# **ORIGINAL ARTICLE**

# Effect of fermentation process on hygiene and perceived quality of *lait caillé*, an ethnic milk product from Burkina Faso

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# Abstract

*Lait caillé* is a traditional fermented milk product in Burkina Faso. The objective of this study was to contribute to consumer acceptance of *lait caillé*. For this purpose, the production practices in rural and urban areas were identified through semi-structured interviews, while the perceived quality of *lait caillé* in urban area was investigated through a survey. Then, microbiological and physico-chemical parameters were analysed on samples from rural and urban sites. Finally, an attempt to improve the hygiene of the traditional processing was proposed by use of *Lactococcus lactis* and *Leuconostoc mesenteroides* stains as starter. These were previously isolated from traditional *lait caillé*. The results on the manufacturing processes revealed from the raw milk practices of spontaneous fermentation, backslopping and contact with bacterial biofilms attached to container. The survey on perceived quality indicated that traditional *lait caillé* possessed a niche market which could be enlarged by implementation of good manufacturing practices in the production sites. The microbiota of the end product was characterised by high loads of *Enterococcus* spp., *Enterobacteria* and *Pichia* spp. Fermented milks by starter cultures showed improved hygienic quality and a positive sensory appreciation. However, the use of selected strains might be followed by loss of some features of traditional *lait caillé*, which scientists should work to resolve.

**Keywords** Traditional *lait caillé*, Manufacturing practices, Consumer perception, Starter culture, Fermentative flora, Hygienic quality

# Introduction

Animal products have an important economic and cultural value in Africa. In Sahelian countries, they occupy the second place in terms of global trade [1]. The dairy sector in particular is an important sector in

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<sup>1</sup> Département Technologie Alimentaire (DTA), Institut de Recherche en Sciences Appliquées et Technologies (IRSAT), Centre National de la Recherche Scientifique et Technologique (CNRST), Ouagadougou, Burkina Faso these countries because it constitutes a strategic lever for reaching food security, gender equity and reducing poverty [2]. The typical local dairy products most frequently encountered are raw milk, pasteurized milk and traditional fermented milk; yoghurt is also produced locally, but generally with imported ingredients such as powdered milk, flavours, starter cultures, which tend to assimilate it to western-like products [3]. In Burkina Faso, the traditional curdled milk, often called *lait caillé*, was reported to be the product of spontaneous fermentation of raw milk by the action of endogenous microorganisms [4, 5]. The raw material for *lait caillé* production is essentially cow milk but sometimes goat milk is used. Historically, people of the Fulani tribe particularly the



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women, were the main processors and traders of lait *caillé*, mostly produced in rural areas [4, 5]. While these areas are still characterised by household production and consumption of local dairy products, urban areas are characterised by the predominance of imported dairy products used as raw materials or end products [3]. Thus, with the advent of food globalization, the traditional lait caillé is being gradually supplanted and mislabelled, with the risk of seeing the legacy of this traditional food disappear. Most of previous research articles on traditional lait caillé focused on identification and/or selection of microorganisms involved in lactic fermentation [4-6]. As a result, the authors pointed out the need to improve the processing and recommended the use of endogenous starter as a way to revitalize the local dairy sector [4-6]. However, a complete view on production practices of lait caillé, as well as a microbiological assessment in parallel with consumer perception are keys aspects for comprehension and preservation of the traditional expertise, and for orientations in future promoting actions. Thus far, there is lack of data related to these important aspects and the production attempts at industrial level are yet to be undertaken.

The objective of this study was to contribute to consumer consumption of the traditional fermented milk, *lait caillé* from Burkina Faso. More specifically, production practices at rural and urban levels and perceived quality of *lait caillé* in urban area were investigated. Then, microbiological and physico-chemical parameters were analysed on fermenting samples. Finally, an attempt to improve the traditional processing was proposed, by the use of endogenous lactic acid bacteria (LAB) cultures.

# **Material and methods**

#### Determination of manufacturing practices

A semi-structured survey was carried out in the cities of Ouagadougou (Centre), Fada-N'Gourma (East), Bobo-Dioulasso (South-West) and 4 surrounding villages of Bobo-Dioulasso which were Yegueresso, Flasso, Samanga and Farakoba (Additional file 1) to determine the traditional curdled milk production practices. In Ouagadougou and Bobo-Dioulasso, interviews took place with individual processors, representatives of an association of small-scale processing units (SCOOPS-TL/Neema) and sellers from 4 open-air markets. In the 4 outlying villages of Bobo-Dioulasso, interviews were held with breeders and processors from 4 family farms and a breeder from a milk collection center (CCL-Yegueresso). In the town of Fada-Ngourma, interviews took place with breeders and representatives of small-scale dairy units. Data collected concerned the origin of the milk, the processing, the storage conditions and the use of the product. Participants were informed about the purpose of the investigation and free consent was sought before the interview.

#### Determination of consumer perception

Consumer perception on the quality of the traditional fermented milk *lait caillé* was determined by a survey in the city of Ouagadougou, capital of Burkina Faso. Data was collected from 208 respondents randomly selected in twenty-six neighbourhoods and concerned socio-demographic profiles, reasons for consumption/non-consumption, consumption patterns and parameters to increase *lait caillé* consumption (Additional file 2). Participants were informed about the purpose of the investigation and free consent was sought from them before taking the survey.

### Production trials and sampling for analyses

Production trials of traditional *lait caillé* were performed at two sites: in a family farm in Yegueresso (a rural area) and in the environment of a public market named Katreyaar, in Ouagadougou (the most important urban city of the country). On both sites, the processors were asked to produce *lait caillé* according to their own diagram which was identified to be spontaneous fermentation of unpasteurised raw milk (Fig. 1). Fermentations at Katreyaar and Yegueresso sites lasted 48 and 49 h respectively. Samples were collected aseptically in sterile vials and transported in an ice-box to the laboratory.

# Determination of pH, enumeration and identification of microorganisms

The pH values were determined on all samples with a pH meter (Hanna, USA). Total LAB, lactococci, yeasts and molds, as well as enterobacteriaceae counts, were performed on traditional *lait caillé* samples by use of respectively De Man Rogosa Sharp (MRS; DIFCO, USA), M17 (Liofilchem, Italy), Sabouraud Chloramphenicol (Liofilchem, Italy) and Violet Red Bile Glucose (Liofilchem, Italy) agar media as previously described [5, 7]. Furthermore, following Gram and catalase tests [8, 9], a molecular identification of the presumed LAB and yeasts was performed on samples from Katre-yaar in Ouagadougou. Identification was done after (GTG)<sub>5</sub>-rep-PCR followed by 16S rRNA and 26S rRNA genes sequencing for LAB and yeast respectively [5, 10–12].

# Use of starter culture for *lait caillé* production at factory scale

Trials in a semi-artisanal dairy unit (Fromagerie Gariko) in the city of Ouagadougou were performed to improve the traditional fermented milk hygiene. Two strains of *Lactococcus lactis* (GenBank accession numbers: MH431827, MH431825) were used individually.



Fig. 1 Flow diagram of *lait caillé* traditional manufacturing practices in Burkina Faso. Three fermentation practices (contact with bacterial biofilms into a specific container, spontaneous fermentation and backslopping) are illustrated

Additionally, *L. lactis* (GenBank accession number MH431827) was used in co-culture with *Leuconostoc mesenteroides* (GenBank accession number MH431793). These LAB strains were previously isolated from traditional *lait caillé* obtained by spontaneous fermentation and were tested in laboratory [5, 13].

Starter cultures were prepared as described previously [13] with some modifications. Following cultivation in agar and broth media, cells were collected by centrifugation at  $4000 \times g$  for 10 min, washed twice with 20 ml of sterile diluent, pH 7.0 ± 0.2 and finally resuspended in 20 mL of sterile diluent. This cell suspension was used for inoculation. Co-cultures were prepared

from cultures of individual strains as described above. Then, equal volumes of the individual strains cultures were mixed to have a final volume of 20 mL. The inoculum load was determined by colony counting on agar media.

Raw milk was filtered through a mesh cloth, pasteurized in a water bath (90 °C, 2 min) and distributed in plastic buckets (4.5L/bucket). Inoculation was carried out at  $32 \pm 2$  °C (0.2%, v/v – 10<sup>6</sup> CFU/mL) followed by incubation at  $32 \pm 2$  °C for 10h30min–11h30min. After first trials, adjustments were made with the producer to improve the hygienic quality of the product, followed by at least two other trials for each starter culture. Duplicate samples were collected for microbiological enumerations and pH determination.

Sensory profile using a 3-point hedonic scale for colour, aroma, texture and taste attributes and ranking tests were carried out on the fermented milks produced by use of the previously characterised LAB. A panel of 7–10 people, not necessarily *lait caillé* consumers, carried out the assessment to provide preliminary indications. Free consent was sought from them before participation.

## Statistical analysis

Chi-square  $(X^2)$  test from SPSS version 20 was used to assess relation between traditional *lait caillé* consumption and socio-demographic factors (p < 0.05). Principal component analysis (PCA) and hierarchical clustering were performed with R commander version 2.8-0 to analyse characteristics suggested by academic groups of respondents to improve traditional *lait caillé* quality.

# **Results and discussion**

### Manufacturing practices of traditional lait caillé

The survey on manufacturing practices provided an overall diagram of different processes.

In family farms in rural areas, raw milk was supplied directly from cattle while at market sites in urban areas, raw milk was supplied by transporters from farms at the outskirts of the town. Production of *lait caillé* was done at home or alternately between home and sale sites (markets). Fulani women were the main sellers and were considered as traditional vendors of *lait caillé*. At the level of family farms, the preliminary operations were milking and filtration (Fig. 1). Milking was generally manual and initiated by stimulation of the calf (Fig. 2). Then the collected raw milk was filtered into a container and transported to the fermentation site (either at home or the sale site). In some cases (in urban areas), it was revealed that the curdled milks sold at the market actually came from the spontaneous fermentation of unsold fresh milk. Due to the very liquid texture and/or the long time before the onset of coagulation of raw milk at ambient temperature at some market sites during the survey, practices of non-conventional practices were suspected among some vendors. This was supported by the report from few respondents of the use of plants or cooking salt to improve the shelf life of raw milk. At the fermentation stage, three different practices were reported.

In most cases, the raw milk was not heated (Fig. 1). Fermentation was spontaneous, at room temperature and in various types of containers (calabashes, plastic, or dishes made of iron, tin, etc.). The process consisted in pouring the raw milk into the container, closing with a lid and waiting for the organoleptic characteristics of the product to be obtained. This practice was the most frequently reported process. In previous studies on the microbiology of fermented milk [4–6], spontaneous fermentation of raw milk was also mentioned. However, non-pasteurized milk may carry undesired microorganisms that may impair the safety of the final product as suggested by previous authors [5, 6].

In other cases, the practice of "back-slopping" was reported for fermentation, consisting of incorporating a



Fig. 2 Pictures of traditional *lait caillé* processing steps (**a**–**f**) according the spontaneous fermentation practise of unpasteurised raw milk, and typical selling points in urban areas (**g**, **h**)

small quantity of curdled milk from a previous production into the raw milk, pasteurized or non-pasteurized (Fig. 1). Nevertheless, traditional curdled milk from a previous production was not always available due to storage challenge. Furthermore, confusing cases were noticed during some reports in urban areas where the fermented milk used as inoculum was a commercial yogurt. Some others processors reported that when the sourness of their intended yoghourt was excessive, they named the product after the denomination of the traditional fermented milk, lait caillé. In rural areas, the low availability of commercial yoghurt might have contributed to prevent its mislabelling for lait caillé. In addition to be perceived more acidic than yogurt, traditional lait caillé is microbiologically different [5, 6]. This confusing naming in urban areas confirms the threat on the legacy of the traditional fermented milk and the need to collect all the traditional expertise in this domain.

In fewer cases, reports of heating raw milk before fermentation were made (Fig. 1). The fermentation vessel was specific. The use of the same fermentation vessel could also be considered as an ancient expertise on the use of starter cultures. Indeed, this practice would gradually select the predominant LAB which remain attached in the container as corroborated by Parker et al. [14]. These authors reported a similar practice in Senegal and indicated that the bacterial biofilm which was formed inside the container, served as starter for the fermentation of pasteurized raw milk. However, the downside of this practice would also be the presence of pathogenic microorganisms or any other undesired microorganism [14].

Fermentation of *lait caillé* lasted for 1 day (overnight) to 3 days, depending on whether the climate was warm or cold. The producer stopped the fermentation when the characteristics of the product were judged to be satisfactory. Then the clot was broken up with a wooden stick (Fig. 2) and the product homogenized using this wooden instrument or any other suitable instrument. *Lait caillé* was consumed directly or in combination with cereal foods or kept for sales or used for rituals.

# **Consumer perception**

The profile of the survey respondents is shown in Table 1.

The consumers represented 74% of the respondents. There was no significant dependence ( $p^{<}0.05$ ) between age, gender, marital status, academic education (Fig. 3), duration of residency in city, religion (Additional file 3) and *lait caillé* consumption, while dependence was found to be significant ( $p^{<}0.05$ ) between *lait caillé* consumption and household size (Fig. 3).

A previous study [15] on the determinants of some dairy products consumption in Bobo-Dioulasso, where

**Table 1** Main socio-demographic characteristics of therespondents. The repartition of the respondents is presentedaccording gender (%), marital status (%), ethnicity (%), religion(%), and length of residency (number of years) in the city

Main features of the respondents (N=208
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	Gender (%)						
	Men		Women				
	65.87		34.13				
Marital sta	atus (%)						
Single	Married	Divorcee	Widow(er)				
40.40	56.70	1.40	1.40				
Ethnic gro	up (%)						
	Mossi		Others				
	67.79		32.21				
Religion (9	6)						
	Animism	Islam	Christianity				
	0.96	64.42	34.62				
Household	d size (numbe	r of people)					
<5	5—10	10—15	≥15				
47.80	41.40	9.40	1.50				
Academic	education (%	5)					
None	Koranic	Other	Primary	Secondary	Higher		
12.50	7.20	1.40	27.40	33.20	18.30		
Years of re	sidency in Ou	agadougou					
<10	10-20	20-30	30–40	40-50	≥50		
25.98	22.06	29.41	17.16	3.92	1.47		

the respondents cultural profile and the fermented milk (artisanal yoghurt) [15, 16] included were different from the ones in the present study, concluded that religion and gender factors had no significant influence on consumption contrarily to marital status.

In the present study, the sour taste, texture (presence of curd and cream), perception as a product of good nutritional value and natural, were the most reported characteristics of *lait caillé* for which consumers valued the product (Fig. 4).

The perception as natural product was probably given in opposition to yoghurt which could be seen more artificial (powder milk, added flavours, foreign origin) by local consumers. Education as source of sensitisation is an important factor that might have contributed to a raised awareness on the hygiene and safety aspects among respondents, since it was previously reported to play an increasing role as a determinant of dietary behaviour in low- and middle-income urban African populations [17–19]. Figure 5a shows a significant relation between the consumer education and the eating site. Indeed, the more the consumer was educated according the formal academic system (primary,



**Fig. 3** Relations between *lait caillé* consumption and some socio-demographic factors in the city of Ouagadougou: **a** age; **b** gender; **c** marital status; **d** academic education; **e** household size. The chi-square ( $X^2$ ) scores, *p*-values and degrees of freedom (d*f*) are presented for each test of association (*p* < 0.05 for significance level)



Fig. 4 Characteristics assigned to lait caillé by consumers (%) in the city of Ouagadougou as reasons for consumption

secondary and higher academic levels), the less the selling site of *lait caillé* was used for consumption (p < 0.05).

This relation emphases the importance of food environment and consumer awareness as determinants for consumption [17]. By grouping the respondents according to the academic level in relation with their suggestions on aspects to improve in traditional lait caillé, hygiene (packaging included) was the most reported point followed by non-desired organoleptic characteristics. Individuals and variables plots from PCA (Fig. 6a, b) showed that the first dimension (57.38% variance explained) was associated with reducing sourness and odour (particularly preferred by respondents of primary and higher academic education) opposed to skimming (mainly suggested by respondents of koranic education). The second dimension (32.26% variance explained) was associated with improving hygiene and packaging (particularly suggested by unschooled respondents). The hierarchal clustering confirmed this tendency, showing that respondents from the formal academic system were the closest in their suggestions on aspects to improve while respondents from koranic education were forming a separate cluster (Fig. 6c).

Paradoxically, unschooled respondents were characterised by a higher demand for hygiene probably because many of them used the selling site as eating place (Fig. 5a) and were exposed to the vendors' outlets and behaviours related to hygiene. The observations could also indicate that academic education was not the only source of sensitisation on food hygiene in this urban area. Indeed, media and word of mouth communication might have played an important role since they are popular and were reported to be effective as driver for consumer purchase decision in some restaurants elsewhere [20]. These data suggest that improving some aspects of *lait caillé* properties (in particular the safety and integrity) and improving the retail outlets, could lead to an increase in consumption.

However, technological improvements should preserve the image of "natural" product which is still well appreciated. Since the sensorial characteristics are variously appreciated, improvements should focus more on maintaining integrity, hygiene and upgrading the storagedistribution system that would also promote endogenous economic development [21, 22].

# Microbiological characteristics of lait caillé samples

The pH values in traditional *lait caillé* samples from rural and urban sites decreased during fermentation to a final value of  $4.4 \pm 0.13$ , while increases were observed for mesophilic aerobic bacteria and LAB (Fig. 7a, b). The number of yeasts and molds peaked at 33 h and 17 h of fermentation respectively at Yegueresso and Katre-yaar sites, while enterobacteria load peaked at 14 h in Yegueresso (8.5 log<sub>10</sub> CFU/g) site and between 17 and 48 h in Katre-yaar site (up to 8.7 log<sub>10</sub> CFU/g). Although standard values for pH in fermented milks were not fixed by the CODEX STAN 243-2003 [23], except for *kefir, kumys* and yoghurt, the standard specified a minimum value



**Fig. 5** Reported eating locations of traditional *lait caillé* (**a**) and aspects to improve (**b**) by respondents in the city of Ouagadougou grouped according to academic education. The chi-square ( $X^2$ ) scores, *p*-values and degrees of freedom (*df*) are presented for the test of association between eating locations and academic education (p < 0.05 for significance level)

of 7  $\log_{10}$  CFU/g for LAB in fermented milks which was satisfied in the two sites. The *Enterobacteriaceae* counts similar to previous reports [5, 6], supports the negative perception of some consumers and confirms the need to improve hygiene including pasteurisation of the milk.

# Identification of LAB and yeasts occurring during *lait caillé* fermentation in Katre-yaar site

LAB isolates in the samples from Katre-yaar (Table 2) showed a predominance of *Enterococcus* spp. followed by *Leuconostoc pseudomesenteroides/Leuconostoc mesenteroides*.

The yeast community was dominated from the start of fermentation by *Cryptococcus* spp. and *Rhodotula* 

mucilaginosa, then by Pichia kudriavzevii/Pichia guilliermondii and Trichosporon spp.

Compared to previous studies [5, 6], *lait caillé* samples from Katre-yaar were characterized by a different profile of cultivable microbiota. While in our previous study [5], *Lactococcus lactis, Enterococcus lactis, Enterococcus hirae*, *Saccharomyces cerevisiae* and *Candida* spp. were revealed to be the major microorganisms from rural *lait caillé* samples, in the present urban *lait caillé* samples less common predominant microorganisms *Enterococcus* spp., *Pichia* sp. and *Trichosporon* spp. were observed. In addition, none of the pre-cited studies [5, 6] reported the presence of yeasts from *Pichia*, *Cryptococcus* or *Rhodotula* genus, which were



**Fig. 6** Principal component analysis (PCA) graph (**a**: variables plot, **b**: individuals plot) for respondents' suggestions to raise traditional *lait caillé* quality and hierarchal clustering (**c**: dendrogram tree) from the PCA. The variables plot in the PCA graph corresponds to the characteristics of *lait caillé* suggested for improvement by the respondents. The individuals plot in the PCA graph corresponds to the academic education of the respondents

Table 2    Lactic acid bacteria (LAB) and yeast successions during
milk fermentation at urban site (Katre-yaar). Sampling during the
fermentation process were done at 05 specific time points from
the raw milk (0 h) to the end product (48 h)

	Fermentation time (h)			
	0	17	24	48
LAB relative abundance (%)				
Enterococcus spp. (mundtii/durans/faecium/etc.)	100	100	100	66.7
Leuconostoc pseudomesenteroides/mesenter- oides	-	-	-	33.3
Yeast relative abundance (%)				
Rhodotorula mucilaginosa	55	-	-	-
Cryptococcus spp. (diffluens/liquefaciens/etc.)	45			
Candida spp.	-	40	-	20
Pichia kudriavzevii/Pichia guilliermondii	-	60	25	50
Clavispora lusitaniae	-	-	-	10
Trichosporon spp.	-	-	75	20
– Not detected				

identified in the present study as in *nunu* from Ghana (*Pichia kudriavzevii*), *sethemi* (*Cryptococcus curva-tus*) from South-Africa and *suusac* (*Rhodotula muci-laginosa*) from Kenya [7, 24, 25]. The high variability of the microbiota involved in spontaneous fermentation of unpasteurised milk illustrates some challenges when it comes to identifying a typical microbiota of *lait caillé*. This fact, combined to the high availability of yoghurt starter in urban area, could explain the use of the latter to produce fermented milks wrongly considered as traditional *lait caillé*.

# Microbial and sensorial quality of milk samples fermented by endogenous LAB from *lait caillé*

Preliminary tests were useful to assess the efficiency of the manufacturing process already in use in the unit. The results showed a high load of *Enterobacteriaceae* in the fermented milks (Fig. 8a), with values above the satisfactory limit of  $2 \log_{10} \text{CFU/ml}$  [26, 27].

Adjustments (Additional file 4) were focused on good handling of pasteurized milk and sanitization of processing materials. Following adjustments, microbial loads were satisfactory (mean values are presented in Fig. 8b) and were ranging between  $<1-3.6 \ 10^1 \ CFU/ml$  for *Enterobacteriaceae* and 2.8  $10^8-2.1 \ 10^9 \ CFU/ml$  for LAB. Final pH values varied between 4.4 and 4.6. The variations of *Enterobacteriaceae* loads, although within the satisfactory limit, suggested the need of strengthening the processors capabilities and monitoring of the system to ensure consistent quality.



Fig. 7 Microbial cell counts and pH variations during spontaneous milk fermentation into *lait caillé* in urban (**a**: Katre-yaar) and rural (**b**: Yegueresso) sites. From the raw milk to the end product, 05 specific time points and 08 specific time points were considered in Katre-yaar and Yegueresso sites respectively, during the fermentation process which was stopped when the traditional producer indicated that the optimal characteristics were reached

# Sensorial appreciation of milk samples fermented with endogenous LAB from *lait caillé*

Sensory evaluation of the fermented milk samples obtained with starter cultures gave a preliminary indication about the sensory attributes. Panellists expressed a positive appreciation regarding overall acceptability. Fermented milks from monocultures were perceived less acidic and were better rated than those which resulted from co-cultures fermentation. This is in line with some of the conclusions from the investigation on *lait caillé* perception where some consumers pointed out the sourness as a cause of non-consumption while others appreciated it.

Data from the controlled fermentation, could be a response to the need for upgrading the traditional fermented milk process. However, lactic fermentations



Fig. 8 Microbiological quality of dairy products from a small manufacturing enterprise during preliminary trials (a) and following adjustments (b) of *lait caillé* controlled production. The controlled fermentation trials were performed with starter cultures of lactic acid bacteria in mono-culture (*Lactococcus lactis*) and co-cultures (*L. lactis* and *Leuconostoc mesenteroides*)

of raw milk performed spontaneously by endogenous microorganisms, lead to dairy products with complex characteristics in terms of flavour, viscosity, biochemical characteristics, safety and health promoting effects [28]. Therefore, the use of selected starter cultures might not lead to products with the same sensorial or nutritional attributes. Nevertheless, industrial-scale production of *lait caillé* cannot be sustainable without the use of starter culture, for the purpose of safety and consistent quality [28]. This is the dilemma that dairy research (particularly biotechnologies and socio-economics) and politics would have to resolve in order to

protect the legacy of traditional *lait caillé* and similar traditional fermented milks from Africa.

# Conclusion

The survey showed that the value chain associated with traditional *lait caillé* was characterized by consumer demand for hygienic and quality products. The manufacturing practices presented some variations with as common characteristics, endogenous expertise on fermentation and starter culture, uncontrolled fermentation and safety hazards. However, traditional *lait caillé* had still a niche market and new consumers could be reached by improving the hygienic quality by means including

pasteurisation of the milk, while preserving the characteristics of the product perceived as natural. The use of selected strains of LAB as starter, such as *Lactococcus lactis* and *Leuconostoc mesenteroides* could be a key for a sustainable production but technical follow up of the manufacturers is needed for appropriation of good manufacturing practises. In addition, improvement in hygiene of the storage-distribution system including packaging should be considered before implementation of such a new process.

#### Abbreviations

LAB	Lactic acid bacteria
MRS	Man Rogosa Sharp
PCA	Principal component analysi

## Supplementary Information

The online version contains supplementary material available at https://doi. org/10.1186/s42779-023-00185-4.

Additional file 1. Figure S1: Locations of Burkina Faso citiesand villagesinvolved in the study.

Additional file 2. Questionnaire of the consumer perception survey. The questionnaire was administered in French. The main points are translated.

Additional file 3. Figure S2: Relation between lait caillé consumption and some socio-demographic factors:religion; years of residency.

Additional file 4. Figure S3: Flow processand pictures of lait caillé manufacturing with starter cultures in a small manufacturing enterprise.

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#### Author contributions

GRB, BD, LJ, HSL contributed to conceptualization; CKY supervised the consumer perception survey; GRB supervised the manufacturing practices survey, performed the laboratory analyses and prepared the first draft of the manuscript. LJ and HSL contributed to validate the study. All authors contributed to methodology, writing the manuscript and approved the final version.

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#### Availability of data and materials

The datasets analysed during this study are included in this published article and its supplementary information files.

#### Declarations

### Ethics approval and consent to participate

Free consent was sought from the respondents before participation in the study.

#### **Consent for publication**

Not applicable.

#### **Competing interests**

The authors declare no conflict of interest.

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