Chemical and texture characteristics and sensory properties of “mozzarella” cheese from different feeding systems

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ABSTRACT: The aim of this study was describing the chemical composition, the rheological characteristics and the sensory properties of “mozzarella” cheese produced with milk from buffalos fed with different diets. The study involved two farms and four feeding systems. In farm C, one group was mostly fed with Ryegrass Hay (RH) and the other group with Ryegrass Silage (RS). In farm T, instead, one group was mostly fed with Corn Silage (CS) and the other one with a Sorghum Silage (SS). In summer, three cheese-makings, for each farm and for each feeding system, were carried out at C.R.A. of Bella. In each farm, data were processed by the analysis of variance in order to compare the effects of two feeding systems. Some parameters of chemical and texture characteristics and sensory properties were influenced by the feeding system. Results were remarkable for the DOP products.

Key words: Buffalo, diets, “Mozzarella” cheese, Quality.

INTRODUCTION - In Italy, the importance of buffalo rearing has increased over the last few years. The increase in heads, from 200,000 in 2001 (Zicarelli, 2001) to about 265,000 in 2003 (ANASB, 2003 sono disponibili i dati del 2005), was due to the high market demand for “mozzarella” cheese, a typical Italian cheese made from fresh buffalo milk, recognized as DOP and called “Mozzarella di Bufala Campana”. Over the last years, some scientists have explored the relationships existing between the conditions under which milk is produced and the sensory properties of cheese, since these upstream factors, especially those related to animal feeding, have increasingly been the focus of consumers’ concern. These factors are particularly important in the case of labelled products, Protected Designation of Origin (DOP) and Protected Geographical Indication (IGP), for which any raw material modification during processing is restricted or prohibited (Verdier-Metz et al., 2005, Martin et al., 2005) and close links with milk production conditions are claimed to be the basis for the “terroir” notion. The aim of this study was describing the chemical composition, the rheological characteristics and the sensory properties of “mozzarella” cheese made with the milk produced from buffalos supplied with different diets.
MATERIAL AND METHODS - Our study involved two farms and four feeding systems. In farm C, one group was mostly fed with Ryegrass Hay (RH) and the other group with Ryegrass Silage (RS). In farm T, instead, one group was mostly fed with Corn Silage (CS) and the other one with a Sorghum Silage (SS). In summer, three cheese-makings, for each farm and for each feeding system, were carried out at C.R.A. of Bella. Milk and “mozzarella” cheese samples were analyzed for chemical composition. Chemical composition of whole milk and “mozzarella” cheese was measured on three samples for each diet. Dry matter and nitrogen were determined by IDF methods (IDF, 1987, 1993). Nitrogen Not Caseinic (NCN) and Non-Protein Nitrogen (NPN) were measured according to Rowland (1938) methods. Fat (Gerber method) and ash (AOAC, 1984) content was determined. The sensory profile of “mozzarella” cheese was detected by ten trained panellists. Each attribute was evaluated on a 0-9 score graduated scale. Rheological parameters were determined by a texture profile analysis (TPA) using the Universal TA.XT2 Texture Analyser (Stable Micro Systems Ltd., England). Measurements were made at 20±1°C. Five parameters have been determined: springiness, cohesiveness, gumminess, chewiness and hardness. All the analyses of milk and “mozzarella” cheese samples were performed in duplicate. Sensory data were normalised (Naes, 1991) before statistical analysis and submitted to ANOVA repeated measurement procedure. Significance was declared as P≤0.05.

RESULTS AND CONCLUSIONS - Milk chemical composition was partially affected by the feeding system (Table 1). In farm C, the highest dry matter and fat content was found in group RS (respectively 17.23% and 6.93% vs. 16.62% and 6.53%). The contrary trend was observed for NCN and NPN. The highest value was observed in the milk of group RH. The effect of different diets was less clear in farm T, only the dry matter and ash content were significantly (P<0.05) influenced by feeding systems. The highest dry matter and ash content was detected in the milk of SS group.

Table 1. Effect of feeding system on pH and chemical composition of buffalo milk.

| Farm C          |                 | Farm T          |                 |
|-----------------|-----------------|-----------------|-----------------|
| Group           | RH              | RS              | s.e. | Signif. | CS              | SS              | s.e.   | Signif. |
| pH              | 6.64            | 6.63            | 0.052 | ns      | 6.54            | 6.57            | 0.007 | ns      |
| Dry matter      | % 16.62 b       | 17.23 a         | 0.194 | *       | 18.93 b         | 19.20 a         | 0.088 | *       |
| Fat             | % 6.53 b        | 6.93 a          | 0.046 | **      | 9.48            | 9.67            | 0.142 | ns      |
| Protein         | % 4.60          | 4.52            | 0.028 | ns      | 4.98            | 4.61            | 0.228 | ns      |
| Ash             | % 0.82          | 0.83            | 0.001 | ns      | 0.82 b          | 0.85 a          | 0.009 | *       |
| NCN             | % 0.151 a       | 0.139 b         | 0.0007 | **      | 0.138           | 0.140           | 0.074 | ns      |
| NPN             | % 0.042 a       | 0.038 b         | 0.0002 | **      | 0.051           | 0.047           | 0.006 | ns      |

**P<0.01; *P<0.05; a, b means, in the row, with different letters were different at P<0.05.
As far as the chemical composition of “mozzarella” cheese is concerned (Table 2), in farm C, the highest fat and (non è significativo) protein contents were detected in “mozzarella” cheese of RS group and, on the contrary, the highest ash content was observed in RH group. In the “mozzarella” of T farm, differences due to different feeding systems were not observed. Differences were observed for the pH value only (5.03 CS group vs. 5.12 SS group).

Table 2. Effect of feeding system on pH and chemical composition of buffalo mozzarella cheese.

|                | Farm C |                | Farm T |                |
|----------------|--------|----------------|--------|----------------|
|                | Group  |                | Group  |                |
|                | RH     | RS             | s.e.   | Signif.        | CS    | SS   | s.e. | Signif. |
| pH             | 5.07   | 5.03           | 0.025  | ns             | 5.03b | 5.12a| 0.024 | *       |
| Dry matter     | %      |                |        |                |       |      |      |         |
| Fat            | 28.41  | 29.25          | 0.381  | ns             | 28.09 | 28.10| 0.316 | ns      |
| Protein        | %      |                |        |                |       |      |      |         |
| Ash            | %      |                |        |                |       |      |      |         |
| NCN            | %      |                |        |                |       |      |      |         |
| NPN            | %      |                |        |                |       |      |      |         |

**P<0.01; *P<0.05; a, b means, in the row, with different letters were different at P<0.05.

Table 3 shows the evaluation of “mozzarella” cheeses as for texture attributes. In farm C, the feeding system affected three out of five texture characteristics. Gumminess, chewiness and hardness resulted higher in the “mozzarella” cheese of RH group. The effect of diets was less pronounced in the “mozzarella” cheese of farm T. Only two out of five texture attributes were significantly (P<0.05) influenced by the different feeding system. The highest value of gumminess and chewiness was found in the “mozzarella” cheese of SS group (154.18 and 110.12 vs. 129.93 and 90.11 respectively in the CS group).

Table 3. Texture characteristics of mozzarella cheese.

|                | Farm C |                | Farm T |                |
|----------------|--------|----------------|--------|----------------|
|                | Group  |                | Group  |                |
|                | RH     | RS             | s.e.   | Signif.        | CS    | SS   | s.e. | Signif. |
| Springiness    | 0.62   | 0.57           | 0.023  | ns             | 0.69  | 0.71 | 0.014 | ns      |
| Cohesiveness   | 0.46   | 0.46           | 0.017  | ns             | 0.52  | 0.51 | 0.008 | ns      |
| Gumminess      | 102.23a| 76.07b         | 9.29   | *              | 129.93a| 154.18b| 7.18 | *       |
| Chewiness      | 64.36a | 45.43b         | 6.58   | *              | 90.11b| 110.12a| 6.92 | *       |
| Hardness       | 708.11a| 564.78b        | 50.44  | *              | 888.0 | 1007.5| 76.96 | ns      |

*P<0.05; a, b means, in the row, with different letters were different at P<0.05.
The feeding system affected few parameters of the sensory properties of “mozzarella” cheese (Figure 1). In the “mozzarella” of farm C, the highest value of herbaceous odour was observed in RH group. In the same group, higher values of springiness and gumminess were detected. These results were comparable with the texture attributes showed in RH group. In farm T, only bitter taste and softness were influenced by the feeding system. A higher value of bitter taste was observed in SS group than in CS group. On the contrary, softness was higher in the “mozzarella” cheese of CS group.

Figure 1. Effect of feeding system on the sensory profile of “mozzarella” cheese.

Results indicate that the chemical composition of milk, and the texture characteristics and sensory properties of “mozzarella” cheese vary according to the forage type. Results are remarkable for the DOP products, in fact animal feeding is one of the elements linking the product to its terroir.

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REFERENCES - ANASB, 2003. Statistical data. AOAC, 1984. Association of Official Analytical Chemists. Official Methods of Analysis, 14th ed. AOAC, Washington, DC. International Dairy Federation, 1987. Milk, cream and evaporated milk total solids. Standard no. 21B, Brussels, Belgium, pp. 1-15. Martin, B., Priolo, A., Valvo, M.A., Micol, D., Coulon, J.B., 2005. Effects of grass feeding on milk, cheese and meat sensory properties. Options Méditerranéennes, 67: 213-233. Naes, T., 1991. Handling individual differences between assessors in sensory profiling. Food. Qual. Pref., 2:187-199. Verdier-Metz, I., Martin, B., Pradel, P., Albouy, H., Hulin, S., Montel, M.C., Coulon, J.B., 2005. Effect of grass-silage vs. hay diet on the characteristics of cheese: interactions with the cheese model. Lait, 85: 469-480. Zicarelli, L., 2001. La bufala Mediterranea Italiana: esempio di una razza autoctona in espansione. Sci. Tecn. Latt-Cas., 52: 279-284. Rowland, S.J., 1938. The determination of nitrogen distribution in milk. Journal Dairy Research, 9: 42-46.