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Estimation of buffalo cheese yield by using the chemical-physical parameters of the milk

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ABSTRACT: The aim of this study was to estimate cheese yield by using the chemical-physical parameters of the milk. Analysis were performed on 325 milk samples with 80-219 days in milk interval. Furthermore, buffaloes which showed a ratio between theoretical cheese yield (calculated by Altiero formula) and real cheese yield at 28 hours higher (Group A) or lower (Group B) than 0.983, were compared taking into account 5 hypothetical analytical potentialities of laboratories: 1) Fat percentage; 2) Protein and fat percentages; 3) Protein and fat percentages, pH and SH; 4) Protein and fat percentages, pH, SH, urea, protein percentage corrected per urea, lactose, solids-not-fat (SNF) and SCC; 5) Protein and fat percentages, pH, SH, urea, protein percentage corrected per urea, lactose, SNF, SCC, TAMF, milk DM percentage, ash percentage and casein percentage. Correlation and regression analyses with stepwise method were performed for curd quantity in relation to the physic-chemical ad microbiological milk composition by using SPSS 15.0. As expected, R^2 value was such high as the number of variables included in the calculation.
A higher R^2 value was observed in those samples characterized by a ThCY/28CY ratio < 0.983. ThCY calculated according to Altiero *et al* (1989), underestimated 28CY of +1.8 g/litre in all samples, whereas a difference between –2.2 (Laboratory 2) and +1.0 (Laboratory 3) g/litre was registered if the actual formula is utilized. According to Altiero formula, 28CY was overestimated of 9.6 g/litre in Group A, whereas it was underestimated of 1.8 g/litre in Group B. According to our study, the estimation of 28CY showed a difference between –9.3 (Laboratory 2) and 9 (Laboratory 1) g/litre in Group A and – 3.5 (Laboratory 1) e 0.0 (Laboratory 5) g/litre.

Key words: Buffalo, Milk, Cheese yield.

INTRODUCTION - In previous studies (Potena *et al*., 2001a, b), it was demonstrated that some buffaloes show a cheese yield at 28 hours (28CY) higher or lower than that calculated by Altiero formula (Altiero *et al*., 1989), although similar fat and protein contents in milk and independently from the productive level and the farm (Zicarelli *et al*., 2001). Hence, a series of multiple correlations between 28CY and the other studied variables were performed, in order to elaborate an equation for foreseeing 28CY and to compare this equation to that of Altiero (Altiero *et al*., 1989). In fact, from 1998 until today, buffalo milk characteristics were more changed because of new rationing and management criteria rather than genetic improvement (Zicarelli, 2004). Another purpose was to estimate cheese yield in cheese factories with different analytical potentiality for samples characterized by an interval of 80-219 days in milk (DIM). In fact, in buffalo species, because of its seasonality and/or the out of breeding season mating technique, the bulk milk is usually delivered in a range of 80-219 DIM. Furthermore, buffaloes that gave a higher or lower curd quantity than that calculated by Altiero formula (1989), were also compared.

MATERIAL AND METHODS - The trial was performed on 9 and 11 groups of buffaloes (n = 60) which were half sib (relationship was ascertained by DNA test). The animals were bred in two farms and a total of 326 milk samples were collected (an average of 1 sample every 50 days for each buffalo). The diets administered in the two farms were characterized by 0.9 milk forage unit (MFU)/ kg of dry matter (DM), 15.5% crude protein and 55:45 % forage: concentrate ratio. Two litres of milk were collected during the morning milking. One liter was utilized to determine cheese yield according to the following procedure: 1) warming of the milk sample (1 litre) to 37°C; 2) adding of 2ml/litre of liquid rennet at 1:10,000 ml ratio; 3) breaking the curd crosswise as soon as it clots; 4) waiting about 10 minutes until whey appears; 5) breaking into small grain-like parts; 6) waiting 10 minutes until syneresis ends; 7) putting curd into perforated cylindrical containers. The content of the containers was weighed after 4 hours in order to determine the fresh cheese yield (FCY) and after 28 hours (28CY). The dry matter content of the curd that derived from 1 litre of milk (CDM) was determined drying up the curd (forced ventilation oven at 65°C) until the reaching of a constant weight. The remaining milk samples were utilized to determine the lactodinamographic parameters (Formagraph, Foss, DN); the complete physic-chemical composition; fat (F), protein (P), casein, lactose, ash, urea, pH and SH (ASPA, 1995); the somatic cells content (SCC) using (Milkoskan); the total aerobic mesophilic flora (TAMF) by the dilution method. Chemical composition of the curd was also determined (protein, fat and ash; ASPA, 1995). The milk protein content was adjusted for the non proteic N content determined in milk as urea (corrected P); the theoretic cheese yield (ThCY) was obtained by the following formula: cheese yield =milk x[-0.88 + 3.50 x P(%)+1.23 x F(%)] x 100^{-1} (Altiero *et al.*, 1989) and the ratio between ThCY/FCY and ThCY/28CY were calculated. Other calculated variables were: FCY/Corrected P, 28CY/Corrected P, CDM/Corrected P. Statistical analysis was carried out by ANOVA and regression analysis (SPSS 15.0).

Regression analysis was performed on all samples which showed DIM between 80 and 219 days. Furthermore, regression was performed on those subjects which showed a ThCY/ 28CY ratio higher or lower than 0.983 (Group A, n = 17 and Group B, n = 43, respectively). Five different elaborations were carried out, taking into account different analytical potentialities of the laboratories in the cheese factories: 1) Fat percentage; 2) Protein and fat percentages; 3) Protein and fat percentages, pH and SH; 4) Protein and fat percentages, pH, SH, urea, protein percentage corrected per urea, lactose, solids-not-fat (SNF) and SCC; 5) Protein and fat percentages, pH, SH, urea, protein percentage corrected per urea, lactose, SNF, SCC, TAMF, milk DM percentage, ash percentage and casein percentage.

RESULTS AND CONCLUSIONS - As expected, R^2 value was such high as the number of variables included in the calculation. A higher R^2 value was observed in those samples characterized by a ThCY/28CY ratio < 0.983, compared to those with a ThCY/28CY ratio > 0.983. If the elaboration was performed independently from ThCY/28CY ratio, an intermediate R^2 value was recorded. ThCY calculated according to Altiero *et al* (1989), underestimated 28CY of 1.8 g/litre in all samples, whereas a difference between –2.2 (Laboratory 2) and +1.0 (Laboratory 3) g/litre was registered if the actual formula is utilized. According to Altiero formula, 28CY was overestimated of 9.6 g/litre in Group A, whereas it was underestimated of 1.8 g/litre in Group B.

Table. 1. Cheese yield estimation in buffaloes with a ThCY/28CY ratio lower (n=101) or higher (n=224) than 0.983 and in total (n=325) performed in laboratories characterized by 1 and 2 potentialities.

	TOTAL		< 0.983		> 0.983	
	1	2	1	2	1	2
R^2	0.414	0.573	0.467	0.615	0.407	0.567
CONSTANT	149.0[a]	15.74	151.1[a]	25.41	156.5[a]	29.60
FAT	12.42[a]	7.90[a]	13.23[a]	7.50[a]	10.92[a]	8.00[a]
CP		36.72[a]		37.48[a]		32.84[a]
28CY	256.6		265.3		252.6	
Altiero formula	254.8		255.7		254.4	
Actual elaboration	256.2	254.4	256.3	256.0	256.1	253.7

Table. 2. Cheese yield estimation in buffaloes with a ThCY/28CY ratio lower (n=101) or higher (n=224) than 0.983 and in total (n=325) performed in laboratories characterized by 3, 4 and 5 potentialities (actual elab.).

	TOTAL			< 0.983			> 0.983		
	3	4	5	3	4	5	3	4	5
R2	0.603	0.631	0.668	0.655	0.663	0.728	0.580	0.603	0.625
Constant	– 313[a]	– 106	– 147	– 344[c]	– 333[c]	– 434[a]	22.9	–14.0	41.9[c]
FAT	7.58[a]	7.44[a]	5.96a	6.53[a]	6.40[a]		7.70[a]	7.40[a]	7.63[a]
CP	39.6[a]	– 207.6[b]		41.0[a]	–100[a]		34.8[a]		
urea			– 0.746[a]						– 0.551[b]
pH	45.8[a]	21.4[c]	25.9[c]	54.8[b]	53.7[b]	60.9[a]			
SH	1.76[c]								
CP x u		247.75[a]	37.90[a]		41.4[a]	44.8[a]		37.3[a]	36.73[a]
SCC								2.82[c]	
DM M			2.16[a]			5.20[a]			
28CY	256.6			265.3			252.6		
Altiero	254.8			255.7			254.4		
P. E.	255.6	255.7	254.5	258.0	259.3	258.5	254.6	254.1	252.6

CP x u = % proteins corrected for urea; DM M = milk dry matter; 28CY = curd yield at 28 h; Altiero = Altiero formula; P. E. = present elaboration.
Values within columns in each categories, with different superscripts are different (a, b, c; $P < 0.05$).

According to our study, the estimation of 28CY showed a difference between –9.3 (Laboratory 2) and 9 (Laboratory 1) g/litre in Group A and – 3.5 (Laboratory 1) e 0.0 (Laboratory 5) g/litre.
In our study, lactose, TAMF, ash and casein never resulted significant in multiple regression analysis. 28CY was affected by either % protein and % protein corrected per urea, 6 times on 12 estimations. When % protein corrected per urea affected 28CY the % protein (for the total and for < 0.983 group) and the urea (for the total and for > 0.983 group) showed negative influence (Table 2).
Altiero formula can be still utilized, although laboratories equipped with automatic machines, that are able to estimate several values, the estimation may be more precise.
However, it is worth pointing out that, according to Altiero formula, proteins (3,5/1.23=2.85) value 2.85 times more than fat in cheese yield estimation. In this trial, it resulted that proteins effect on cheese yield is 4-6 times higher that that of fat. This interesting finding is important for either milk payment and selection.

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