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Monitoring Some Physicochemical and Bacteriological Parameters and Sensory Analysis of *Juniperus phoenicea* L. Leaves-supplemented Goat Milk: A South-western Algerian Traditional Flavored and Fermented Product

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ABSTRACT

Background: Traditional dairy products are widely consumed by the Mediterranean and sub-Saharan countries; they are traditionally prepared by rural women. This work focuses on understanding the traditional practices and enhancing the same by studying the physicochemical, bacteriological and organoleptic properties of fermented raw goat milk, supplemented by the leaves of the Phenician juniper species.

Methods: Monitoring of the juniper leaves-supplemented goat milk sample against a control one (without juniper leaves) was conducted. Three physicochemical parameters were tracked: pH, titratable acidity and temperature. However, the bacteriological analysis featured the following parameters: the total aerobic mesophilic flora, thermotolerant coliforms, coagulase-positive Staphylococci, Pathogenic bacteria namely *Salmonella spp* and *Listeria monocytogenes*, while the sensory test was based on the descriptive and hedonic analyses.

Result: The obtained physicochemical results showed a significant change in the pH and the titratable acidity parameters of the test sample compared to the control sample. This change was marked by an increase in the total aerobic mesophilic flora load (due to the fermentation phenomenon) and a decrease in the thermotolerant coliforms and the coagulase-positive Staphylococci loads for the test sample compared to the control test. A total absence of *Salmonella spp* and *L. monocytogenes* as pathogenic microorganisms was also notified for both samples. The qualitative phytochemical screening carried out on the *J. phoenicea* L. leaves showed the presence of several compounds known as constituents having an antimicrobial effect. On the sensory level, the control sample was characterized by a milky and acidic taste, while the herbaceous taste due to the components of the Phenician juniper leaves characterizing the test sample gave it a lower score on the established rating scale. A vision to maintain this type of artisanal practice, traditional knowledge and preserve this important indigenous wealth become necessary which contributes to improving the hygienic, sensory quality and shelf-life of the fermented goat milk.

Key words: Fermentation, Goat milk, Hygienic and organoleptic properties, *J. phoenicea* L. leaves, Traditional knowledge.

INTRODUCTION

The goat remains the most competitive animal in marginal areas where natural conditions require a minimum of adaptation and production potential in animal resources (Fantazi, 2004). According to Hellal (1986), the goat population in Algeria includes local and improved breeds of goats and is represented by the Arabian, Mekatia, Kabyle and M'zabit goat breeds. For centuries, goat milk is known for its nutritional value due to its richness in proteins, calcium, vitamins and to its better digestibility compared to cow's milk (Freund, 1997).

In general, milk is considered an excellent source of well-balanced nutrients that exhibits a range of biological activities and has several advantages on the level of digestion, metabolic responses to absorbed nutrients, organ growth and resistance to disease (Singh and Sachan, 2011, Rahimah *et al.* 2019). Otherside, traditional dairy products are widely consumed by the Mediterranean and sub-Saharan countries (Koussou *et al.* 2007). They are traditionally made by rural women (Medouni *et al.* 2005), whose fermented foods are the main source of nutrition for both rural and urban communities (Guetouache and Bettache, 2020).

The composition and nutritional value that allow milk among the most consumed products worldwide makes it a favorable environment for the multiplication of

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microorganisms (Guigma, 2013; Benyagoub and Ayat, 2015). In this context, a very interesting traditional practice is carried by southwestern Algeria's inhabitants. Their knowledge induced to practically add juniper leaves to goat's milk. This medicinal and aromatic plant is widely used in traditional and modern medicine, mainly as pharmaceutical preparations for an antiseptic goal or many other properties (Bellakhdar, 2006; Amalou and Mouhoubi, 2014).

A practice that not only makes the milk acidic, but also improves its organoleptic quality by reducing the acidic taste resulting from the acidification by fermentation and therefore derives the benefit from both raw milk and juniper leaves. For this purpose, this study aims to follow some physicochemical and bacteriological parameters, in parallel of analyzing the sensory quality of the flavored and fermented goat milk, a product of the southwest region's tradition of Algeria. To the best of our knowledge, this is the first time that this product and traditional practice have been highlighted on the level of the hygienic and sensory properties.

MATERIALS AND METHODS

All experiments were carried out at the laboratory of the Rokia dairy industry (Bechar-Algeria) and Mohammed TAHRI University of Bechar (Algeria), for three months from February to April 2021.

Sampling of raw goat milk

The sampling of raw goat milk of the *Arabia horra* breed (Arabian goat breed) was manually carried out by the breeder himself on a farm located in Bechar (South West of Algeria).

A sufficient volume of the milk was distributed in two sterile glass jars fitted with a hermetically sealed hatch and filled at the rate of 3L for each container (Fig 1), where we added to the test sample a mass of 26 g of *J. phoenicea* L. leaves, while the other sample without juniper leaves was considered as a control sample.

Plant material

Collect of *J. phoenicea* L. leaves

The studied species is called in Arabic (el Ar-ar) (vernacular name), in French (Genévrier de Phénicie) (Quézel and Gast, 1998) and in English (Phoenician juniper). This is certainly the most widespread species in North Africa where it is present from the coastal dunes to the Saharan limits (heliophilic species).

The *J. phoenicea* L. leaves were collected from the Mecheria region (Naâma province-West of Algeria) in November (2020) (Fig 2a) where they were cleaned, dried in dark and open-air (Fig 2b). A mass of confined leaves in the form of a knot and covered with sterile gauze (Fig 2c) was added to raw goat milk.

Phytochemical screening of *J. phoenicea* L. leaves

The various phytochemical tests were carried out on the aqueous, etheric and methanolic extracts, to identify the main phytochemical groups (secondary metabolites) of *J. phoenicea* L. leaves.

This is a qualitative analysis based on color reactions and/or tube precipitation and characterization by thin-layer chromatography (TLC), which were carried out according to standard methods described by (N'Guessan *et al.* 2009; Benyagoub *et al.* 2017; Benyagoub *et al.* 2018a; Traoré *et al.* 2019; Benyagoub *et al.* 2020a, Benyagoub *et al.* 2020b) as follows:

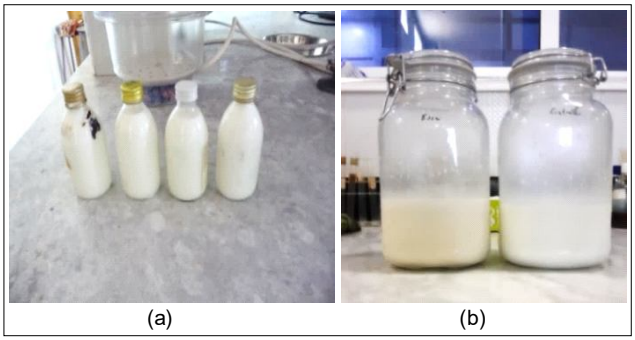
-Alkaloids (Mayer and Dragendorff test).

-Coumarins: A volume of 5 mL of ether extract and the methanolic extract was evaporated to dryness, the residue was dissolved in 1-2 mL of water by heating and then 0,5 mL of 10% NH_4OH was added. The tubes were observed under UV light at 365 nm. An intense fluorescence in the ammonia-containing tube indicates the presence of coumarins.

-Steroids and triterpenes (Liebermann-Büchard test).

-Tannins and polyphenol (Iron III chloride test and Stiasny test).

-Flavonoids (Shibata's or Shinoda test, Cyanidin test).

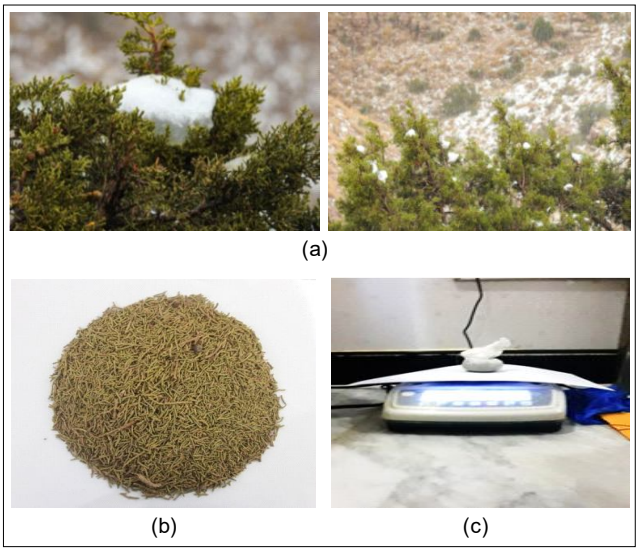


(a) (b)

Fig 1: Raw goat milk (Source: Original, 2020).

(a): Step 1: Analyzed sample of raw goat milk to assess its physicochemical and bacteriological quality.

(b): Step 2: Monitoring the fermentation process of raw goat milk (test sample and control sample).



(a)

(b) (c)

Fig 2: *Juniperus phoenicea* L. (Source: Original, 2020).

(a): *Juniperus phoenicea* L. tree from the Mecheria region. (Naâma province-West of Algeria) (November 2020). (b): Dried leaves of *Juniperus phoenicea* L. (c): *J. phoenicea* L. leaves packaged in the form of a knot covered by sterile gauze.

-Anthracenosides, free quinones and emodin (Bornträger test).
-Starch (Iodine test).
-Saponins (Foam stability index test).
-Reducing sugars (Fehling reaction).

Monitoring the fermentation of raw goat milk with *J. phoenicea* L. leaves

Physicochemical analyses

The samples intended for fermentation (test and control samples) have been undergone physicochemical analyses according to the standards (NA 676, 1994) by monitoring some parameters during natural fermentation, namely: pH, temperature (°C) and titratable acidity (g/L) which were measured as follows :

• The temperature and the pH of the milk were measured according to standard methods with a thermometer pH-meter (Adwa AD 1040, Romania) (AFNOR, 1986),

• Measurement of titratable acidity which is to measure lactic acid with sodium hydroxide (NaOH N/9) (Sigma-Aldrich, Czech Republic) until the beginning of a pink color (NF V04-206, 1969; ISO/TS 11869, 2012) in the presence of phenolphthalein (1%) (Sigma-Aldrich, India) as a color indicator. The acidity was expressed in grams of lactic acid per liter (g/L) of milk.

Detection of antibiotic residues

The agar well diffusion method was used for the detection of antibiotic residues. Freshly grown and standardized reference bacterial strains of *Escherichia coli* ATCC 25922 and *Staphylococcus aureus* ATCC 25923 was spread on Mueller Hinton agar (Sigma-Aldrich, India) using a sterile swab (spread plate technique), then, wells were punched into Mueller-Hinton agar plates to which were filled by a volume of 50 µL of raw goat milk.

The reference antibiotics tested by the disk diffusion method were as follows (Liofilchem, Italy): beta-lactams (Penicillin P 10 µg, Amoxicillin AMX 10 µg), Oxytetracycline (TE 30 µg), Erythromycin (E 15 µg) and Trimethoprim-sulfamethoxazole (SXT 25 µg) recommended by the 'Ceva Santé Animale Association' (Thabaut and Durosoir, 1979; Djemil, 2016).

The result was expressed by measuring the diameter of the inhibitory zone in (mm) produced around the wells after 18 to 24 hours of incubation at 37°C and then classified as sensitive (S), intermediate (I), or resistant (R) according to the criteria established by the Clinical and Laboratory Standards Institute (CLSI, 2018).

Bacteriological analysis

A series of dilutions of the sample to be analyzed up to the dilution factor of 10^5 was carried out with peptone water (PW) as a diluent (FIL-IDF 122C, 1996; ISO 8261, 2001). The choice of the dilution factor depends on the nature and the composition of the food as well as the level of contamination. The analyzed bacteriological parameters were as follows:

• Detection and enumeration of the total aerobic mesophilic flora (TAMF) (NF V 04-016, 1985; NF ISO 4833, 1991) were carried out by the pour plate technique on PCA agar medium (Liofilchem Diagnostici, Italy).

• Detection and enumeration of thermo-tolerant coliforms (ISO 4832, 1978; NF V08-050, 2009) were carried out by the pour plate technique on MacConkey agar medium (Liofilchem Diagnostici, Italy).

• Detection and enumeration of coagulase-positive Staphylococci (CoPS) were carried out using spread plate technique on Baird-Parker agar medium (Liofilchem Diagnostici, Italy) (JORA n.70, 2004).

• Detection of *Salmonella spp* (ISO 6785, 2001; JORA n.44, 2017).

• Detection and enumeration of *Listeria monocytogenes* (Corry *et al.* 2003; JORA n.3, 2006; ISO 11290-1, 2017).

• The assessment of the lactic acid bacteria load (LAB) was carried out using the pour plate technique (JORA n.43, 2004) on MRS agar and M17 agar for lactobacilli and Streptococci species, respectively (Liofilchem Diagnostici, Italy). Before pouring the medium, cycloheximide at a concentration of 1% (v/v) was added to the agar plate. The Petri dishes were incubated at 30°C for 48 to 72°C in microaerophilic conditions using an anaerobic gas jar pack system to reduce oxygen levels.

The horizontal counting methods for bacterial loads described by (FIL-IDF 100B, 1991; AFNOR, 1980; JORA n.70, 2004) were followed. However, monitoring the microbial evolution was assessed as a function of time (days) at room temperature, with a plotted curve representing the average bacterial load of two tests (duplicate) expressed in $\log_{10}$ CFU/mL.

Biochemical identification of bacterial isolates

The isolated bacteria on selective agar medium suspected as pathogenic isolates namely *Staphylococcus aureus*, *Salmonella spp* and *Listeria monocytogenes* were subjected to serial biochemical identification tests according to standard microbiological methods, mainly the phenotypic characterization by macroscopic examination on agar, fresh microscopic examination and Gram stain, coagulase test, catalase test, urease test, oxidase test and esculin hydrolysis (Tille, 2018; Benyagoub *et al.* 2018b).

Sensory analysis

For a long time, sensory analysis remains an essential approach to assess the quality of a food product. Closely associated with the characterization of physicochemical properties, it can be a tool for quality control and formulation of processed products (Benyagoub, 2011).

According to the French standard NF ISO 5492 (2008), sensory analysis is defined as 'the examination of the organoleptic properties of a product by the sense organs'. Due to the five senses, the human being has become the instrument of measurement of sensory analysis methods to characterize and assess products.

On an industrial scale, sensory analysis is at the heart of product development. For a better characterization of the foodstuffs as a product, sensory analysis is an essential tool not only for Research and Development (R&D) but also for the marketing/communication teams nowadays, to better

communicate their products internally through production teams and externally to the consumers (Thomas, 2016).

The sensory analysis carried out in this study was that of the descriptive analysis according to NF ISO 13299 (2010), which aims to qualify the difference between two products (Control and test sample). A 'sensory profile' was established for each product by the flavor profile method (Thomas, 2016).

A set of descriptors were grouped into sensory categories in a proposed tasting sheet, which has two parts:

The first part aims to describe the established descriptors, namely taste intensity, odor intensity, color intensity, aftertaste and viscosity, while the general appreciation was the second part carried out by a hedonic analysis (scoring test) aimed at capturing the hedonic status of the two products offered to compare them, which were rated on a hedonic 5-point scale of preference frequently used in the literature (AFNOR, 1995; Hernández and Lawless (1999) and defined by Depledt, SSHA (2009) as the state of a product favorably received by a specific individual or a specific population, depending on its organoleptic properties.

This analysis was carried out during the morning at a temperature between 20 and 25°C in the presence of 5 experts affiliated to Rokia dairy unit located in Ouakda-Bechar (South-West of Algeria), where an evaluation sheet was assigned to each expert and both encoded products ('A' was the test sample and 'B' was the control one). Besides, a bottle of water for rinsing the mouth was provided to experts.

Interpretation of the analysis results

The results were interpreted based on the contamination limit thresholds (m and M) of the bacterial parameters given by the Official Journal (JORA n.39, 2017), while the results of the physicochemical parameters were interpreted according to Algerian standards (NA 2692, 1992; JORA n.69, 1993).

Statistical analysis of data

The different analyses were carried out in two trials (duplicate) to confirm the obtained results, where the average was used for each parameter, on which the graphical presentations in the form of curve and radar were plotted using the Origin Lab Software (2018).

RESULTS AND DISCUSSION

Phytochemical screening of *J. phoenicea* L. leaves

The qualitative phytochemical screening results of *J. phoenicea* L leaves were given in Table 1. According to the table below, the phytochemical screening showed the presence of several compounds namely coumarins, tannins, terpenoids, free quinones, alkaloids salts, flavonoids, starch and also many others, with the absence of alkaloids bases, emodin, saponins and reducing sugars.

Monitoring the fermentation of raw goat milk with *J. phoenicea* L. leaves

Detection of antibiotic residues

The wells diffusion method results indicate an absence of inhibitory zone around the wells and consequently inhibitory residue-free, namely antibiotic one. This confirms the hygienic quality of the analyzed sample that meets national regulations (JORA n.39, 2017). Also, the susceptibility assay confirms these results, where the reference bacterial strain *E. coli* was susceptible to trimethoprim/sulfamethoxazole and tetracycline, while *S. aureus* strain was susceptible to oxacillin, erythromycin, cotrimoxazole and tetracycline (Table 2).

Table 1: Qualitative phytochemical screening of *J. phoenicea* L. leaves.

Phytochemicals compounds	Diethyl ether extract	Methanolic extract	Aqueous extract
Alkaloids bases	(-)	/	/
Emodin	(-)	/	/
Coumarins	(+)	(+)	/
Sterols or triterpenes	(+)	/	/
Terpenoids	(+)	/	/
Free quinones	(+)	/	/
Fatty acid and volatile oil	(+)	/	/
Alkaloids salts	/	(+)	(-)
Tannins	/	(+)	(+)
Reducing sugars	/	(-)	/
Flavonoids	/	(+)	/
Anthracenoside	/	(-)	/
Sterols glycosides	/	(+)	/
Anthocyanosides	/	(+)	/
Saponins	/	/	(-)
Starch	/	/	(+)
pH value of *J. phoenicea* L. aqueous leaves macerate	/	/	5.29

(+): Positive test; (-): Negative test; Diethyl ether, methanol and distilled water serve as a negative control. All chemicals used for analytical procedures were analytical grade or the highest purity available, free from any analyzed phytochemical compound.

Table 2: Multidrug-resistant profiles of the tested reference bacterial strains.

Bacterial strains	Antibiotics
E. coli ATCC 25922	TE-FOX-AMC-IPM-SXT-AMP and Susceptible to FOS-C-AK-CN
S. aureus ATCC 25923	E-TE-P and Susceptible to SXT-C-OFX-RA-CIP-CN-LEV

AMC: Amoxicillin-clavulanic acid, P: Penicillin, AMX: Amoxicillin, TE: Tetracycline, E: Erythromycin, SXT: Trimethoprim-sulfamethoxazole, CN: Gentamicin, FOS: Fosfomycin, CIP: Ciprofloxacin, RA: Rifampicin, OFX: Ofloxacin, C: Chloramphenicol, LEV: Levofloxacin, IPM: Imipenem, AMP: Ampicillin, AK: Amikacin, FOX: Cefoxitin.

The wells' diffusion method carried out for the detection of antibiotic residues confirms the hygienic quality of the analyzed sample which meets national regulations (JORA n.39, 2017). Milk without residues of antibiotics would increase consumer safety and competitiveness at the level of national and international trade According to Roostita *et al.* (2011), even at low concentrations, the consumed antibiotic residues can cause health problems such as allergies, intoxication and antibiotic resistance. Moreover, milk containing antibiotic residues cannot be treated with a microorganism starter. Thus, a study conducted by Rahimah *et al.* (2019), showed that *E. coli*, *S. aureus* and *Salmonella sp* strains isolated from raw milk in Indonesia were resistant to chloramphenicol, trimethoprim and ampicillin, due to the overuse of antibiotics in the livestock industry which has led to a high diversity of multiple antibiotic resistance genes.

Physicochemical parameters

Fig 3 shows the change in pH, temperature and titratable acidity of goat milk (the test and control samples) during fermentation.

We noticed an increase in the titratable acidity of the control and the test samples, at the beginning of the 2nd day with higher values for the test sample compared to the control one. However, the pH parameter experienced a decrease over time, *i.e.* an increase in titratable acidity. The mean temperature of the test and control samples was 17,86±1,18°C and 17,98±0,91°C, respectively. This variation depends on the ambient temperature of the milk as an extrinsic factor.

The pH is a parameter that determines the storability of foods. The pH measurement provides precise information on the state of the freshness of milk (Luquet, 1985). It is one of the main obstacles that microbial flora must overcome to ensure its proliferation. However, both parameters: the pH and the titratable acidity of the milk depending on the casein and on the mineral salts' content, extrinsic conditions such as temperature, endogenous flora or contamination load, biochemical components such as lactose content that depends not only on the breed but also on the stage of lactation and the hydration status of the animal. Also, the level of compliance with hygiene practices during the milk handling process (milking, transport, processing and storage) (Tantaoui *et al.* 1983; Boubekri, 1984; Labioui *et al.* 2009; Benyagoub *et al.* 2013; Benyagoub and Ayat, 2015).

The decrease in pH values can be explained by the biodegradation of the lactose into lactic acid for the control sample, as well as the effect of juniper leaves added to the test sample where the *J. phoenicea* L. aqueous leaves macerate had a pH value of 5,29, which can provide real protection against deterioration caused by unwanted microorganisms (Leksir and Chemmam, 2015).

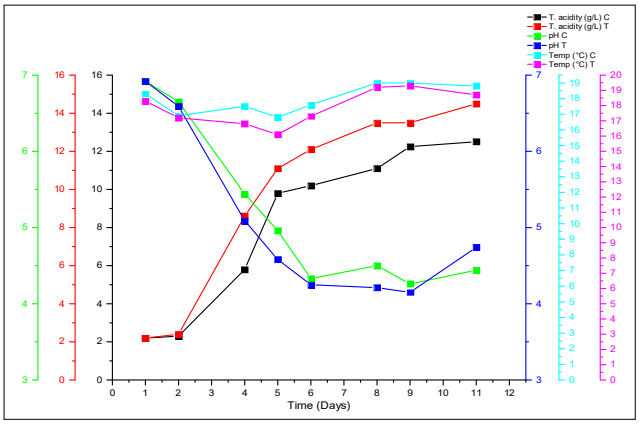


Fig 3: Evolution of the physicochemical parameters of goat milk during fermentation (The test and control samples).
T. acidity: Titratable acidity; Temp: Temperature;
C: Control sample; T: Test sample.

The temperature as an extrinsic factor has an impact on chemical reactions, enzymatic activity and the rate of microorganisms' growth in food. According to the results of the analyzed samples' temperature, little variation was recorded, where the ambient temperature was relatively stable during the period of analysis.

However, the susceptibility assay results showed the absence of antibiotic residues in the analyzed sample where their presence will affect the process of the natural fermentation of milk (Melahi and Benhila, 2017). Moreover, well progress of the fermentation process was confirmed by the evolution of both physicochemical and microbial parameters of the milk over time.

Bacterial parameters

Total aerobic mesophilic flora

Fig 4 shows the evolution of the total aerobic mesophilic flora of goat milk (test and control samples) during fermentation over time.

The total aerobic mesophilic flora is a good indicator of the hygienic quality of milk, stability of products as well as the quality of facilities (Guiraud, 2003). Its presence in high load is justified by non-compliance with hygienic practices during milking, transport, processing, or storage. Fig 4 shows

an increase in the bacterial load of the TAMF incubated at 22 and 30°C ranging from 3.2 to 7 Log_{10} CFU/mL, which was important for the control sample compared to sample one. Noting that the bacteriological quality of the collected milk complies with national regulations.

The TAMF's load of the control sample was higher compared to the test sample. These results can be explained by the effect of phytochemical compounds of juniper added.

Contaminants and pathogenic bacteria

Coliforms

Fig 5 shows the evolution of coliform organisms (total coliforms) and thermotolerant coliforms (fecal coliforms) of goat milk (test and control samples) during fermentation.

The presence of fecal coliforms is considered as an indicator of strong fecal contamination of animals (case of mastitis) or human origin due to lack of hygienic practices during milking or poorly cleaning and sanitizing the utensils used for milk collection (Boufeldja, 2017).

The thermotolerant coliforms load in the collected milk complies with national regulations, but over time, the bacterial load increases to 3,85 Log_{10} CFU/mL for the control sample. However, the test sample experienced a decrease in the microbial load going from 3,23 to 2,3 Log_{10} CFU/mL.

Pathogenic bacterial strains

Fig 6 shows the evolution of contaminating and pathogenic bacteria, namely coagulase-negative Staphylococci, *Salmonella spp* and *Listeria monocytogenes* in goat milk (test and control samples) during fermentation.

At the reception, the sample had a load of coagulase-negative Staphylococci of 1,8 Log_{10} CFU mL. However, national regulations set a load of m= 2,47 Log_{10} CFU/mL and M= 3,47 Log_{10} CFU/mL for coagulase-positive Staphylococci (CoPS).

The control sample showed an increase in the staphylococcal load up to a maximum value of 2,4 Log_{10} CFU/mL which was still within the range given by national regulations. After 2 days of storage, the test sample revealed a maximum load of 2,3 Log_{10} CFU/mL, then a decrease in this bacterial load was noted. However, no contamination was revealed by the pathogenic strains *Salmonella spp* and *Listeria monocytogenes*.

The contamination of milk by pathogenic microorganisms namely *Staphylococcus spp*, *Salmonella spp* and *Listeria spp* is a possible sign of one (Rainard and Poutrel, 1993; Feknous *et al.* 2018; Benyagoub, 2018; Benyagoub, 2019):

- Direct contact of the udders with dirty soil (wounds, unwashed udders before milking).
- Non-compliance with hygienic practices during milking at the farm level.
- Mastitis infection.
- The person who practices milking may be the carrier of a disease that can contaminate the milk (oronasal sphere, skin, wounds).

Thus, to produce a good quality and safe to consume milk, good handling and management are needed from the

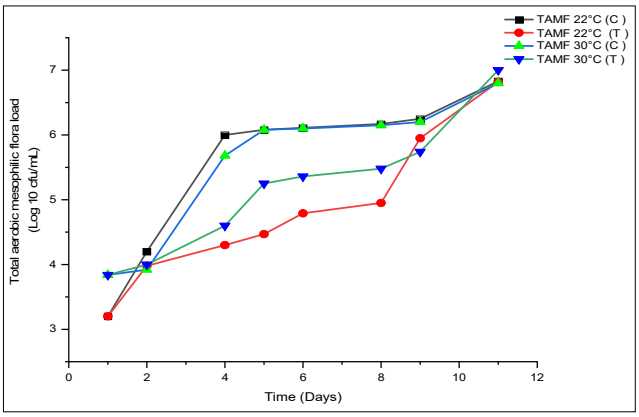


Fig 4: Evolution of the total aerobic mesophilic flora of goat milk (test and control samples) during fermentation.

TAMF: Total aerobic mesophilic flora; C: Control sample; T: Test sample.

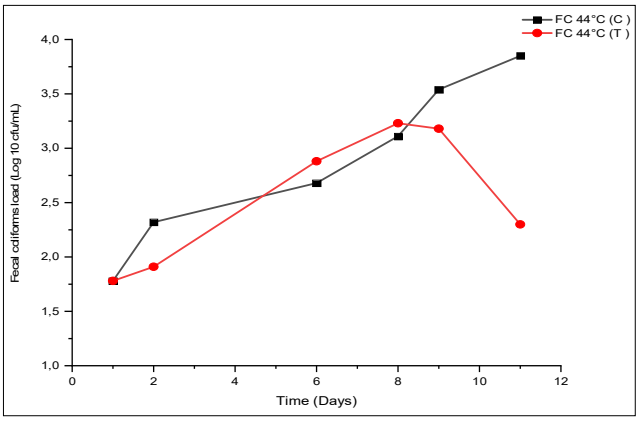


Fig 5: Evolution of thermotolerant coliforms in goat milk (test and control samples) during fermentation.

FC: Fecal coliforms (Thermotolerant coliforms); C: Control sample; T: Test sample.

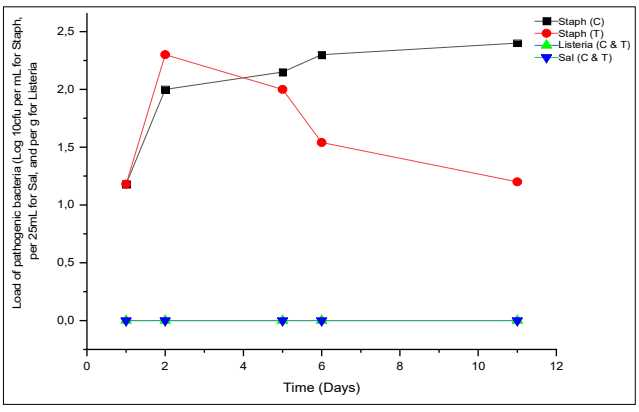


Fig 6: Evolution of coagulase-negative Staphylococci and pathogenic strains of goat milk strains (test and control samples) during fermentation.

Staph: *Staphylococcus aureus*; Listeria: *Listeria monocytogenes*; Sal: *Salmonella* spp; C: Control sample; T: Test sample.

beginning of milk production to reduce the risk of microbial contamination and growth in milk (Rahimah *et al.* 2019). However, the absence of pathogens in both samples, as well as the decrease in the coliform load in the test sample, can be justified by the good health of the animal and by the action of the acidity of the product and the effect of *J. phoenicea* L. leaves phytoconstituents on the growth of contaminating and pathogenic microorganisms, where the major phytoconstituents as secondary metabolites were similar to the results reported by Draoui *et al.* (2020).

Knowing that the antibacterial action of *J. phoenicea* L. leaves varies from one microorganism to another because each bacterium has its characteristic. Several studies confirm the antiseptic action of *J. phoenicea* species, namely Aljaiyash *et al.* (2016); Draoui *et al.* (2020).

Concerning its use and benefit, the twigs, leaves and fruits of Phenician juniper are used in traditional medicine and their phytochemical compounds are incorporated in pharmaceutical preparations particularly for antiseptic use, attributed to the presence of essential oils.

The leaves are used as a herbal decoction against diabetes, diarrhea and rheumatism, while the dried and powdered fruit can cure skin ulcers and abscesses (Mansouri *et al.* 2011). The leafy branches are used for the production of plant tar to treat some cases of eczema and inhalation for asthma, bronchitis, headaches, dizziness and to control arthritis (Abdelli, 2017).

Lactic acid bacteria

Fig 7 shows the evolution of lactic acid bacteria of goat milk (test and control) during fermentation.

An increase in the lactic acid bacteria load for the control sample was revealed from 4,6 and 3 $\log_{10}$ CFU/mL to 6,3 and 5,84 $\log_{10}$ CFU/mL for the lactobacilli and Streptococci groups, respectively. While the test sample experienced an increase in the streptococci lactic flora load after reporting a decrease of the lactobacilli load so that at the end of the fermentation it was 5.08 and 4.95 $\log_{10}$ CFU/mL, respectively. The evolution of pH and titratable acidity results in an increase in the microbial load that makes up the indigenous microflora of milk. During fermentation, the transformation of lactose into lactic acid creates a favorable acid environment for the growth of endogenous milk flora.

Fermented milk revealed an increased load in lactic acid flora. Through the proteolytic activity, lactobacilli species attack the casein which releases the peptides allowing streptococci to continue their growth. Moreover, streptococci stimulate lactobacilli by producing formic acid. Thus, the increase in lactic streptococci comes from the reduction of lactobacillus loads which were responsible for the acidity of the product.

The lactic acid flora loads in the test sample were lower compared to the control one. This was probably due to the high acidity of the sample supplemented with juniper leaves which has a selective effect on microbial growth.

Sensory properties

The results of the sensory analysis were presented in Fig 8. According to the graphical representation of the sensory analysis, the tasters focused on the two offered products, where the descriptors that experienced a difference were mainly as follows:

The tasting intensity for the acidic taste character, the odor intensity for the two characters (the herbaceous and sour smell) and the viscosity of the product, which produced a rating difference of appreciation where the control sample (B) was the most preferred one compared to the test sample (A).

The descriptive sensory analysis allowed us to describe the characteristics of the samples which according to the tasters:

• The color of the test sample was different from the control sample, due to the addition of the juniper leaves, which changed the color into dull white.

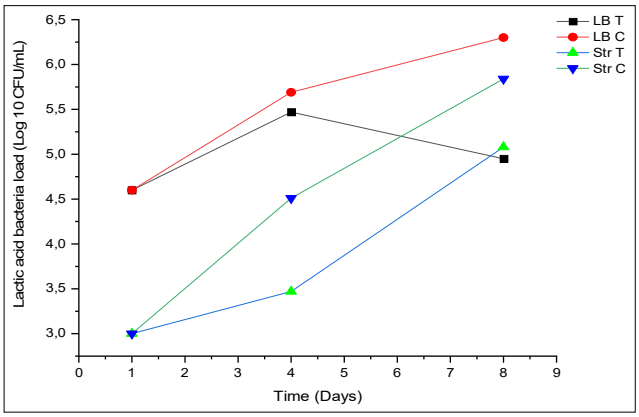


Fig 7: Evolution of lactic acid bacteria flora of goat milk (test and control samples) during fermentation.
LB: Lactobacilli, Str: Streptococci, C: Control sample, T: Test sample.

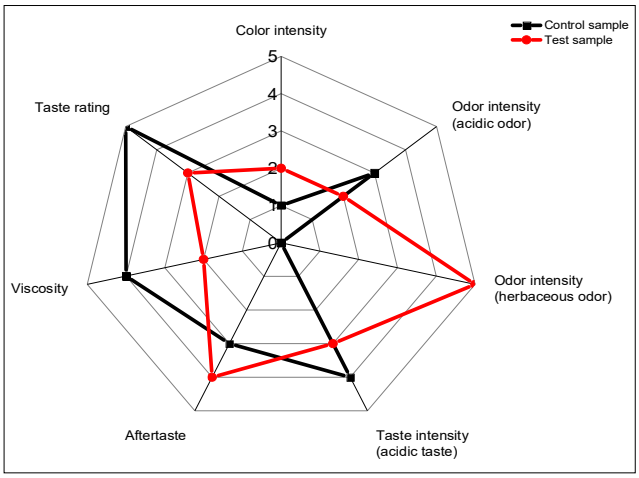


Fig 8: Sensory analysis of the flavored and fermented goat milk (test and control samples).

• In terms of smell, the tasters judged that the control sample was characterized by an acidic odor; though the test sample was more acidic, the addition of aromatic juniper leaves gave a herbaceous odor which hides the acidic smell of the sample.
• The control sample had high viscosity compared to the test sample (medium viscosity) probably because of the high lactic acid flora load, revealed through microbiological analysis, which produces more exopolysaccharides leading to an increase in the viscosity and improving the texture of fermented milk (Douaer, 2018).
• The taste, the aftertaste and the general appreciation: The tasters judged that the taste of the test sample was acidic, where this character was not only attributed to the fermentation process, but also to the acidity provided by adding juniper leaves, which left a strong aftertaste in the mouth. According to the tasters, it was probably due to the relatively high m/v ratio (the weight of the added juniper leaves compared to the volume of the used milk). While the strong acid/milky taste of the control sample comes from the transformation of lactose into lactic acid and the natural milky taste allows it to have the best score of 5/5 on the established scale of preference which was very pleasant.

In addition to the concentration of aromatic juniper leaves, lactic acid bacteria also release flavor compounds and participate in the development of some organoleptic characteristics relating to the aroma and milky taste.

CONCLUSION

This study focused on this traditional practice where the microbiological analysis results indicate the probable antimicrobial effect of the used aromatic plant which not only promotes the organoleptic quality of the product, but also participates in the stability of the bacterial load and makes it a food preservative at room temperature for such a perishable product widely consumed in Algeria and possibly improving the digestibility that requires further research.

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