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Seasonal variations of Italian Mediterranean Buffalo (*Bubalus bubalis*) Mozzarella cheese quality

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Water buffalo Mozzarella cheese is more appreciated in the summer, but milk production is higher during wintertime, as water buffalo are seasonally polyoestrous animals. The aim of the study reported in this Research Communication was to evaluate the effect of the reversing of the calving period on Mozzarella cheese composition and quality traits. Ten batches of Mozzarella cheeses produced during the summer and winter periods were analysed for pH, colour, chemical composition. Seasonal differences were observed for cheese yield (26·66% in winter and 25·61% in summer), moisture content (66·54% in winter and 61·18% in summer) colour and consumer evaluation.

Keywords: Water buffalo, milk, cheesemaking, fatty acid profile, consumer evaluation.

Water buffalo Mozzarella cheese is a fresh dairy product that is very popular in Italy and is consumed mainly in the spring and summer (Borghese & Mazzi, 2005). The increase in volume sales of water buffalo Mozzarella is accompanied by significant growth in the primary production of raw material but the standard lactation of buffalo is regarded as 270 d and the peak of maximum production is reached at 50–60 d from calving with 90% of the births concentrated between late summer and beginning of autumn (Sabia et al. 2015). Recently, efforts were made at farm level to reverse the calving season to produce higher amounts of milk in the summer, to coincide with the higher market demands for Mozzarella cheese during that time. To progressively reverse the calving season, with most of the births between January and August, an out-of-breeding-season-mating technique was suggested, that consists in removing the bulls from the herd in October and introducing them again from March to end of September (Zicarelli, 1997).

No data is available on Mozzarella cheese quality traits from farms that adjust births. The aim of this study was to evaluate the effect of this practice on Mozzarella cheese yield, composition, physical traits and consumer evaluation.

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Materials and methods

Animals and samples

This study was conducted on water buffalo Mozzarella samples, produced in a cheese factory with milk from a nearby dairy farm, both located in Corigliano Calabro (Cosenza, Italy). The animals fed on the same feeding regime throughout the year, adequate for their physiological state. Only one farm/producer was tested in this study to avoid multiple effects that could overlap the season of production (Catillo et al. 2002) such as farm management type or Mozzarella cheesemaking process. The births were adjusted to have milk production along the year (online Supplementary Table S1).

Mozzarella cheese production technique

Different batches of Mozzarella cheese were produced in winter and summer as follows: the refrigerated milk was thermised at 55 °C for 40 s and unloaded in the coagulation tank at 36–38 °C. Natural whey containing a mixed culture of mesophilic and thermophilic lactic acid bacteria strains (*Streptococcus salivarius* subsp. *thermophilus, Lactobacillus delbrueckii* subsp. *bulgaricus, Lactococcus lactis* subsp. *lactis* biovar *diacetylactis*) was added to the milk (3% v/v), and when the titratable acidity reached almost 7°SH, liquid calf rennet 1 : 20 000 (Mofin Alce Group, Novara, Italy) was also added (0·01% v/v). After

about 40–60 min the curd obtained was subjected to a first break in the shape of a cross. After checking the rising acidity of the curd by controlling the acidity of serum (over 24°SH), manual cutting was performed through a cheese harp to reach the fragment size of approximately 3 cm^3. The curd was then left to purge the whey for about 4 h kneaded with the addition of hot water (85 °C), stretched manually, formed mechanically in pieces of 125 g and then transferred into a tank containing saline solution (water added with 2% salt and lactic acid at 6° SH). The Mozzarella was then packed in polypropylene bags for food, together with the preserving liquid, and placed in a refrigerated chamber.

Analytical determinations

Summer (June to August) and winter (December to March) were chosen for the evaluation of the Mozzarella characteristics because in the summer, there is a peak in Mozzarella consumption, while in the winter, the Italian Mediterranean Buffalo produces the largest quantity of milk. During processing the actual cheese yield was also calculated according to Metzger et al. (2000).

Ten batches of Mozzarella for each season were considered. The Mozzarella samples already packaged in individual sale units, were taken on the day of production and promptly sent to the laboratory. Upon arrival, three samples from each batch were processed for pH, colour (CIE L^* a^* b^*), chemical composition and NaCl content, as reported by Branciari et al. (2014).

The overall liking of the products was analysed by a series of consumer tests (two sessions for each season considered) that involved students and personnel of the Department of Veterinary Medicine. Four Mozzarella cheeses from the same batches used for the analytical determination were cut into 2 × 2 × 2 cm pieces and served on white plastic plates coded with three-digit random numbers. For each session, 30 regular cheese consumers were involved, for a total of 120 participants (aged 18–65 years, 54 male and 66 female). Practicing sessions were performed before the test to allow consumers to become familiar with the use of a nine-point hedonic scale ranging from 1, 'dislike extremely', to 9, 'like extremely'. Consumers received no information about the product.

Statistical analyses

For the Mozzarella cheese determinations, the values recorded in summer and in winter were evaluated by ANOVA (Statview SAS Institute Inc, Cary, NC, USA) with the season as the fixed factor. Post hoc Tukey's test was then performed and the level of significance was set at $P < 0{\cdot}05$. For the consumer evaluation, the model was integrated with consumer sections (two for each year) as variable factor.

Table 1. Chemical and physical evaluation of water buffalo Mozzarella cheeses produced in winter and summer ($n = 20$; mean value ± SD)

	Winter	Summer	*P* value
pH	5·55 ± 0·24	5·40 ± 0·06	n.s.
Outer colour			
L^*	94·46 ± 0·96	94·58 ± 1·35	n.s.
a^*	−2·81 ± 0·48	−2·28 ± 0·55	<0·05
b^*	7·66 ± 1·36	6·83 ± 1·22	n.s.
Inner colour			
L^*	89·63 ± 0·81	91·15 ± 1·23	<0·01
a^*	−4·26 ± 0·15	−4·13 ± 0·24	n.s.
b^*	12·08 ± 0·40	12·84 ± 0·71	<0·01
Moisture (%)	66·54 ± 0·92	61·18 ± 3·93	<0·05
Protein (%)	10·20 ± 1·30	12·92 ± 1·26	<0·05
Fat (%)	21·50 ± 2·23	25·24 ± 2·96	n.s.
Ashes (%)	1·75 ± 0·01	1·64 ± 0·30	n.s.
NaCl (%)	1·20 ± 0·15	0·82 ± 0·28	n.s.

n.s.: not significant. L^*, a^*, b^*: colour (CIE) characteristics (Branciari et al. 2014).

Results

The average actual cheese yield (mean ± SD) registered in the summer was 25·61 ± 0·29% while in winter it was 26·66 ± 0·43% ($P < 0{\cdot}01$).

No difference in pH values was recorded between the products obtained in the two periods considered, while significant differences were recorded for the colour, in particular for the a^* values in the outer part and the L^* and b^* values in the inner part. Winter products proved to have more moisture than summer ones, while summer Mozzarella had a higher protein percentage ($P < 0{\cdot}05$), as shown in Table 1, but if dry matter is considered, no difference were recorded between the two groups (data not reported).

The consumer tests reported a higher preference (overall liking score) for winter Mozzarella cheeses (7·24 ± 0·47) than for summer products (6·30 ± 0·36: $P < 0{\cdot}001$).

Discussion

Calving data (online Supplementary Tables S1 and S2) emphasised that, even if the reverse of the calving season technique is adopted, a seasonality of milk composition may be present and affect the quality of the final product. Furthermore, the higher protein content recorded in milk during winter is probably responsible for the increased cheese yield (Ahmad et al. 2013). The physical and chemical parameters analysed (Table 1 and online Supplementary Table S3) showed no differences in regard to the final pH of Mozzarella cheeses. This parameter is influenced mainly by the microbial population present in the milk, in the whey and then in the Mozzarella (Mucchetti & Neviani, 2006). The use of the same production method ensured proper acidification during both the winter and summer as

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a consequence of microbial growth (online Supplementary Figure S1). As for the colour determination, Mozzarella cheese produced in the winter was darker and less yellow than that produced in the summer. This phenomenon may be due to the different composition of the milk that, under the same technological treatment, influenced the amount of water, higher in the winter Mozzarella. The yellower colour in the summer product could be due to a different pigment concentration (Pandya & Kahn, 2006), rather than oxidation that takes place generally in ripened cheese.

The moisture content of the product affected the sensory evaluation as usually water buffalo Mozzarella is consumed fresh and appreciated for the high moisture content responsible for its soft body and juicy appearance (Ercolini et al. 2004). These characters strongly influenced the consumers who preferred the juicier winter products (Pagliarini et al. 1997). Furthermore, the winter products result in an increased perception of typical smells and consistency (online Supplementary Table S4). The sensorial data obtained are easily related to differences in the main parameters of milk which contribute to texture, microstructure and rheological characteristics of the final cheese (Rogers et al. 2009).

Conclusion

While the adjustment of seasonal births allows production performance to be in synchrony with the market demand for Mozzarella, it cannot avoid seasonal differences in milk and subsequently in Mozzarella cheese characteristics and appreciation. Further studies are needed to better understand the mechanisms involved in buffalo milk production and if correction could be performed for the standardisation of the product characteristics throughout the year.

Supplementary material

The supplementary material for this article can be found at https://doi.org/10.1017/S0022029916000649.

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