i>Lactobacillus</i>	<i>acidophilus</i>	88.4	3

Lactobacilli identified the following species: *Lactobacillus plantarum*, *Lactobacillus helveticus*, *Lactobacillus fermentum*, *Lactobacillus brevis* and *Lactobacillus acidophilus*.

noted that in the area of Moundou, sanitary measures are satisfactory. Ben Amor et al. (1998) have identified twelve (12) isolates, seven (7) *Lactococcus lactis* subsp *lactis*, *Lactococcus lactis* subsp *cremoris* and two (2) bacteria contamination. These same authors have conducted additional research identified *Lactococcus diacetylactis*. They have shown by their results that the mesophilic lactic flora is represented by three species of *Lactococcus* flora associated with contamination of *Enterococcus* genus. Many studies (Tantawi et al., 1983., Abo Elnaga et al., 1977; Jiraidi et al., 1996) in the Maghreb and the Middle East on the microbiological analysis of "Leben" or "Laban" showed that lactic flora dominant is that belonging to the lactic streptococcus represented by the following species: *Lactococcus lactis* subsp *lactis*, *Lactococcus lactis* subsp *cremoris* and *Lactococcus* subsp *diacetylactis* associated with flora pseudolactique contamination dominated by *Enterococcus* genus. These authors although worked in hot climates but they have not reported thermophilic lactic acid bacteria. Ouadghiri (2009) reported that "Lben" in Morocco is typically dominated by species *Lactococcus lactis*, *Lactobacillus plantarum* and *Leuconostoc pseudomesenteroides*. For Ngassam (2007), on ten (10) samples of curd during cold, he could identify with the M17 medium and API 20 STREP galleries ten (10) *Lactococcus lactis* subsp *lactis* exclusively. These results are similar to ours because we have not met flora contamination. El-Baradei et al. (2007) did not find in their research flora contamination. They were identified as lactic genres themselves even if the species different from ours. This is *Lactococcus lactis* subsp *lactis*, *Lactococcus* and *Lactococcus garviae raffinolactis*. Lafarge et al. (2004) have been confirmed by molecular methods the predominant presence of the species *Lactococcus lactis* subsp *lactis*. Pu et al. (2002) are enriched in the scientific field of lactic acid bacteria by the use of PCR. With few exceptions, these authors found similar to our own species: *Lactococcus lactis* subsp *lactis*, *Lactococcus lactis* subsp *cremoris* and *Lactococcus lactis hordniae*. As against the Lebanese and Iraqi in the hot or cold season, they have always identified *Streptococcus thermophilus* and *Lactobacillus bulgaricus* associated with yeast as *Kluyveromyces fragelis*, *Saccharomyces cerevisiae* and *Saccharomyces lactis* which play an important role in the fermentation "Laban" (Abo Elnaga et al, 1977; Loons, 1994). The isolation of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* is linked to the synergistic action of these two bacteria.

Regarding the ten (10) *Lactobacilli* isolates, we identified four (4) species of *Lactobacillus plantarum*, two (2) species *Lactobacillus fermentum*, two (2) species *Lactobacillus brevis*, one (1) species of *Lactobacillus acidophilus* and one (1) species of *Lactobacillus helveticus*. These results show that in Sudanian species

are different because in the Sahel of Chad we met only one species: *Lactobacillus plantarum*. Ben Amor et al. (1998) also identified seven (7) of *Lactobacillus plantarum* strains on seven (7) isolates. They argue that *Lactobacilli* are either absent (Leben Algeria and Tunisia), or in very low numbers for the Moroccan "Leben". But research on the Chadian "Laban" helped highlight several species of *Lactobacilli*. Similarly, Khosrof (1996) found on the Tunisian "Leben" an association of *Lactobacilli*: *Lactobacillus helveticus*, *Lactobacillus acidophilus*, *Lactobacillus fructosus*, *Lactobacillus casei* subsp *pseuplantarum* and *Lactobacillus delbruekii* subsp *lactis*. Weerkamp et al. (1996) in Europe have shown that lactic flora is a mesophilic : *Lactococcus lactis* subsp *lactis*, *Lactococcus diacetylactis*, *Lactococcus lactis* subsp *cremoris*, *Leuconostoc lactis* and *Leuconostoc mesenteroides*. This would mesophilic flora in relation to the climate of this continent which is unfavorable to the development of thermophilic bacteria. Saied and Boudabous (1994) isolated from local dairy products the following germs: *Streptococcus*, *Lactobacillus*, *Lactococcus lactis* subsp *lactis*, *Lactococcus lactis* subsp *diacetylactis*, *Lactococcus lactis* subsp *cremoris*. With regard to species and subspecies, the authors identified among other *Lactobacillus brevis*, *Lactobacillus plantarum*, *Lactobacillus casei*. But these authors have not only worked on the curd. They also worked on the cheese and yogurt. They worked in the cold season, but they could find thermophilic species as in the present study.

CONCLUSION

These work in the Sudanian zone of Chad complemented those that have been made in the Chadian Sahel. Identified lactic species are: *Lactococcus diacetylactis*, *Streptococcus thermophilus* and *Lactococcus lactis*. Regarding *Lactobacilli*, we discovered the following species: *Lactobacillus plantarum*, *Lactobacillus helveticus*, *Lactobacillus fermentum*, *Lactobacillus brevis* and *Lactobacillus acidophilus*. It is clear from our study; Curd "Laban Rayib" contains a variety of species of lactic acid bacteria whose properties would be useful in the processing of milk. The study has enriched the knowledge of ecology of lactic acid bacteria. However, these preliminary results are far from exhaustive. A much more thorough study using molecular biology techniques could help to characterize these bacteria benefit. Such work would be more in improving the quality of fermented dairy products consumed and sold in Chad.

REFERENCES

Abo-Elnaga IG, El Aswad Moqi M (1977). Some chemical and

- Microbiological characteristics of the leben. *Milchwissenschaft*. 32: 521-524.
- Ahmed AI, Mohammed AA, Faye B, Blanchard L, Bakheit SA (2010). Assessment of quality of camel milk and gariss, north Kordofan State, Sudan. *Res. J. Anim. Vet. Sci.* 5(1):18 – 22.
- Badis A, Laouabdia-Sellami N, Guetarni D, M Kihal Ouzrout R (2005). Phenotypic characterization of lactic acid bacteria isolated from raw milk goat populations of two local "Arabia and Kabyle." *Science and Technology C - N °23*: 30-37.
- Ben Amor K, Cornelieus C, Mahjoub A, Thonart PH (1998). Identification of the lactic flora Tunisian traditional fermented milk (Lben) and evaluation of flavoring compounds. *Microb. Hyg. Ali.* 10 (27): 31-36.
- Chammas GI, Saliba R, Beal C (2006). Characterization of the fermented milk —LabanII with sensory analysis and instrumental measurements. *J. Food Sci.* 71: S156–S162.
- Doutoum AA, Tidjani A, Abdelaziz Arada I, Tidjani SMT, Balde M, Sylla KSB, Seydi Mg, Toguebaye BS (2013). Identification of the lactic microorganism responsible for milk coagulation in Abeche (Chad). *Afr. J. Food Sci.* 7(5):103-106.
- EIBaradei G, Delacroix-Buchet A, Ogier CJ (2007). Biodiversity of bacterial ecosystems in traditional Egyptian Domiat cheese. *Applied and environmental microbiology* the 73(4): 1248-1255, Egypt: American Society for Microbiology.
- EI-Baradei G, Delacroix-Buchet A, Ogier JC (2008). Bacterial biodiversity of traditional Zabady fermented milk. *Int. J. Food Microbiol.* 121: 295–301.
- FAO (1995). Le lait et les produits laitiers dans la nutrition humaine. Série FAO : Alimentation et nutrition – 28 :271
- Fédération Internationale du Lait., "Lait et produit laitiers, Préparation des échantillons et des dilutions en vue de l'examen
- Jiraidi Z, Guizani N (1996). Physicochemical characterization and microbiological leben Tunisia. *Microb. Hyg. Ali.* 8 (22): 1-7.
- Jiwoua C, Milliere JB (1990). Lactic Acid Bacteria and Enterococci curd (Pindidam) produced in Adamawa (Cameroon). 70:475-486.
- Kandler O, Weiss N (1986). Regular Gram-positive rods nonsparing, in: Sneath PHA, Mair NA, Sharpe ME, Holt JG (1986) (Eds.), *Bergey's Manual of system. Bacteriol.* Williams and Wilkins, Baltimore MD, p. From 2:1209-1234.
- Khosrof S (1996). Isolation and Identification of *Lactobacillus* from dairy products. *Microb. Hyg. Ali.* 8(21):1-8.
- Lafarge V, Ogier JC, Girard V, Maladen V, Leveau J Y, Delacroix-Buchet A (2004). The potential for studying bacterial TTGE some raw milk and dairy products, In: *Milk* 84:169 – 178, Paris: INRA, EDP Sciences.
- Leveau JY, BOUIX M (1993). Microbiologie industrielle : les micro-organismes d'intérêt industriel. Tec et Doc Lavoisier, Paris, France.
- Loons A (1994). Milk fermented by lactic acid bacteria. Lactic acid bacteria: fundamental and technological aspects. Ed: F. M Luquet. : pp.136 - 154.
- Luquet F, Corrieu MG (2005). Lactic acid bacteria and probiotics. Edition 8c Tec Doc Lavoisier. Paris. pp. 307.
- microbiologique", Document 122C.
- Ngassam CT (2007). Contribution to the study of the microbiological characteristics of lactic acid bacteria fermented milks craft in Senegal: the case of the Niayes. Dakar: Th Med. Vet. N° 19.
- Ouadghiri M, Vancanneyt M, Vandamme P, Naser S, Gevers G, Lefebvre K, Swings J (2009). Identification of lactic acid bacteria in Moroccan raw milk and traditionally fermented skimmed milk 'lben'. *J. Appl. Microbiol.* 106 : 486–495.
- Pu ZY, Dobos MG, Limsowtin KY, Powell IB (2002). Integrated polymerase chain reaction-based procedures for the detection and identification of the species and subspecies of Gram-positive bacterial genus *Lactococcus*:. In: *J. appl. Microbiol.* 94:353-361
- Rastall RA, Gibson GR, Gill HS, Guarner F, Klaenhammer TR, Pot B, Reid G, Rowland IR, Sanders ME (2005). Modulation of the microbial ecology of the human colon by probiotics, prebiotics and synbiotics to enhance human health: an overview of enabling science and potential applications, *FEMS Microbiol. Ecol.* 52: 145–152.
- Raynaud S (2006). Régulation métabolique et transcriptionnelle de l'autoacidification chez *Lactococcus lactis*. Thèse de Doctorat. Institut National des Sciences Appliquées de Toulouse, 309 p.
- Saied KR, Boudabous A (1994). Bacteria of the genera *Lactobacillus* and *Streptococcus* isolated from local dairy products. *Microb. Hyg. Ali.* 15 (6): 3 - 21.
- Savadogo A, Ouattara CAT, Bassole IHN, Traore AS (2004). Antimicrobial activities of lactic acid bacteria strains isolated from Burkina Faso fermented milk. *Pakistan. J. Nutr.* 3(3):174-179.
- Takahiro M, Nobuhiko K, Toshinao G (2007). Milk consumption does not affect body mass index but may have an unfavorable effect on serum total cholesterol in Japanese adults. *Nutr. Res.* 27: 395–399.
- Tantawi-Elaraki A, Berada M, Emarrakchi A, Berramou A (1983). Preparation of Moroccan leben using selected bacterial strains. *Proceedings of the Inst. Agro. Vet. (Morocco)*. 3:49- 58.
- Weerkamp AH, Klijin N, Neeter R, Smit G (1996). Properties of mesophilic lactic acid bacteria from raw milk and naturally fermented raw milk: *Milk Netherlands. Dairy. J.* 50: 319-332.
- Zadi-Karam H, Karam NE (2007). Growth and acidification kinetics of strains of *Lactobacillus* isolated from camel milk. *Renc. Rech. Ruminants*, 2007, 14.
- Zamfir M, Vancanneyt M, Makras L, Vaningelgem F, Lefebvre K, Pot B, Swings J, De Vuyst L (2006). Biodiversity of lactic acid bacteria in Romanian dairy products. *Syst. Appl. Microbiol.* 29:487–495.