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# Sensorial and Physico-Chemical Characteristics of Yoghurt Manufactured with Ewe's and Skim Milk

[1]Chougrani Fadela, [1]Cheriguene Abderrahim and [2]Bensoltane Ahmed

[1]Laboratoire de Microbiologie et Biologie Végétale, Département de Biologie,
Faculté des Sciences, Université de Mostaganem, BP 227 Mostaganem 27000 Algeria
[2]Laboratoire de Microbiologie Alimentaire et Industrielle, Département de Biologie,
Faculté des Sciences, Université d'Oran Es Senia, Algeria

**Abstract:** Yoghurts were prepared with commercial strains "CHR, HANSEN Denmark " using two types of milk, ewe's milk and skim milk "CELIA". A dose of 2.5% of commercial starters was used for the preparation of yoghurt. Physico-chemical, organoleptic and rheological propeties of yoghurts prepared with both types of milk were studied in order to determine the best preparation depending on the type of milk. The sensory analysis revealed that the product made with ewe's milk was better compared to that made from skim milk. Furthermore, the effect of type of milk was clearly observed on the acidity, the cohesiveness and the number of lactic acid bacteria in this type of milk.

**Key words:** Yoghurt · Fermentation · Ewe’s milk · Lactic acid · Viscosity · Cohesiveness · Adhesiveness

## INTRODUCTION

In recent years, there has been increasing demand for a new range of dairy products, including yoghurts, which are similar to traditional products but have a low fat content [1].

Yoghurt is one of the most popular fermented dairy product widely consumed all over the world. It’s obtained by lactic acid fermentation of milk by the action of a starter culture containing *Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus*. The role of these two genera in yoghurt manufacture can be summarized as milk acidification and synthesis of aromatic compounds [2,3].

Yoghurt is more nutritious than many other fermented milk products because it contains a high level of milk solids in addition to nutriments developped during the fermentation process. Different forms of yoghurt are now available in the market like stirred, set, frozen and liquid yoghurt.

To preserve its inherent quality during storage and, in particular, its physicochemical and sensory characteristics, packaging is essential [4].

Yoghurt can be stored for up to four weeks. During this period, the product undergoes changes of physico-chemical and rheological that may affect its organoleptic quality. The aim of this work is to study these variations during the period of fermentation as well as storage period.

**Analytical Methods:** All analytical determinations were performed at least in triplicate. Values of different parameters were expressed as the mean ±standard deviation (X±SD).

**Yoghurt Manufactue:** The yoghurt is manufactured according to international standards of yoghurt manufacture IDF [5] standards. The milk is homogenized and heated to 90°C for 3 min for pasteurization, then cooled to 45°C. It is then inoculated with 2.5 percent of a mixed lactic starter (2:1 *Streptococcus salivarius* ssp. *thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus*). Yoghurt samples were elaborated of quantities of 100 ml for each sample and the experiment was realized in triplicate.

The inoculated milk is incubated to 45°C until a pH of 4.4 was attained in approximately 4 hours (the pH end point). When the pH end point was achieved, the yoghurts were cooled at 6°C, stored at the same temperature during all period of post-acidification (for 21 days).

**Corresponding Author:** Chougrani Fadela, Laboratoire de Microbiologie et Biologie Végétale, Département de Biologie, Faculté des Sciences, Université de Mostaganem, BP 227 Mostaganem 27000 Algeria

**Experimental Analysis:** The physico-chemical analysis were carried out according to AOAC [6].

During the fermentation period, the tests are conducted for 2 hours and between 3 and 4 h for skim milk, while the period of post-acidification, they are made weekly for a period of 21 days.

**Measurement of pH and Acidity:** The pH of yoghurt samples was measured at 1,7, 14 and 21 days of storage at 6°C using a pH meter with a glass electrode over the range 6.8 to 4.0.

Dornic acidity is determined by titration with 0.1 N NaOH using phenolphthalein as an indicator color. Results were expressed as degree Dornic [7].

**Measurement of Viscosity:** Viscosity was measured using a viscometer model HAAKE Viscosimeter (Mess Technik GmbH) (Brookfield Engineering Laboratories Inc., Stoughton, MA) using a glass tube and a normalized ball equipped with a chronometer at 25°C and was expressed as mPas. Every experiment was repeated 3 at 5 times to have some meaningful results after a statistical analysis. Viscosity was expressed as millipoises (m.p.s).

**Organoleptic Tests Yoghurt:** Throughout the period of post-acidification (7th, 14th and 21st days of storage), the organoleptic quality of yoghurt products will be evaluated by a jury of 10 panelists with a seven point scale [8] and involves three parameters. Flavour, cohesiveness and adhesiveness of the samples were evaluated following the recommendations of International Dairy Federation standard 99A [9].

Flavour was assessed by the estimation of acidity developed by specific lactic acid bacteria in the samples.

A strict protocol was imposed to panelists to minimize variability. At each session, subjects have tasted samples of yoghurt (5 g) to 10°C. They were asked to keep the yoghurt in the mouth for 12 seconds, then swallow. This time was chosen after preliminary tests conducted with 10 subjects. The subjects tasted samples of yoghurt in the most natural possible, keeping the mouth closed and by swallowing the product.

The yoghurt samples were presented in random order. Water was used for rinsing between samples. A small period of several minutes was required between samples.

Panel members were then asked for cohesineness which reflects the maximum capacity of deformation of the sample before break. This technique was performed using a spoon. Samples were then evaluated for adhesiveness which reflects the power required to defeat the forces of links between the surface of the coagulum and the surface of materials (this technique is also performed by a spoon).

The texture can be defined as a property on the sensory touch. The analysis of the texture allows an objective measure by mechanical action.

The importance of texture in the assessment of food varies depending on the expectations of consumers.

**Microbiological Analysis of Yoghurt (Enumeration of Specific Bacteria of Yoghurt):** Yoghurt is produced by fermentation of milk, with two bacteria, *Lactobacillus bulgaricus* and *Streptococcus thermophilus*, which act together. Both bacteria are found in live yoghurt and therefore, in the mouth of gourmet who consumes.

The enumeration of *S. thermophilus* and *L. delbrueckii* ssp. *bulgaricus* was performed as described by the International Dairy Federation (IDF Standard 306, [IDF, [10]). The following media were selected as suitable for enumeration: M17 agar and aerobic incubation at 42°C for 24 h for the selective enumeration of *S. thermophilus*, for the enumeration of *L. delbrueckii* ssp. *bulgaricus* MRS agar incubated at 42°C for 24 h. Microbiological count data are expressed as colony forming units (cfu) per gram of yoghurt.

Four dilutions were carried out to determine the number of bacteria during storage.

## RESULTS AND DISCUSSION

**Physico-Chemical Properties of Yoghurt**

**Changes in pH and Acidity:** The results obtained for chemical characterization of the yoghurt samples are presented in Table 1.

During the period of fermentation, we noticed a remarkable decrease in pH for yoghurt samples manufactured with skim milk. This decrease is less important for the yoghurt manufactured with ewe's milk with an average of 5.56 compared to 4.34 for the other samples. This result can be explained by the composition of each kind of milk. However, our results showed in a precedent study that the titratable acidity of ewe's milk is slightly low and does not exceed 21°D (Table 2). Our results are in keeping with those reported by Sokolinska *et al.* [11], who indicated that the pH values of milk decreased during the manufacturing process, from the time it was inoculated with bacterial cultures to the time when it was manufactured ranging from 6.7 to 4.34. The same observations were reported by O'Neil *et al*. [12].

Table 1: Physico-chemical analysis of yoghurt

| Analysis | Ewe's milk | Skim milk | Analysis of variance |
|---|---|---|---|
| Titratable acidity | 85.667±27.21 | 101.533±15.268 | NS |
| pH | 5.569±0.318 (a) | 4.34±0.338 (b) | ** |
| Viscosity | 0.304±0.135 (b) | 24.39±6.68 (a) | ** |

NS: Not significant

*: Significant (≤0.05)

**: Highly significant (≤0.01)

a,b,c: The homogeneous groups after means comparing

Table 2: Physico-chemical analysis of ewe's milk

| Analysis | pH | °D | Dry matter (%) | Fats (%) |
|---|---|---|---|---|
| Ewe's milk | 6.7 | 21 | 11.5 | 6.5 |
| Standards | 6.5-6.85 | 22-25 | 18.3 | 7.1 |

Table 3: Sensorial analysis ((Σ ranks n=40)

| Analysis | Ewe's milk | Skim milk | Analysis of variance |
|---|---|---|---|
| Flavour | 70.50 (b) | 49.50 (a) | ** |
| Cohesiveness | 75 (b) | 45 (a) | ** |
| Adhesiveness | 77 (b) | 44 (a) | ** |

Moreover, according to Luquet [13], lactic strains have the ability to ferment lactose into lactic acid, with an increase of acidity and a decrease in pH of fermented milk, which reveals the influence on the composition of the inoculum on the rate of bacteria growth such as *Streptococcus*. Indeed, the development of these germs seems to be proportional to the rate of protein (and certainly the rate of amino acids) in the medium. In addition, during the total experimental period, the values of the acidity are even higher.

The analysis of variance showed that the fermentation period and the storage have a significant effect on reducing the pH.

Similar changes were observed in the level of titratable acidity in the yoghurt during storage.

We noted that there is a proportional relationship between the rate of inoculation strains and acidity, the degree of acidity increases proportionally to inoculation rate [14].

In addition, we recorded low values of acidity for yoghurt prepared using skim milk with a mean of 101.53°D (Table 1).

Gueimonde *et al*. [15] Salvador and Fiszman, [16] found similar results in pH and titratable acidity when they studied the quality of plain yoghurt.

**Evolution of the Viscosity During Fermentation:** The viscosity of yoghurt prepared with ewe's milk varies with time. The results indicate that the values differ from one type of milk to another. We note that the viscosity is much greater in the yoghurt made from skim milk compared to those made from ewe's milk, despite the richness of the fat. This may be due to some factors that affect the quality of ewe's milk as the physiological status of the animal, its diet, race and the climat.

According to Rawson and Marshall [17], *Streptococcus thermophilus* are the most germs incriminated in the production of exocellular texturising agents called exopolysaccharides that might interact with the protein content of milk and increase the viscosity and rheologial quality of products.

During the post-acidification period, the activity of *Streptococcus thermophilus* is not completely stopped, but it is less important compared to that of *Lactobacillus bulcaricus* which not only produces lactic acid, but probably a small amount of texturising agents [18].

**Rheological Properties of Yoghurt**

**Evolution of Flavour:** The panelists found the flavour of yoghurt inoculated at a rate of 2.5% prepared with commercial strains using ewe's milk as the best compared to skim milk with an average sum of ranks of 70.50 against 49.50 respectively (Table 3). This difference in flavour was probably the result of important fermentation of lactose by lactic acid bacteria [19].

However, the panelists described the flavour of yoghurt prepared with ewe's milk as more acceptable.

In terms of statistical analysis, the factor type of milk has a highly significant effect on the evolution of this parameter.

**Evolution of the Cohesiveness:** Generally, the cohesiveness is more satisfactory in the fermented milk made from ewe's milk; it is an average of 75 against 45 of the sample produced from skim milk.

According Rawsan and Marshal [17], the assessment of rheological yoghurt (adhesiveness and cohesiveness) is probably linked to exopolysaccharides produced by specific strains of yoghurt *Streptococcus thermophilus* and *Lactobacillus bulgaricus*.

The analysis of variance showed significant effect of the factor kind of milk on the development of cohesion in tested yoghurt.

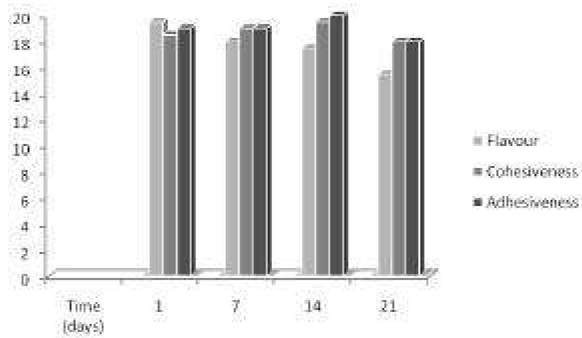


Fig. 1: Evolution of rheological properties in ewe's milk yoghurt

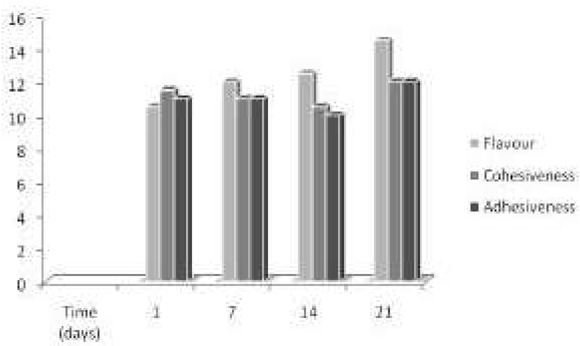


Fig. 2: Evolution of rheological properties in skim milk yoghurt

**Evolution of Adhesiveness:** Adhesiveness has increased in the prepared yoghurt milk sheep between the 1st and 14th days.

At the end of the experiment, during the 21st day, a slight decrease was observed (Fig. 2).

Furthermore, in the yoghurt made from milk powder, this is growing at the end of fermentation, it is about 77 against 44 on average compared to skim milk. Similar remarks were reported by Rawson and Marchal, [17] and Katsiari *et al*. [20] who reported an increase in adhesiveness of ewe's yoghurt during storage.

The analysis of variance showed a significant effect of factor kind of milk on the development of adhesiveness in tested yoghurt.

**Microbiological Analysis:** Yoghurt consumption is beneficial to human health because of the bacteria the yoghurt contains. Although quantitative standards for yoghurt bacteria differ [21], it is generally accepted that the yoghurt should contain $10^7$ cfu of viable bacteria (*Streptococcus thermophilus* and *Lactobacillus bulgaricus*) per mL of yoghurt.

Table 4: Sensorial evolution of flavour, cohesiveness and adhesiveness of experimental yoghurts prepared with ewe's milk and skim milk during fermentation and post-acidification period (Σ ranks n=40).

a-Ewe's milk

| | Parameter studied | | |
|---|---|---|---|
| Periods (days) | Flavour | Cohesiveness | Adhesiveness |
| 1 day | 19.50 | 18.5 | 19 |
| 7 day | 18 | 19 | 19 |
| 14 day | 17.50 | 19.50 | 20 |
| 21 day | 15.50 | 18 | 18 |

b-Skim milk

| | Parameter studied | | |
|---|---|---|---|
| Periods (days) | Flavour | Cohesiveness | Adhesiveness |
| 1 day | 10.50 | 11.50 | 11 |
| 7 day | 12 | 11 | 11 |
| 14 day | 12.50 | 10.50 | 10 |
| 21 day | 14.50 | 12 | 12 |

During the fermentation process, the number of *Streptococcus thermophilus* is relatively higher compared to *Lactobacillus bulgaricus*.

In parallel, the presence of these germs is much greater in skim milk compared to ewe's milk. We noted about $21{,}6.10^6$ cfu/ml against $1{,}8.10^6$ cfu/ml.

In terms of analysis of variance, we reported a highly significant of factor kind of milk in the evolution of this parameter.

## REFERENCES


1. Begoña de Ancos, M. and P.C. Rosario Gomez, 2000. Characteristics of stirred low-fat yoghurt as affected by high pressure, Int. Dairy J., 10: 105-111.
2. Serra, M., J.A. Trujillo, B. Guamis and V. Ferragut, 2009. Flavour profiles and survival of starter cultures of yoghurt produced from high-pressure homogenized milk. International Dairy Journal, 19: 100-106.
3. Sahan, N., K. Yasar and A.A. Hayaloglu, 2008. Physical, chemical and flavour quality of non-fat yoghurt as affected by a β-glucan hydrocolloidal composite during storage. Food Hydrocolloids, 22: 1291-1297.
4. Saint-Eve, A., C. Levy, M. Le Moigne, Ducruet and I. Souchon, 2008. Quality changes in yoghurt during storage in different packaging materials. Food Chemistry, 110: 285-293.

5. International Dairy Federation, 1987. *Skimmed milk, whey and butter milk *determination of fat content*. FIL-IDF Standard 22B, Bruxelles, Belgium.
6. AOAC, 2005. Association of official analytical chemists-Official methods of analysis of the association analytical chemists (18th ed.). Washington, DC: AOAC.
7. AFNOR, 1980. Lait et produits laitiers: méthodes d'analyse (1[ère] ed.). Paris: AFNOR.
8. Meilgaard, M., G.V. Civille and B.T. Carr, 1999. Sensory evaluation techniques (3rd ed.). Boca Raton, FL, USA: CRC Press.
9. International Dairy Federation., 1987. Sensory evaluation of dairy product. FIL-IDF Standard 99A, Bruxelles, Belgium.
10. International Dairy Federation, (IDF)., 1995. Fermented and non-fermented milk products. Detection and enumeration of *Lactobacillus acidophillus* Culture media. FIL-IDF Standard 306. Brussels: International Dairy Federation.
11. Sokolinska, D.C., M.M. Michalski and J. Pikul, 2004. Role of the proportion of yoghurt bacterial strains in milk souring and the formation of curd qualitative characteristics. Bull. Vet. Inst. Pulawy, 48: 437-441.
12. O'neil, J.M., D.H. Kleyn and L.B. Hare, 1979. Consistency and Compositional Characteristics of Commercial yoghurts. J. Dairy Sci., 62: 1032-1036.
13. Luquet, F.M., 1990. Laits et produits laitiers: vache, brebis, chèvre. Tome 2: Les produits laitiers, transformation et technologies. Ed., Lavoisier, pp: 637. (Sciences et Techniques Agro-alimentaires).
14. Chougrani, F., A. Cheriguene and A. Bensoltane, 2008. Use of lactic strains isolated from Algerian ewe's milk in the manufacture of a natural yogurt, Afr. J. Biotechnol., 7(8): 1181-1186.
15. Gueimonde, M., L. Alonso, T. Delgado, J.C. Bada-Gancedo and C.G. de los Reyes-Gavilan, 2003. Quality of plain yoghurt made from refrigerated and $CO_2$-treated milk. Food Res. Int., 36: 43-48.
16. Salvador, A. and S.M. Fiszman, 2004. Textural and Sensory Characteristics of Whole and Skimmed Flavored Set-Type Yoghurt During Long Storage. J. Dairy Sci., 87: 4033-4041.
17. Rawson, H.L. and V.M. Marschall, 1997. Effect of 'ropy' strains of *Lactobacillus delbrueckii* ssp. *bulgaricus* and *Streptococcus thermophilus* on rheology of stirred yoghurt. Int. J. Food Sci. Technol., 32: 213-220.
18. Luquet, F.M., 1994. Lait et produits laitiers, vers E1/Tec et Doc. Lavoisier.
19. Bourgeois, C.M. and J.P. Larpent, 1989. Microbiologie alimentaire. Tome 2. Tec et Doc Lavoisier, Paris.
20. Katsiari, M.C., L.P. Voutsinas and E. Kondyli, 2002. Manufacture of yoghurt from stored frozen sheep's milk. Food Chem., 77: 413-420.
21. Tamine, A.Y. and H.C. Death, 1980. Yoghurt: Technology and biochemistry. J. Food Prot., 43: 939-977.