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DEVELOPMENT OF A BRINE FOR MOZZARELLA PRESERVATION

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ABSTRACT

Mozzarella shelf life is highly influenced by spoilage microorganisms, which are responsible of off-flavour, texture deterioration and chromatic alteration. The effect of 24 different preserving brines on the chemical, microbiological and sensory characteristics of the product during storage was investigated. Both the brine and product compositions changed over time, because of mass transfer phenomenon. Most of the brines tested caused worsening of the characteristics, whereas that containing 1% calcium lactate at pH 3.50 gave very interesting results. The product stored in such brine had lower bacterial counts and better sensory characteristics than the control, and did not undergo to chromatic alteration.

Keywords: mozzarella, shelf-life, brine, spoilage microorganisms, blue discoloration

1. INTRODUCTION

Mozzarella is a fresh cheese with soft body and milky flavor that is sold packaged in a liquid for preserving freshness. Shelf life is very short, and commonly ranges from a few days to 2 weeks, depending on the type of milk (raw or pasteurized), product (buffalo or cow) and preserving liquid (pot water or brine). In the case of buffalo mozzarella, the liquid is an acidic brine that consists of salt and "stretching process water" or salt added with citric or lactic acid (PAONESSA, 2004). Such brines cannot be used for the bovine type that presents too delicate skin: for this product, pot water is commonly used that, in the case of industrial manufacturing, can be also pasteurized. A possible alternative is the use of diluted NaCl solutions (less than 2.0 g L^{-1}). Deterioration of mozzarella is caused both by spoilage microorganisms and by interactions between cheese and preserving liquid (LAURIENZO *et al.*, 2008). Among spoilage microorganisms, psychrotrophic bacteria play a primary role since the cheese is maintained under refrigeration until consumption. *Pseudomonas* spp. is one of the most feared psychrotrophic microorganism, since it causes off flavours and chromatic alterations. A number cases of "blue discoloration" defect in bovine mozzarella recently occurred in Europe, which was ascribed to *Pseudomonas fluorescens*, a bacteria that also induces fluorescence (CHIESA *et al.*, 2014; CARRASCOSA *ET AL.*, 2015; DEL OLMO *et al.*, 2018). Very interestingly, this defect is very rare in buffalo mozzarella. Recently, an innovative strategy has been proposed to counter the activity of *Pseudomonadaceae* in bovine mozzarella, involving addition of antimicrobial compounds to the milk or preserving liquid (DEL NOBILE *et al.*, 2009; GAMMARIELLO *et al.*, 2010; GORRASI *et al.*, 2016). Unfortunately, almost all the active principles that have been proposed cannot be adopted by the dairies, due to impact on the sensory characteristics or incompatibility with the EU legislation. The present study reports the results of an experimentation that aimed to evaluate the effect of several brines, made only with low-compatible compounds, on mozzarella shelf life.

2. MATERIALS AND METHODS

Mozzarella knots weighing about 70 grams were manufactured in a local dairy from pasteurized milk by direct acidification and packaged immersed in 24 different brines (Table 1) or water (as control).

Table 1. Composition of the brines used in the experimentation.
*= present; - = absent

	pH	Citric acid	Lactic acid	Calcium chloride	Calcium lactate	Polypropylene glycol	Sorbic acid	Sodium chloride
A1	4.50	*	-	1.0	5.0	-	-	-
A2	4.50	-	*	1.0	5.0	-	-	-
A3	4.50	*	-	2.0	5.0	-	-	-
A4	4.50	-	*	2.0	5.0	-	-	-
A5	4.50	*	-	1.0	10.0	1.0	5.0	-
A6	4.50	-	*	1.0	10.0	1.0	5.0	-
A7	4.50	*	-	2.0	10.0	1.0	10.0	-
A8	4.50	-	*	2.0	10.0	1.0	10.0	-
A9	4.00	*	-	1.0	-	-	-	4.0
A10	4.00	-	*	1.0	-	-	-	4.0

A11	4.00	*	-	2.0	-	-	-	8.0
A12	4.00	-	*	2.0	-	-	-	8.0
A13	4.00	*	-	4.0	-	-	-	4.0
A14	4.00	-	*	4.0	-	-	-	4.0
A15	4.00	*	-	4.0	-	-	-	8.0
A16	4.00	-	*	4.0	-	-	-	8.0
A17	3.50	*	-	-	5.0	-	-	-
A18	3.50	-	*	-	5.0	-	-	-
A19	3.50	*	-	-	5.0	-	-	-
A20	3.50	-	*	-	5.0	-	-	-
A21	3.30	*	-	-	10.0	-	-	-
A22	3.30	-	*	-	10.0	-	-	-
A23	3.30	*	-	-	10.0	-	-	-
A24	3.30	-	*	-	10.0	-	-	-

All ingredients were food grade and were allowed by legislation in dairy manufacturing as additive or as adjuvant. Storage of the packages took place at 8 ± 1 °C (average conditions of commercial distribution) for 3 weeks (3 replicates). Samples were taken at 0, 7, 14 and 21 days storage and subjected to the following determinations: pH, moisture (oven drying method), NaCl (Volhard method), organic acids (ZEPPA *et al.*, 2001), counts of spoilage microorganisms (total viable, Enterobacteriaceae, *Pseudomonas* spp., yeasts and molds) as reported in a previous paper (FACCIA, 2019), and Qualitative Descriptive Sensory Analysis (TRANI *et al.*, 2016). All analytical data were processed using Statistica 7.1 for Windows program. Least significant different analysis was used to determine differences between control and experimental samples. For the sensory analysis, the means of the scores were calculated.

3. RESULTS AND DISCUSSION

Both the brine and product compositions changed over time, because of mass transfer phenomenon. In most cases, the brine caused sloughing of the cheese skin and fast decrease of the sensory characteristics. This effect was much more pronounced when citric acid was present, due to the strong calcium sequestering property. Maintaining an intact skin is of pivotal importance for shelf life of mozzarella, not only under the sensory point of view (appearance of the product), but also for limiting the mass transfer that causes enrichment of the brine in nutrients. The most suitable brine for shelf life extension proved to be that containing the pair calcium lactate/lactic acid, at pH 3.50. At the end of the storage period, the samples kept in such brine had lower pH (5.21 versus 5.98), and better microbiological and sensory characteristics than the control. In particular, the growth of total viable, *Pseudomonas* spp. and Enterobacteriaceae was significantly delayed, whereas yeasts and molds were not affected (Fig. 1).
Very interestingly, the samples kept in the experimental brine did not undergo to chromatic alteration, differently from the control sample that evidenced fluorescence of the liquid after 2 weeks (Fig. 2) and, in some cases, blue discoloration at the end of the storage period (not shown). The antimicrobial effect was confirmed by the pattern of the organic acids: citric acid was not degraded, and both lactic and acetic acid remained almost constant with time. The reason of the antimicrobial activity observed should be attributed both to the low pH and to the effect of lactate anion (SHELEF, 1994). We had already found a weak

antimicrobial effect of calcium lactate in a previous work but, in that study, the brine had not been acidified (FACCIA *et al.*, 2013).

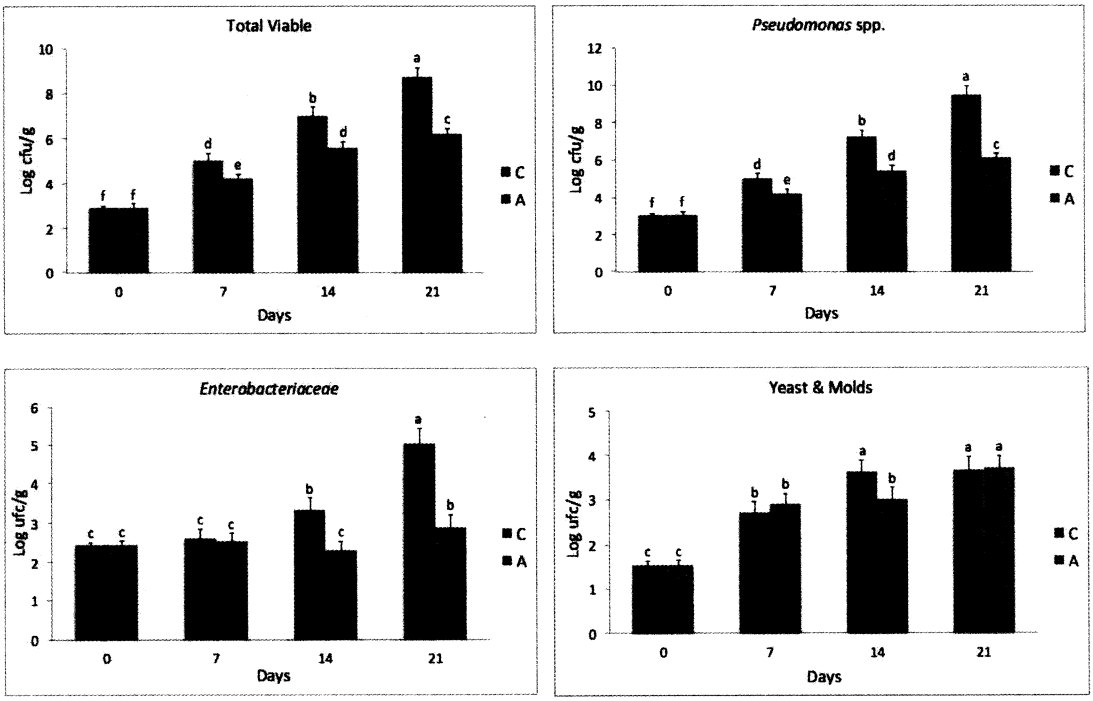

Figure 1. Average counts of the spoilage microorganisms during mozzarella storage. A= experimental brine; C= control (in water).

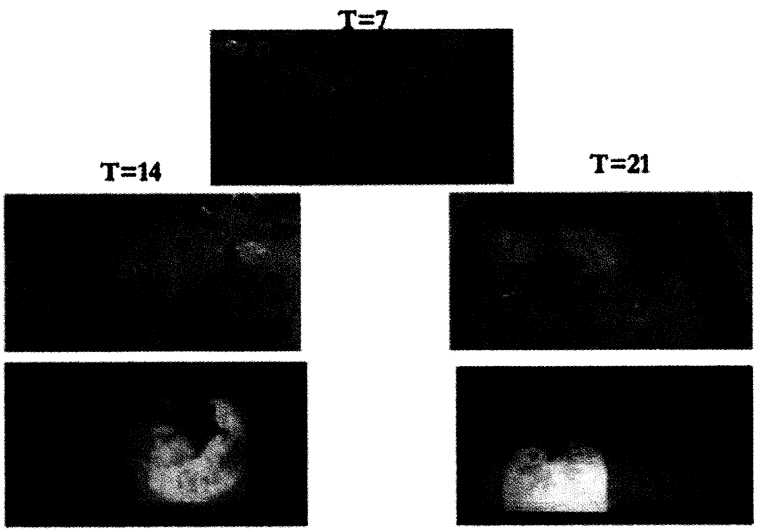

Figure 2. Occurrence of fluorescence in the preserving liquid of mozzarella during storage. A= calcium lactate brine; C= control (in water)

The experimental brine did not influence the sensory characteristics of the product (Fig. 3), which were preserved for long time. Moreover, many texture and taste parameters received better scores than the control: it is likely to be connected to the formation of a thin but elastic skin on the cheese surface, which exerted a sort of "barrier effect" against the pseudo-osmotic exchanges.

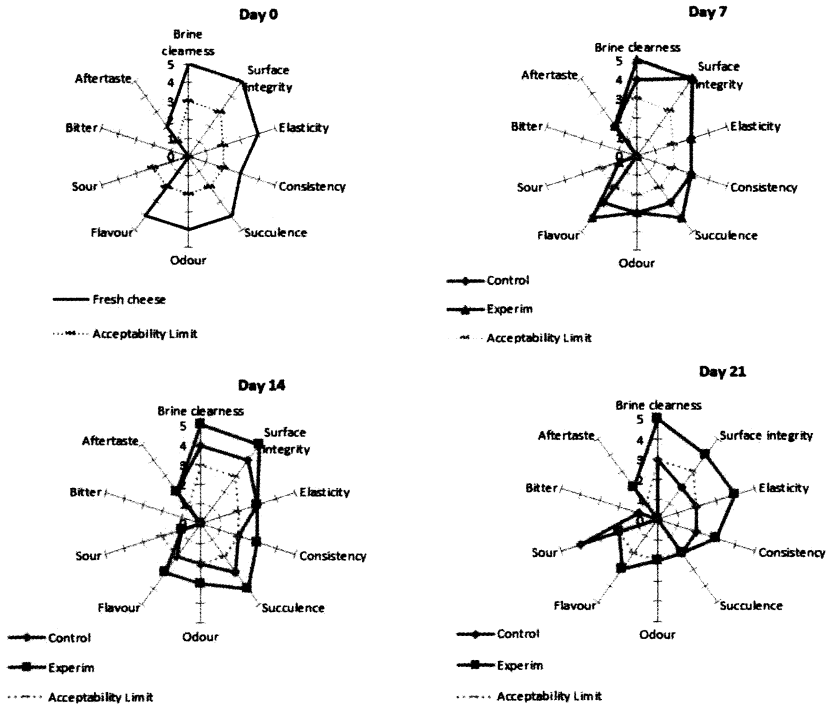

Figure 3. Quantitative Descriptive Analysis of mozzarella samples stored in water (Control) or Experimental brine.

The higher concentration of NaCl in the experimental sample at 21 days (3.2 $g.kg^{-1}$) with respect to control (1.4 $g.kg^{-1}$) gave an evidence of the reduction of such exchanges. The results obtained were slightly better than those reported in a previous paper (FACCIA *et al.*, 2019), of which the present experimentation represent the continuation.

4. CONCLUSIONS

The use of calcium lactate/lactic acid brine at pH 3.50 as preserving liquid allowed delaying the growth of spoilage microorganisms in bovine mozzarella and to counter the occurrence of discoloration without impairing the sensory characteristics. The brine has low economic impact, is easy to prepare and is fully compatible with the EU legislation

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