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Preliminary characterization of coagulation properties of buffalo milk in Veneto region

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ABSTRACT

This study is a preliminary contribution to the characterization of milk production from buffaloes reared in Veneto region and examines the relationships between milk coagulation properties (MCP) and milk composition traits. A total of 66 buffaloes were sampled during the morning milking and analyzed within 3 h from collection. Measures of MCP were obtained using a Formagraph whereas milk composition traits were assessed through a MilkoScan FT120. Significant relationships were found between production traits and MCP. Rennet coagulation time seems to be related mainly to milk yield and casein content whereas curd firmness to protein percentage, casein percentage and acidity. With respect to curd firming time, a significant relationship has been found with casein content and acidity. Results allowed a preliminary characterization of buffalo milk traits in northeast Italy. Further studies are needed to better investigate the variability of MCP and the relationships between MCP and cheese yield.
(Keywords: buffalo, milk coagulation properties, milk quality traits)

INTRODUCTION

In Italy, buffaloes (*Bubalus bubalis*) are used as dairy animals, because they have been selected for milk production and have acquired specific traits characteristic of the actual "Italian Mediterranean buffalo". The use of buffaloes is steadily increasing in terms of both number of animals and farms also in the northern part of Italy because of the economic returns coming from the transformation of milk in the traditional Mozzarella cheese and other innovative products (*Addeo et al.,* 2007). Therefore, buffaloes may represent a potential tool for dairy farms to differentiate products and increase competitiveness in the market.

Milk coagulation properties (MCP) are of great relevance for cheese production, mainly because of their role in cheese-making (*Aleandri et al.,* 1989; *Wedholm et al.,* 2006; *De Marchi et al.,* 2008). Good reactivity to rennet, high curd firming capacity, good syneresis ability and whey drainage are crucial features of milk transformed into cheese. Assessment of MCP can be performed through computerized renneting meter (*Annibaldi et al.,* 1977; *Zannoni and Annibaldi,* 1981), providing measures of rennet coagulation time (RCT, min), curd firmness (a_{30}, mm) and curd firming time (k_{20}, min). Measurement of MCP is of special relevance for cheese manufacturing as cheese yield tends to increase with decreased RCT and increased a_{30}.

Previous studies (*Zicarelli et al.,* 2001; *Potena et al.,* 2001a; *Potena et al.,* 2001b) investigated the variability of milk quality traits in buffaloes and their relationships with

MCP in the southern Italy; however, such relationships are not yet fully explained. This study is a preliminary contribution to the characterization of milk production of buffaloes in Veneto region and examines the relationships between MCP and milk composition traits.

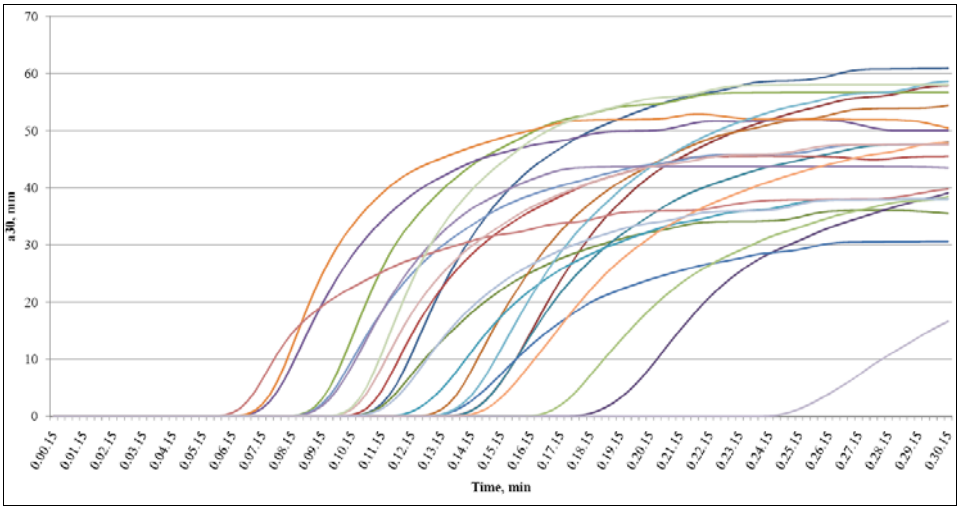
MATERIALS AND METHODS

A total of 66 buffaloes, reared in one herd located in Veneto region, were sampled once in February 2010. Milk samples (50 mL) were collected during the morning milking, stored in portable refrigerators (4 °C), transferred to the milk quality lab of the Department of Animal Science (Padova, Italy) and analyzed within 3 h from collection.

Ten mL of milk were heated to 35 °C; once the temperature was reached, 200 µL of rennet (Hansen standard 190 with 63% of chymosin and 37% of pepsin, Pacovis Amrein AG, Bern, Switzerland) diluted 1.6% in distilled water were added to milk. Measurement of MCP, determined by a Formagraph (Foss), ended within 31 min after the addition of the clotting enzyme. Measured traits were RCT (the time interval in minutes from the addition of the clotting enzyme to the beginning of coagulation), k_{20} (the time in minutes required to achieve 20 mm of firmness), and a 30 (the width in millimeters of the diagram 31 min after rennet addition, i.e., the firmness of the curd; *Figure 1*). The remaining amount of milk (40 mL) was used to determine fat and protein contents and titratable acidity through the MilkoScan FT120 (Foss). All samples were warmed up to 35 °C using a water bath and mixed gently prior to spectra recording at this temperature. The analysis is based on the FTIR measuring principle, respecting IDF and AOAC standards. Pearson product-moment correlations were obtained through the CORR procedure of SAS and were used to evaluate the relationships among milk attributes and MCP.

Figure 1

Coagulation process of buffalo milk samples



RESULTS AND DISCUSSION

Descriptive statistics of MCP, milk yield and quality traits are reported in *Table 1*. Milk yield averaged 8.04 kg/d. Protein, casein and fat contents were 4.73, 3.86 and 8.24%, respectively and showed large variability. Milk yield as well as milk attributes are comparable to the average of buffaloes registered in the National Herdbook (*ANASB*, 2009). Measure of fat content was more variable compared to other components; however, the value is in agreement with that reported by *Pilla and Moioli* (1992) and *Tiezzi et al.* (2009).

Table 1

Descriptive statistics of milk yield, quality traits and coagulation properties in buffalo cows

Trait[1]	N	Mean	SD	Minimum	Maximum
DIM, d	58	110	56	13	218
MY, kg/d	60	8.04	2.88	2.70	17.80
Protein, %	63	4.73	0.48	3.68	5.97
Casein, %	63	3.86	0.36	2.99	4.50
Fat, %	63	8.24	1.61	4.72	12.45
TA, °SH/100	63	9.06	1.47	5.88	12.97
RCT, min	63	12.51	4.45	6.00	25.45
k_{20}, min	61	2.71	0.98	1.45	6.30
a_{30}, mm	63	44.10	11.56	10.60	65.00

[1]DIM: days in milk, MY: milk yield, TA: titratable acidity, RCT: rennet coagulation time, k_{20}: curd firming time, a_{30}: curd firmness

Averages for RCT, k_{20} and a_{30} were 12.51 min, 2.71 min and 44.10 mm, respectively. These measures are close to recommended values in practical cheese making by *Zannoni and Annibaldi* (1981) and are better than those frequently found in dairy cows (*Cassandro et al.*, 2008). Values of RCT, k_{20} and a_{30} observed in this study are indicative of faster coagulation rates and better results of the curd firming process than those reported by *Ariota et al.* (2007) for individual milk samples of buffaloes. However, *Bartocci et al.* (2002) reported values of a_{30} higher than our results, ranging from 52.48 to 55.59 mm.

Pearson's correlations among milk yield, quality traits and coagulation properties are in *Table 2*. As expected, estimates among MCP traits were high and ranged from 0.66 to 0.82 in absolute value. These results were expected as MCP describe consecutive steps of the milk coagulation process. If milk takes a short time to coagulate, it leaves more time for curd firming and has better coagulation ability in general; thus, the final curd will be firmer. Conversely, if milk takes a long time to coagulate, the curd will have less time to firm and it will be weaker. Favourable MCP were associated with high casein content (–0.25 and 0.71 with RCT and a_{30}, respectively). The strong correlation of a_{30} with casein confirms the key role of casein in milk coagulation process. The importance of casein in increasing curd firmness of cow's milk has been reported by several authors (*Pagnacco and Caroli*, 1987; *Summer et al.*, 1999). The relationship between MCP and protein was slightly lower than casein, however it is worth noting that a_{30} and protein are strongly related. Correlations of acidity with k_{20} and a_{30} were

moderate (-0.52 and 0.59 with RCT and a_{30}, respectively), while no relationship has been found between acidity and RCT. This result is in disagreement with estimates reported in literature on cows which usually highlighted the strong relationship between acidity and RCT. The correlation of MCP with fat was weak and not significantly different from zero (except for a_{30}), in accordance with values reported by *Lindström et al.* (1984). It appears that the amount of fat does not influence the coagulum strength nor it is able to be completely retained during the cheese making process. This result appears to be consistent with the work of *Aleandri et al.* (1989) who found that the efficiency of fat recovery (retention of fat in the curd) increased with the protein to fat ratio. The relationship between milk yield and RCT was moderate and favourable; this result is not consistent with other findings on bovine milk (*Cassandro et al.*, 2008).

Table 2

Correlations among milk yield, quality traits and coagulation properties in buffalo cows

Trait	MY	Protein	Casein	Fat	TA	RCT	k_{20}	a_{30}
MY, kg/d	-	-0.25^{*}	-0.08^{ns}	-0.30^{*}	-0.18^{ns}	-0.52^{***}	-0.24^{ns}	0.27^{*}
Protein, %		-	0.87^{***}	0.57^{***}	0.90^{***}	-0.04^{*}	-0.44^{***}	0.58^{***}
Casein, %			-	0.73^{***}	0.85^{***}	-0.25^{*}	-0.56^{***}	0.71^{***}
Fat, %				-	0.60^{***}	0.16^{ns}	-0.20^{ns}	0.30^{*}
TA, °SH/100					-	-0.11^{ns}	-0.52^{***}	0.59^{***}
RCT, min						-	0.74^{***}	-0.66^{***}
k_{20}, min							-	-0.82^{***}
a_{30}, mm								-

MY: milk yield; TA: titratable acidity; RCT: rennet coagulation time; k_{20}: curd firming time; a_{30}: curd firmness; ^{ns} not significant; * P<0.05; ** P<0.01; *** P<0.001

CONCLUSIONS

In conclusion, buffalo milk exhibited large variability for both chemical composition and MCP. Significant relationships were found between production traits and coagulation properties. These results allowed a preliminary characterization of buffalo milk traits in northeast Italy. Further studies are needed to better investigate the variability of MCP and mainly the relationships between MCP and cheese yield.

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