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Influence of Technological Treatments On the Physicochemical and Biochemical Qualities of Algerian Raib

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Abstract
The aim of the present experiment is to characterize the impact of processing technology “pasteurization and inoculation” on the physicochemical and biochemical qualities of a milk-derived product, “Raib.” The various Raib samples manufactured using different technological methods (artisanal Raib, Raib made from inoculated unpasteurized milk, industrial Raib, and Raib made from pasteurized uninoculated milk) reveal significant variations. The artisanal Raib and the inoculated Raib samples show pH levels that comply with the standards of the Algerian Official Journal (4.58 and 4.46, respectively), whereas their acidity levels do not meet Algerian standards (88°D and 95°D, respectively). Conversely, the industrial Raib and the pasteurized Raib samples comply with standards for both pH (4.60 and 4.57, respectively) and acidity (62°D and 65°D, respectively). As for organic biochemical components, the protein content recorded in artisanal Raib and inoculated Raib is higher than that found in industrial Raib and pasteurized Raib. Furthermore, the fat and mineral content obtained in artisanal Raib is close to that recorded in industrial Raib.
Keywords: Raib, pasteurization, inoculation, technology, fermentation.

INTRODUCTION

Dairy products are essential to our diet, particularly milk, which constitutes a significant part of the diet in Algeria. With its high energy content, milk is rich in essential nutrients such as high-quality proteins, carbohydrates, fats, minerals, and vitamins, providing approximately 700 Kcal per liter (Siboukeur, 2007).

The bacterial microflora of milk, mainly composed of lactic acid bacteria, significantly influences the organoleptic characteristics of fermented dairy products such as fermented milk and cheese. Scientific studies indicate that dairy products traditionally produced from raw milk offer flavors and nutritional values that are highly appreciated by consumers (Ouadghiri, 2009).

Fermented milk, such as « Raib » a dairy product traditionally consumed in the Maghreb results from the lactic fermentation of milk by lactic acid bacteria and potentially other microorganisms. This microbiological transformation aims to extend the shelf life of milk. This dairy product is distinguished by its regional popularity; its recognition is based on its distinctive organoleptic attributes and nutritional composition. Over time, these products have evolved from artisanal/traditional manufacturing to industrial production, using selected bacterial cultures and modern technologies (Cogan, 1996; Oberman, 1998).

Curdled milk ranks fourth in terms of dairy product consumption, with relatively high consumption observed in the eastern region of Algeria, reaching 2.66 kg (accounting for 2.53% of the total). In comparison, consumption in the central and western regions stands at 2.09 kg and 1.64 kg respectively, representing an average of 1.83% and 1.46% of the total for each region. Conversely, consumption in the southern region of Algeria is minimal, at only 0.52 kg. The national average consumption among the surveyed population is 1.75 kg (representing 1.81%) (Ramdane, 2019).

In this research work, we aimed to evaluate the impact of processing technology on a milk-derived product, namely Raib, which is in high demand among Algerian consumers. Moreover, this study allowed us to examine the influence of lactic starters involved in the manufacturing process of this product, as well as the impact of thermal treatment (pasteurization) on the quality of the final product.

MATERIALS AND METHODS

Materials

Experimentation Sites

This study was conducted in two phases. The first phase took place at the laboratory of Giplait Laiterie, le Littoral Mostaganem, while the second phase was carried out at the research laboratory of the Higher School of Agronomy in Mostaganem.

Milk Sampling

Milk Collection

The milk used in this experiment was collected on April 16, 2024, from dairy cows located on various farms in the Mostaganem province (Algeria).

Immediately after milking, the milk was transported in isothermal tanks from the farms to the Giplait laboratory. This process was governed by formal agreements between the farmers and the dairy plant, ensuring the quality and freshness of the milk throughout transportation. Upon arrival at the dairy plant, samples were taken from each batch for physico-chemical analysis.

Preparation of Raib Samples

Four types of Raib samples were produced from the collected milk, as follows:

a. Raib from raw, unpasteurized, and unstartered milk ("Artisanal Raib")

This Raib was produced from raw cow's milk that had not undergone any thermal treatment. It was then subjected to spontaneous fermentation at room temperature for 24 hours. This fermentation period induced milk coagulation and the formation of a characteristic curd typical of artisanal Raib.

b. Raib from raw, unpasteurized milk with starter culture

This Raib was prepared from raw cow's milk without prior thermal treatment. The milk was inoculated with lactic acid bacteria (Chr. Hansen CHN-11) and rennet (CHY-MAX Powder Plus NB), then left to ferment at room temperature for 24 hours. After this period, coagulation and curd formation were observed.

c. Raib from pasteurized, unstartered milk

This Raib was produced from raw cow's milk that underwent high-temperature pasteurization (85–90°C for 20–30 seconds) to eliminate microorganisms. The milk was then cooled to a temperature of 25–30°C and left to ferment naturally for 24 hours at room temperature. This fermentation period led to coagulation and curd formation.

d. Raib from pasteurized milk with starter culture ("Industrial Raib")

The production process of industrial Raib begins with high-temperature pasteurization (85–90°C for 20–30 seconds) to eliminate microorganisms. The milk is then cooled to a temperature between 25°C and 30°C, mixed with lactic acid bacteria (Chr. Hansen CHN-11) and rennet (CHY-MAX Powder Plus NB) in a tank, stirred for 5 minutes, and packaged in one-liter containers. After a 12-hour maturation in a heated chamber, the product is stored at 4–6°C until it is ready for commercialization.

Methods

pH determination

The pH was measured using an electrometric or potentiometric method with a pH meter, an instrument that detects the potential difference between two electrodes (Audigie, 1984).

Dornic Acidity Determination

In this study, acidity determination was conducted following the AFNOR method (1999). Assessing the acidity of dairy products is crucial to ensure their quality and food safety. Typically, this involves titration with an alkaline solution and phenolphthalein as an indicator. The acidity is mainly attributed to lactic acid, produced from lactose fermentation by lactic acid bacteria, and it can affect protein stability (Tamime & Robinson, 2007).

Density Determination

Milk density is defined as the ratio of the mass of a specific volume of milk at 20°C to the mass of the same volume of water (Pointurier, 2003). This parameter was measured using a lactodensimeter according to the AFNOR method (1999).

Dry Matter and Mineral Content

Dry matter and mineral content were determined based on the AFNOR method (1985). For dry matter analysis, 5g of each Raib sample were placed in porcelain crucibles and dried in an oven set at 105°C for 24 hours. For mineral content, 1g of each Raib sample was placed in pre-weighed, empty porcelain crucibles, which were then placed in a muffle furnace set at 550°C for 3 hours.

Antibiotic Residue Test (MilkSafe™ 3BTS)

This rapid test protocol aims to detect residues of beta-lactam antibiotics, particularly cephalexin, as well as tetracyclines in milk. The test was performed using a specialized device for this analysis, namely the MilkSafe™ 3BTS.

Fat Content

Fat content in the different samples was determined using the Gerber method (1891). This method involves dissolving proteins by adding sulfuric acid and separating the fat through centrifugation using a butyrometer.

Protein Content

Protein quantification was carried out using the method described by Lowry et al. (1951). This method combines a biuret reaction and a reaction with the Folin-Ciocalteu reagent. The latter reacts with tyrosine and tryptophan residues, producing a blue coloration in addition to that of the biuret reaction. Optical densities were measured between 550 and 750 nm, using a reference solution containing all reagents except the sample.

Statistical Analysis

Results are expressed as means ± standard deviation. The different parameters were analyzed using analysis of variance (ANOVA), followed by comparison of means using the Newman–Keuls test.

Results and Discussion

Physicochemical and Biochemical Analysis of Different Types of Raib

Physicochemical Properties

pH and Acidity

The results of pH and acidity monitoring for the different types of Raib produced are summarized in Table 1 below.

Statistical analysis revealed no significant differences in pH among the types of Raib studied during the various stages of production (beginning, middle, and end).

At the start of production, the pH across all Raib samples was around 6.66, in accordance with the standards set by the J.O.R.A.D.P (1993). However, as the production process progressed, both the artisanal Raib and the Raib made from non-pasteurized, inoculated milk showed a decline in pH, reaching values of 4.58 and 4.46, respectively, by the end of the process. These results are consistent with those reported by Boubekri et al. (1984), who found that the pH of artisanal curdled milk ranged from 3.8 to 4.7.

Furthermore, the pH values of Raib made from pasteurized, non-inoculated milk and industrial Raib remained relatively stable, with values of approximately 4.57 and 4.60, respectively. These values comply with the standards set by J.O.R.A.D.P (1993).

Tableau 1 : Monitoring of pH and Acidity of Raib Samples

Echantillons	Parameters	Start of Production	Mid-Production	End of Production
Artisanal Raib	pH	6.66±0.05 (a)	5.16±0.57 (b)	4.58±0.0 (c)
	Acidity	18±20 (f)	42.33±2.08 (e)	88±2.64 (b)
Raib from raw, unpasteurized milk with starter culture	pH	6.66±0.05 (a)	4.6±0.1 (b)	4.46±0.01 (c)
	Acidity	18.66±1.15 (f)	75±5.0 (c)	95±5.0 (a)
Raib from pasteurized, unstartered milk	pH	6.66±0.05 (a)	6.23±0.20 (b)	4.57±0.0 (c)
	Acidity	16.33±0.57 (f)	22±2.0 (f)	65±5.0 (d)
Industrial Raib	pH	6.66±0.05 (a)	5±2.0 (b)	4.60±0.01 (c)
	Acidity	18±1.0 (f)	60±5.0 (d)	62±8.18 (d)
Standards according to J.O.R.A.D.P	pH	6.6 – 6.8	/	4.40- 4.60
	Acidity	14-18	/	65-75

a, b, c, d, e, f: For each parameter, values marked with different letters are significantly different ($p < 0.05$). Not significant: values sharing the same letters are not significantly different ($p > 0.05$).

The statistical study showed that the two technological variables "pasteurization and inoculation" have no significant effect (p>0.05) on the acidity at the beginning of the production of the different Raibs in our experiment (18°D for artisanal Raib, 18.66°D for inoculated Raib, 16.33°D for pasteurized Raib, and 18°D for industrial Raib).
However, the acidity recorded during production was 42.33°D, 75°D, 22°D, and 60°D for artisanal Raib, inoculated Raib, pasteurized Raib, and industrial Raib, respectively.
At the end of production, the analysis of variance revealed no significant effect (P>0.05) of pasteurization on the acidity recorded in pasteurized and industrial Raib, with values of 65°D and 62°D respectively. However, a significant difference (p<0.05) was observed between the acidity of artisanal Raib and inoculated Raib, with values around 88°D and 95°D respectively.
The acidity values recorded at the beginning of production vary slightly between the different Raibs in our experiment, ranging from 16.33°D to 18.66°D. The obtained results comply with the standards required by J.O.R.A.D.P (1993).
During production, artisanal Raib and Raib made from raw unpasteurized inoculated milk show a strong increase in acidity, with respective values around 88°D and 95°D. These results exceed the standards required by J.O.R.A.D.P (1993). Moreover, our results are consistent with those reported by Boubekri et al. (1984), who reported acidity values for artisanal curdled milk ranging from 63°D to 110°D with an average of 81.6°D.
Furthermore, the acidity values obtained in Raib made from raw pasteurized uninoculated milk and industrial Raib reveal a more moderate increase, reaching 65°D and 62°D at the end of production, and these results remain in compliance with the standards required by J.O.R.A.D.P (1993).

Biochemical Properties

The various biochemical results related to the Raib samples studied in this research are presented in Table 2 below.

Table 2: Results of the physicochemical analyses of Raib samples expressed in %.

Samples	Fat	Proteins	Dry matter	Ashe	Antibiotic
Artisanal Raib	3.2±0.0 (a)	3.45±0.21 (a)	10.95±0.39 (b)	0.4±0.17 (a)	Absent
Raib from raw, unpasteurized milk with starter culture	3.2 ±0.0 (a)	3.50±0.15 (a)	15.76±1.25 (a)	0.7±0.10 (a)	Absent
Raib from pasteurized, unstartered milk	3.2±0.0 (a)	2.94±0.20 (b)	9.48±0.93 (b)	0.5±0.17 (a)	Absent
Industrial Raib	3.2±0.0 (a)	2.92±0.15 (b)	9.49±0.94 (b)	0.4±0.10 (a)	Absent

a and b: For each parameter, values assigned different letters are significantly different ($p < 0.05$). Values assigned the same letters are not significant ($p > 0.05$).

Dry Matter Content

Statistical analysis revealed a significant difference in dry matter content between the inoculated Raib (15.76%) and the other Raib samples studied, with contents of approximately 10.95% for artisanal Raib, 9.48% for pasteurized Raib, and 9.49% for industrial Raib.

The dry matter content of Raib made from raw unpasteurized inoculated milk remains higher than that of the other Raibs studied, with a value of 15.76%, followed by artisanal Raib with a content of 10.95%. However, pasteurized Raib and industrial Raib show almost identical values, reaching 9.48% and 9.49%, respectively. All these values comply with the standard established by J.O.R.A.D.P (2021), which requires a dry matter content of 8% or higher.

The dry matter levels of pasteurized and industrial Raib are lower than those required by J.O.R.A.D.P (1993), with values ranging from 109 to 111 g/l. Moreover, the dry matter contents of artisanal and inoculated Raib exceed the values reported by Boubekri et al. (1984) in artisanal and industrial curdled milk, with contents ranging from 79.8 to 100.5 g/l (average 88.96 g/l).

Mineral Matter Content

Statistical analysis revealed no significant effect of the technologies (pasteurization and inoculation) on the mineral matter content in the different Raibs studied. It is noted that the mineral matter contents in artisanal and industrial Raib were similar (0.4%), whereas this content was around 0.7% for inoculated Raib compared to 0.5% for pasteurized Raib.

The low ash values can probably be attributed to limitations of the technique and handling conditions. Furthermore, they are also the result of the low amount of ash produced in milk, which is about 0.75% according to Sboui et al. (2009).

Fat Content

The fat contents recorded in the different Raib samples studied were approximately 3.2%, which remains in accordance with the standards accepted by J.O.R.A.D.P (2021), requiring a fat content of 3% or higher.

Moreover, the results obtained (3.2%) are lower compared to those recorded by Renault (1998), who reported a fat content of 4.9 g/100 g for industrial curdled milk, while he reported about 1.8 g/100 g for artisanal curdled milk; a value lower than ours.

The fat content (FC) of cow's milk samples (raw and pasteurized) as well as fermented milk shows an average of 3% and 3.2% respectively. This observation reveals a significant increase in fat content after fermentation. Previous studies by Omer & Eltinay (2009) and Bahobail et al. (2014) also confirmed a similar increase in fat content after fermentation. This increase could be attributed to the synthesis of lipids during the growth of lactic acid bacteria, which are then released by acid hydrolysis.

Protein Content

Statistical analysis revealed no significant difference between the protein contents of artisanal Raib and inoculated Raib, which were approximately 3.45% and 3.50%, respectively. The same applies to the protein contents recorded in pasteurized Raib and industrial Raib, with values of 2.94% and 2.92%, respectively.

The protein contents in artisanal Raib and inoculated Raib were higher than those of pasteurized and industrial Raib, with respective values of 3.45%, 3.50%, 2.94%, and 2.92%. The recorded results comply with the standards of J.O.R.A.D.P (2021), which requires a protein content of 2.8% or higher for whole curdled milk.

Furthermore, the results obtained for artisanal Raib were higher than those reported by Renault (1998), who highlighted a protein content in artisanal curdled milk of about 2.26 g/100 g. However, the protein content in industrial curdled milk, according to the same author, was higher than our results (industrial Raib: 2.92%) with a value of 3.7 g/100 g.

Antibiotics

The test results show that the different Raib samples in our experiment are free of antibiotics, confirmed by the antibiotic test conducted against the control, indicating a negative result.

Conclusion

At the end of this study, it was concluded that the non-pasteurized inoculated Raib presents the best physicochemical and biochemical qualities. With a view to continuing this work, it would be wise to broaden the study of physicochemical and nutritional parameters by focusing on the quantification of fatty acids and amino acids, and to assess the impact of pasteurization and inoculation on these two highly important components. Moreover, it would be relevant to include a tasting test in this study in order to observe consumer preferences regarding these different types of Raib.

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Conflict of Interest
None.

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