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Effects of an automatic milking system on milk yield and quality of Mediterranean buffaloes

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ABSTRACT

A study was carried out to evaluate the effects of an automatic milking system (AMS) on milk yield and composition of buffalo (Mediterranean-type *Bubalus bubalis*) cows. Performed from January 2015 to December 2015 in an organic buffalo dairy farm equipped with both a traditional tandem milking parlor and an AMS, the study involved 90 primiparous buffaloes randomly allotted to a tandem or AMS group from 5 to 10 d of lactation onward. Number of milkings per day and daily milk yield of each cow were recorded, and individual milk sampling was carried out twice a month. Compared with the tandem, the AMS group showed significantly higher daily milk yield and persistence of lactation. Use of the AMS resulted in higher protein and casein contents, and lower somatic cell and total bacterial counts, whereas fat, freezing point, and pH were unaffected by the system. We conclude that, in terms of milk yield and quality, automatic milking may be a suitable alternative to conventional milking for buffaloes.
Key words: automatic milking system, dairy buffalo, milk yield, milk quality

INTRODUCTION

In Italy, water buffalo (*Bubalus bubalis*) dairy farming is a traditional zootechnic activity almost exclusively focusing on mozzarella cheese production (Masucci et al., 2016). Although buffalo farming has changed substantially in recent decades, undergoing rapid intensification of rearing techniques (Napolitano et al., 2004; Masucci et al., 2011), the first automatic milking system (**AMS**) for buffaloes was only introduced in 2008 in an organic farm in southern Italy. At present, the number of AMS for buffaloes is still very low, mainly due to concerns about the adaptability of buffalo cows to robotic milking. Indeed, compared with dairy cows, buffaloes present delayed milk ejection due to a different mechanisms of milk ejection, mammary anatomy, and the internal arrangement of mammary tissue, as well as longer and thicker teats (Thomas et al., 2004; Borghese et al., 2007; Ambord et al., 2010). Whereas the use of AMS has been studied deeply in dairy cows (Jacobs and Siegford, 2012), to date, scientific research on Mediterranean buffaloes is still limited (Caria et al., 2014; Faugno et al., 2015; Tangorra et al., 2017). The most attractive aspect of an automatic system for a farmer may be relief from the milking routine (Jensen, 2004). Yet AMS can positively influence milk yield in both cows (Baines, 2002; de Koning et al., 2002; Wall and McFadden, 2007) and buffaloes (Faugno et al., 2015). On the other hand, beside the large initial investment, a drawback to implementing AMS is a potential lowering of milk quality (Rasmussen et al., 2002). To our best knowledge, no research is currently available on the effect of AMS on Mediterranean buffalo milk quality. Therefore, this study aimed to shed light on the influence of AMS on buffalo milk yield and quality in terms of major constituents (i.e., fat, protein, casein, and lactose), udder health and hygiene [i.e., SCC and total bacterial count (**TBC**)], pH, and freezing point.

MATERIALS AND METHODS

Study Site, Experimental Design, and Animal Management

The study was carried out on an organic buffalo farm (40°27′N, 15°01′E, 31 m above sea level) in Campania, a region in southern Italy. The farm is equipped with both a traditional system and an AMS that was installed in 2008. In the traditional system, cows are housed in freestall barns and milked in a conventional tandem (5 + 5) parlor. In the AMS, cows are placed in a stall divided into 4 sectors (40 × 32 m), each provided with a robotic milking machine (De Laval Voluntary Milking System 2007, Tumba, Sweden) serving a freestall pen of 40 to 45 buffaloes. A selection gate between pen and milking robot allows cows to be milked if a minimum

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time interval of 7 h elapses between 2 consecutive milkings. Otherwise animals are redirected to the feeding area. Further details on housing, management, and milking systems are given elsewhere (Faugno et al., 2015).

The study period considered was from January 2015 to December 2015. Ninety lactating primiparous buffaloes at the beginning of lactation (5 to 10 DIM) were randomly allotted to 2 groups milked with either the traditional system (tandem group) or with the AMS (AMS group). For AMS buffaloes it was ascertained that udder and teat shape were suitable for the automatic system as observed in cows. Primiparous cows were chosen to avoid potentially confounding effects due to experience with previous milking systems and because they adapt to AMS more quickly than multiparous cows (Hopster et al., 2002; Jago and Kerrisk, 2011). The animals were housed in the same automatic sector (AMS group) or pen (tandem group) and were fed once a day (0730 to 0900 h) the same TMR at 13% of CP (on a DM basis) and 5.9 MJ/kg of DM of energy. The ration was based on silages, commercial concentrates, hays, and mineral and vitamin mix. Cows were also given a concentrate supplement ranging from 3 to 5 kg/d per animal, depending on individual milk yield. For the tandem group, supplement was fed in 2 equal meals at the 0500 and 1700 h milking, whereas for the AMS group, it was split into 2 or 3 equal meals depending on the expected number of milkings. The working parameters of milking equipment were identical for both systems (i.e., 42 kPa vacuum, 60 cycles/min pulsator rate, and 60% pulsator ratio).

The number of milkings per day, milk yield/milking, and milk yield per day of each cow were collected daily by the software incorporated in the system (AMS group) or by farm staff by means of recording jars (tandem group). Individual milk samples were collected twice a month at afternoon milking (tandem group) or by using automatic milk sampling units (AMS group). Samples (100 mL with azidiol) were analyzed in the following 24 h for macro-components, SCC, pH, freezing point, and TBC by infrared analysis (Integrated Milk Testing Milkoscan FT 6000, Bactoscan 8000, Foss Electric, Hillerød, Denmark).

Data Selection and Analysis

Statistical analysis was performed by means of R Studio software (version 1.1.383). Before analysis, normality and homogeneity of variance of data were checked by using the Shapiro-Wilks test and Levene test. Value of SCC and TBC were log-transformed to base 10. Data from 10 d after calving until the end of lactation (i.e., milk yield <1 kg) were considered; for the AMS group, data relative to a milking gap >24 h were discarded (Faugno et al., 2015).

Daily milk yield and number of milkings per day (for AMS group) of each cow were examined until d 270 of lactation (i.e., standard lactation length of buffaloes) and estimated by dividing the whole yield and total milkings by 270. Real lactation length and daily milk yield were analyzed by 1-way ANOVA (tandem or AMS) using cow as the experimental unit.

For each group, persistence of lactation (i.e., the rate of milk yield decline after the lactation peak) was calculated from d 57 to 270 as the percentage ratio between average milk yield in a month and the average milk yield of the previous month. Analysis was carried out by 1-way ANOVA (tandem or AMS) with month of lactation as experimental unit.

The lactation curves of the tandem and AMS groups were compared on a daily basis by means of 1-way ANOVA with the milking system as the fixed effect.

Data on milk quality (i.e., macro-components, SCC, TBC, pH, and freezing point) underwent ANOVA for repeated measures (mixed procedure) with the milking system as a nonrepeated factor and month of sampling and milking system × month of sampling as repeated factors. The cow variance was considered as random and used as the error term to test the main effect of the milking systems.

RESULTS AND DISCUSSION

The number of milkings per day for the AMS group was 2.5 ± 0.24. Higher daily milk yield ($P < 0.001$) and persistency of lactation ($P < 0.05$) were observed in AMS compared with the tandem group (Table 1). These results extend and confirm those of our previous work carried out on the same farm from January 2013 to May 2014 in which cows milked automatically showed higher milk production (Faugno et al., 2015). Moreover, our findings are in agreement with those of several studies on dairy cows (de Koning and Ouweltjes, 2000; Wagner-Storch and Palmer, 2003; Wade et al., 2004), even though others found no milk yield increase in primiparous cows (Abeni et al., 2005, 2008; Speroni et al., 2006). The yield increase with the AMS may be due to several factors, especially the increase in milkings per day compared with the conventional system (Jacobs and Siegford, 2012), and a higher lactation persistence leading to a more stable production until the end of the lactation (Stelwagen, 2001). These results and assumptions are confirmed by the different lactation curve shapes of the 2 groups (Figure 1). In particular, the AMS group showed a statistically higher milk yield before and immediately after the lactation peak, and from d 233 onward.