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# MAXIMIZING THE POTENTIAL OF WATER BUFFALO MILKABILITY: BEST PRACTICES AND LESSONS LEARNED

## Maximizando el potencial de la ordeñabilidad de los búfalos de agua: mejores prácticas y lecciones aprendidas

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### ABSTRACT

Milk yield and flow profiles are essential parameters to record and evaluate. Buffaloes are characterized by longer teats and teat canals and, in particular, stronger muscular resistance of the teat wall than in cows; it is necessary to have a high vacuum level to open the teat canal and begin milk ejection. The milk stored in the buffalo udder can be divided into two fractions: the cisternal fraction, which has already been transferred from the alveoli to the cistern during the interval between milkings and is immediately available, and the alveolar fraction, which can only be removed from the udder by the action of oxytocin. In buffalo milking management, the milking machine is a critical point, and the characteristics of the milking vacuum and the pulsation rate are closely related to milk flow observations; in Italy, the most commonly used vacuum levels are 44–46 kPa (range 40–53 kPa). The data on the milkability traits of the Mediterranean Italian breed made it possible to classify eight different types of milk flow curves due to anatomical, physiological, and management differences. The most represented milk flow curve was type 3 (with a similar time between PPT and DPT, 27.32%), followed by type 6 (17.79%), characterized by a very long plateau phase. The least represented curve was type 1 (4.41%), characterized by a long lag time and low peak flow rate. Buffaloes with curves of type 5 (10.62%) and 6 (17.79%) were characterized by the highest milk yield at milking, the lowest somatic cell score, and the shortest milking time. The analysis of the milk emission profiles showed an excessive duration of DPT and overmilking (BT); these results suggest the detachment of the milking cluster to reduce the BT with the following advantages: a) reduction of the total milking time and consequently of the worker's time, b) improvement of the farmer's income and milk quality thought the mastitis incidence decreases. Concerning the automation of milking technologies, a recent study analyzed the main milk flow traits and milk yield recorded in Mediterranean Italian buffaloes milked with the Automatic Milking System (AMS). The results showed a considerable variation in milk ejection and, consequently, in the milk flow curves of the buffaloes milked in AMS with a forced system compared to the conventional one. The differences were the following: better pre-stimulation allowing a positive endogenous release of oxytocin, with reduced lag time; independent milk ejection for each teat, with optimal milking of all quarters, with the reduction of BT; improvement of milking hygiene during milking, limiting the incidence of mastitis and with a low value of somatic cell score; adverse effects due to failed or incomplete milking (17% of the total milkings), limiting the potential capacity and efficiency of AMS; frequent leakage of airflow, which could cause alteration of milk composition. In conclusion, continuous monitoring of milk ability will help to optimize milking practices by reducing labor time and increasing farmers' income through better milk quality and fewer udder issues. In addition, the identification of buffaloes with desirable types of milk flow curves could be helpful for buffalo breeders' associations to address farmer management and also to define potential new breeding objectives.

**Keywords:** dairy buffalo, milkability, milk flow curves, milking time.

### RESUMEN

Los perfiles de producción y flujo de leche son parámetros esenciales para registrar y evaluar. Los búfalos se caracterizan por tener pezones y canales pezones más largos y, en particular, una mayor resistencia muscular de la pared del pezón que en las vacas; es necesario tener un nivel de vacío alto para abrir el canal del pezón y comenzar la eyección de la leche. La leche almacenada en la ubre de búfala se puede dividir en dos fracciones: la fracción cisternal, que ya ha sido transferida de los alvéolos a la cisterna durante el intervalo entre ordeños y está inmediatamente disponible, y la fracción alveolar, que sólo puede extraerse de la ubre por la acción de la oxitocina. En el manejo del ordeño de búfalas, la máquina de ordeño es un punto crítico, y las características del vacío de ordeño y la tasa de pulsación están estrechamente relacionadas con las observaciones del flujo de leche. En Italia, los niveles de vacío más utilizados son de 44 a 46 kPa (rango de 40 a 53 kPa). Los datos sobre las características de ordeñabilidad de la raza mediterránea italiana permitieron clasificar ocho tipos diferentes de curvas de flujo de leche debido a diferencias anatómicas, fisiológicas y de manejo. La curva de flujo de leche más representada fue la tipo 3 (con un tiempo similar entre PPT y DPT, 27,32%), seguida de la tipo 6 (17,79%), caracterizada por una fase de meseta muy larga. La curva menos representada fue la tipo 1 (4,41%), caracterizada por un largo tiempo de desfase y un bajo caudal máximo. Los búfalos con curvas de tipo 5 (10,62%) y 6 (17,79%) se caracterizaron por la mayor producción de leche en el momento del ordeño, el menor puntaje de células somáticas y el menor tiempo de ordeño. El análisis de los perfiles de emisión de leche mostró una duración excesiva del DPT y del sobreordeño (BT); Estos resultados sugieren el desprendimiento del grupo de ordeño para reducir el BT con las siguientes ventajas: a) reducción del tiempo total de ordeño y consecuentemente del tiempo del trabajador, b) mejora de los ingresos del productor y de la calidad de la leche al disminuir la incidencia de mastitis. En cuanto a la automatización de las tecnologías de ordeño, un estudio reciente analizó las principales características del flujo de leche y la producción de leche registrada en búfalas italianas del Mediterráneo ordeñadas con el Sistema de Ordeño Automático (AMS). Los resultados mostraron una variación considerable en la eyección de leche y, en consecuencia, en las curvas de flujo de leche de las búfalas ordeñadas en AMS con sistema forzado respecto al convencional. Las diferencias fueron las siguientes: mejor preestimulación que permite una liberación endógena positiva de oxitocina, con un tiempo de retardo reducido; eyección de leche independiente para cada pezón, con ordeño óptimo de todos los cuartos, con reducción de BT; mejora de la higiene del ordeño durante el ordeño, limitando la incidencia de mastitis y con un bajo valor de puntuación de células somáticas; efectos adversos por ordeño fallido o incompleto (17% del total de ordeños), limitando la capacidad potencial y eficiencia del AMS; Fugas frecuentes de flujo de aire, que podrían provocar alteraciones en la composición de la leche. En conclusión, el monitoreo continuo de la capacidad lechera ayudará a optimizar las prácticas de ordeño al reducir el tiempo de trabajo y aumentar los ingresos de los ganaderos a través de una mejor calidad de la leche y menos problemas con la ubre. Además, la identificación de búfalas con tipos deseables de curvas de flujo de leche podría ser útil para que las asociaciones de criadores de búfalas aborden la gestión de los ganaderos y también para definir posibles nuevos objetivos de cría.

**Palabras clave:** búfala lechera, ordeñabilidad, curvas de flujo de leche, tiempo de ordeño.

## INTRODUCTION

The buffalo (*Bubalus bubalis*) is a species of worldwide importance, reared for the production of milk, meat, hides, and other by-products and often used as a working animal in marginal rural areas [1, 2]. Although the milk produced by buffaloes is an irreplaceable source of nutrients and energy, especially in some countries or confined environments, its extraction from the mammary gland is not always easy. Milk removal is essential both for production purposes and to ensure the health of the organ; it can be done in two ways: a) natural extraction by sucking the calf, b) artificial extraction by manual or mechanical milking. In dairy species, milking is the foremost essential operation affecting production efficiency. A general definition of "*milkability*" is 'the ability of an animal to provide regular, complete and rapid milk secretion from the mammary gland in response to correct milking technique.' The primary method of assessing "*milkabilit*y" is based on the analysis of the milk flow curve; in this way, the electronic milk meter (LactoCorder® device) records milk yield in the whole milking, electrical conductivity, and the main parameters of the milk flow curve, including the Total Milking Time (TMT). Since 1999, the Milk Quality laboratory of the "Istituto Zooprofilattico Sperimentale del Lazio e della Toscana M. Aleandri" (Rome, Italy) has been engaged in the study of milk emission kinetics by recording milk flow curves in the main dairy species (buffalo, cow, goat, sheep, and donkey).

## CLASSIFICATION OF THE TYPES OF MILK FLOW CURVES

A graphical representation of milk ejection can be displayed through milk flow curves, which differ according to the dairy species [3, 4]. The milk flow curves are subdivided into three main phases and a fourth one. The first phase is the "Lag Time" (LT), represented by the time elapsed between the attachment of the milking clusters and the time until there is a constant milk flow. The second is the "Plateau Phase" (PPT), where the milk flow is constant. The third phase is the "Decreasing Phase" (DPT), which represents the time from the PPT until milk flow drops below 0.20 kg/min. The fourth phase may be the "Blind Phase" (BT). The BT (milk flow below 0.2 kg/min) occurs between the end of the DPT and the detachment of the milking cluster [5, 6]. Usually, the detachment is not performed promptly to collect the small amount of milk, the residual fraction, by stripping (often obtained by manual traction of the milking cluster by a milker) followed by further overmilking before detachment of the milking cluster.

Milk letdown is influenced by several factors: anatomical, physiological, sanitary, and environmental [7, 8, 9]. Many studies performed in different countries have shown that buffalo are challenging to milk because there is a delay in milk ejection. Because the udder anatomy and arrangement of the mammary tissue, a cisternal fraction of milk, and teat canal length are pretty different in buffaloes compared to dairy cattle [10, 11, 12]. Although each animal has its anatomical and physiological characteristics, the milking machine can affect the milkability and machine times. Buffaloes are characterized by a longer teat with a longer teat canal and stronger muscular resistance of the teat wall [11, 7, 10]. Therefore, a higher vacuum level is needed to open the teat canal and start milk ejection in this species.

In buffalo milking management, milking machine set-up is critical, and the milking vacuum levels and pulsation rate are strictly connected with milk flow observations. For Mediterranean Italian (MI) breeds, a working vacuum level of up to 45 kPa in buffalo is generally ineffective unless alveolar milk ejection has occurred. Generally, different studies conducted in different parts of the world in which the vacuum level varies in the range of 45–68 kPa for buffalo, while In Italy, the most used vacuum levels are 44–46 kPa (range 40–53 kPa) [8, 9, 13].

Data on milkability traits available in the literature can be traced back to the MI breed. In a recent study of 2,419 MI buffaloes reared on 187 farms in central Italy, Boselli et al. [14] classified eight types of milk flow curves based on anatomical, physiological and management differences. The classification of curves was based on visual inspection of curve shape, milk yield, and milk flow parameters. Only the 2,288 milk flow curves have been classified into eight different types. The most represented curve was type 3 (similar time between PPT and DPT, 27.32%), followed by type 6 (17.79%), characterized by a very long plateau phase. The least represented curve was type 1 (4.41%), characterized by a long lag and low peak flow rate.

According to the analysis of variance, the milk yield ranged from 2.21 to 5.22 kg per milking for types 1 and 6, respectively, while the peak flow rate was minimum (0.50 kg/min) and maximum (1.73 kg/min) for types 1 and 4 respectively. Concerning the main milkability parameters, the results show that the TMT averaged 11.29 min; the lag time and the milk emission time averaged 2.19 min and 4.30 min, respectively. The 12.5% of the total curves were classified as bimodal (two different peaks of milk flow are evident; the first peak is due to the removal of the cisternal milk fraction, while the second peak is due to the action of oxytocin, which allows the fraction of alveolar milk), and 60 of these were found to be of type 4. Based on the literature, type 4 curves are representative of very short teat canals and very high milk flow. The average somatic cell score was 3.63 units, with a maximum value found for type 1 and a minimum for type 6. The highest milk yield at milking, the lowest somatic cell score, and the shortest milking time characterized buffaloes showing curves of type 5 and 6.

The results of this study showed that such traits could be used as indicators to improve udder health and milkability in dairy buffaloes. The classification proposed in our field study shows significant differences among the milk flow curves, which could impact milk production and udder health. The results showed a high prevalence of overmilking, which may be responsible for adopting a higher TMT in buffaloes than in cows. Appropriate pre-milking udder stimulation should be used to reduce LT, increase Average Flow Rate (AFR), and limit TMT. In addition, proper milking practices would result in reduced labor time and improved farmer income due to better milk quality and fewer udder diseases. The results of this study allowed the identification of optimal milk flow curve types for the MI breed in terms of milk production and udder health; these results could be helpful to buffalo breeders' associations in herd management and in defining potential new breeding goals.

## FUTURE PERSPECTIVES

Further research is needed to investigate the variability of these phenotypes at the population level and whether they can be used as indicator traits for breeding purposes. Finally, a brief mention is made of the Automatic Milking System (AMS), which has been available since 1992 and used as a method of voluntary milking in cattle and, more recently, in dairy buffaloes. Only a few authors [15, 16, 17, 18] report data on the adaptability of buffaloes to AMS. Boselli et al. [15] measured data on buffalo with a portable milometer LactoCorder installed after the tubes connecting the milking cups. The TMT measured between the beginning of the cleaning of the first teat and the detachment of the last teat ranged from 8.80 min [15] to 8.3 min [16].

Regarding the number of milkings per day, Faugno et al. [17] reported 2.3 milkings per buffalo per day, Sannino et al. [18] and Boselli et al. [15] reported 2.5 milkings per buffalo per day. Concerning the introduction of AMS in dairy buffaloes, the preliminary results of the recent study show considerable differences in milk ejection and milk flow curves for buffaloes milked in AMS with a forced system compared to the conventional one. The differences are as follows: better prestimulation, allowing a positive endogenous release of oxytocin, with a reduced milk letdown phase; independent milk ejection for each teat, with optimal milking of all quarters, with a reduction in overmilking; better milking hygiene during the milking routine, limiting the incidence of mastitis and with a low somatic cell score; adverse effects due to failed or incomplete milkings (17% of the total milkings), which limit the potential performance and efficiency of AMS; frequent air leakage, which could cause alterations in milk composition. AMS is suitable for buffaloes and opens up a new strategy for recording and managing many milk ability traits in dairy buffalo milking.

## CONCLUSIONS

In conclusion, it is possible to know the milkability of the herd by monitoring milk flow curves. Continuous milkability monitoring will help optimize milking practices by reducing labor time and increasing farmers' income through better milk quality and fewer udder diseases. In addition, identifying buffaloes with desirable types of milk flow curves could be helpful for buffalo breeders' associations to address farmer management and define potential new breeding objectives. However, further research is needed to investigate the variability of these phenotypes at the population level and to understand whether they can be used as trait indicators for reproductive purposes.

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