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Use of Penn State Particle Separator for the evaluation of total mixed rations typical of Parmigiano Reggiano cheese production area

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ABSTRACT: An observational study was conducted on 18 dairy farms located in the area of Parmigiano Reggiano cheese production with the aim to supply some recommendations regarding the more efficient TMR physical form. The effects of TMR particle size distributions on digestion process and on dairy productivity were investigated. Lower particle size appeared to improve digestion process and resulted in increased DMI, milk yield, and milk casein level without affecting milk fat. Routinary TMR particle size measurement with PSPS could be a good practice to standardize TMR particle size distribution and to maximize DMI and dairy productivity.

Key words: Total Mixed Ration, Penn State Particle Separator, Dry matter intake, Milk production, Parmigiano Reggiano.

INTRODUCTION – Both the amount and physical form of fiber are important in the diet of lactating dairy cows in order to maintain proper ruminal function (Tafaj *et al.*, 2001; Yang *et al.*, 2002; Teimouri Yansari *et al.*, 2004), animal health status (Sudweeks *et al.*, 1981) and milk composition (Kononoff and Heinrichs, 2003). Fiber physical form has been demonstrated to affect ruminal stratification, filling and retention (rate of passage) such as ruminal feed degradation and fermentation, chewing activity and rumination. Since saliva secretion increases during chewing and rumination (Poutiainen, 1966), fiber physical form can also contribute to ruminal buffering affecting rumen pH, acetate to propionate ratio and milk fat synthesis. As reported by Kononoff and Heinrichs, (2003), the effect of feed particle size on ruminal pH and on milk fat is more sensible when fiber content is low or under the recommended levels. To meet high producing lactating dairy cattle requirements, relatively high proportions of concentrates are included in the diet. This sometimes lead to a dramatic decrease in ration fiber content. Moreover, in total mixed rations (TMR), forages are often finely chopped and fiber physical effectiveness appears reduced. Kononoff *et al.* (2003) developed a practical device for the measurement of forages and/or TMR physical form, the New Penn State Particle Separator (PSPS). Composed of three sieves (Upper: 19.0 mm, Middle: 8.0 mm, Lower: 1.18 mm) and a Bottom pan, the PSPS includes a 1.18 mm screen for the evaluation of physically effective NDF (peNDF) in rations based on Mertens' equation (Mertens, 1997). Optimal distribution of particles, express as a percent of total sample (dry matter and/or as fed) are also provided for silages, haylages and TMR by the same authors. peNDF is at the moment one the most important parameters for the evaluation of the effectiveness of TMR in stimulating chewing activity, increasing ruminal buffering and sustaining milk fat synthesis. In the area of Parmigiano Reggiano cheese production, diet formulation is regulated by a "policy" which establishes the minimum proportion of forages in the ration at a level of 50%, but it does not supply indications about the physical form of roughages. In the same area, a growing number of dairy farms applies the TMR technique for lactating cows nutrition without any specific indication regarding the optimal particle size distribution. The aim of this observational study is to investigate the effects of TMR particle size distribution on digestion process and on dairy productivity in the attempt to supply some recommendations regarding Parmigiano Reggiano TMR physical form.

MATERIAL AND METHODS – The study was conducted on a total of 18 dairy farms, ranging from 40 to 600 lactating cows, located in the area of Parmigiano Reggiano cheese production, in which TMR technique was applied. Diet formulation was different between farms but respected the "policy" for Parmigiano Reggiano cheese production. Each farm has been visited three times with an interval of about 2 months and only the fresh group (30 to 60 days in milk) was considered for observations and measurements. At each visit the following data were recorded: (a) average milk yield and milk composition (fat, casein, acidity and urea), on the base of data supplied by the local breeders association laboratory (APA); (b) DMI, estimated on the base of the bulk TMR fed to cows and of the orts relieved in feed bunk; (c) TMR particle size distribution, calculated and expressed as farm average percentage for each sieve and for the bottom pan. Particle size was measured using PSPS as described by Kononoff *et al.* (2003) on three TMR samples of about 0.8 Kg, collected in different positions of the feed bunk; (d) peNDF, estimated by multiplying the concentration of NDF in the diet by the proportion (corrected for moisture content) of dry matter retained on the 19.0-, 18.0-, and the 1.18 mm sieves as proposed by Mertens (1987); (e) fecal pH, evaluated on a sample of about 10 % of fresh cows. Fecal score was estimated on the base of the scale described by Hutjens (2001), while pH was measured by a pH-meter immediately after sampling from the rectum (Sensor CRISON Cat. 032, pH 2-11, 0-80 °C). Fecal pH values were reported as farm average; (f) representative TMR and fecal samples were collected for starch (polarimetric method) and NDF (Goering and Van Soest, 1975) laboratory analysis. Statistical analysis was conducted using software SPSS version 14.0. Correlations between recorded parameters were evaluated.

RESULTS AND CONCLUSIONS – Particle size distribution showed an high variability among the observed TMR rations especially in the Upper and Middle screens, affecting peNDF values which ranged from 14.84 to 38.72, respectively lower and higher than the recommended level of 20-22% (Mertens, 1997). Despite the lower levels of peNDF, any clinical effect was observed on cattle. High variability was observed also for diets chemical composition, with NDF ranging from 24.33% to 48.83% and starch level ranging from 10.01% to 24.28%, such as for milk yield and composition (Table 1 and 2). In Table 3 the correlations between the main parameters observed on the herds are summarised. Particle size distribution affected DMI and milk yield and quality (Table 3). Bottom proportion appeared significantly and positively correlated both with DMI ($r=0.421$; $P<0.01$) and milk yield ($r=0.516$; $P<0.05$), while Upper proportion resulted negatively correlated with milk yield ($r=-0.510$; $P<0.01$). These results are similar that reported by Kononoff and Heinrichs (2003) which observed a reduction in DMI with increasing TMR particle size. Upper proportion appeared negatively related with casein percentage ($r=-0.297$; $P<0.05$) which resulted directly correlated with Bottom level ($r=0.373$; $P<0.05$). Dietary NDF percentage negatively affected milk yield ($r=-0.291$; $P<0.05$) and resulted, like Bottom proportion, directly related with casein percentage ($r=0.303$; $P<0.05$). This effect could be due to the higher digestibility of NDF contained in thinner forage particles and in concentrates, which reach the Bottom pan during sieving. Since dietary NDF was generally higher than the recommended levels, TMR particle size had no effects on milk fat content, according to Beauchemin *et al.* (2003). peNDF was calculated as a product of NDF (%) and percentage of particles > 1.18 mm and its effect on milk production ($r=-0.477$; $P<0.01$) depended directly on these parameters. Increasing dietary starch increased milk yield ($r=0.454$; $P<0.01$) reducing fecal starch (-0.300; $P<0.05$) probably through an improved ruminal fermentation of degradable carbohydrates. The present study shows that, in high NDF and low starch forage-hay based TMR rations for Parmigiano Reggiano cheese production, there is the potential for enhancing particle size reduction. This could be a simple tool to increase DMI, milk yield and milk quality of dairy cattle in early lactation. Even if more studies are needed to define the minimum level of peNDF necessary in hay-based TMR rations, routinary TMR particle size measurement with PSPS could be a good practice to standardize TMR particle size distribution and to maximize DMI and dairy productivity.

Table 1. Physical and chemical characteristics of the diet.

	Upper (%)	Middle (%)	Lower (%)	Bottom (%)	peNDF (%)	Dietary NDF (%)	Diet Starch (%)
Mean ± sd	20.12 ± 7.90	18.57 ± 6.94	32.81 ± 5.14	28.49 ± 6.08	26.46 ± 4.72	36.86 ± 5.17	18.08 ± 3.50
Min.	4.56	8.83	21.81	16.56	14.84	24.33	10.01
Max 4	2.65	41.22	49.97	39.87	38.72	48.83	24.28

Table 2. DMI, fecal output and productivity.

	DMI (Kg)	Fecal pH	Fecal starch (%)	Fecal NDF (%)	Milk yield 4%FCM (Kg)	Milk fat (%)	Milk casein (%)	Milk acidity (°SH)	Milk urea (mg/100ml)
Mean ±	22.18 ±	6.39 ±	1.51 ±	55.79 ±	29.95 ±	3.31 ±	2.57 ±	3.32 ±	25.83 ±
sd	2.80	0.13	0.74	4.28	3.72	0.22	0.08	0.19	3.23
Min.	19.37	5.95	0.11	45.43	22.00	2.97	2.40	2.45	19.00
Max	27.17	6.72	2.75	64.38	38.00	4.03	2.70	3.55	34.00

Table 3. Correlations between diets physical and chemical characteristics and herds productivity.

	Upper (%)	Middle (%)	Lower (%)	Bottom (%)	Dietary NDF (%)	Dietary Starch (%)	peNDF (%)
DMI	ns	ns	ns	0.421**	ns	ns	ns
Fecal pH	0.407**	-0.288*	ns	ns	ns	ns	ns
Fecal Score	ns	ns	ns	ns	ns	ns	ns
Fecal Starch (%)	0.362*	ns	ns	-0.276*	ns	-0.300*	ns
Fecal NDF (%)	0.376*	ns	ns	ns	ns	-0.444**	ns
Milk Yield (Kg)	-0.510**	ns	ns	0.516*	-0.291*	0.454**	-0.477**
Milk Fat (%)	ns	ns	ns	ns	ns	ns	ns
Milk Casein (%)	-0.297*	ns	ns	0.373*	0.303*	ns	ns
Milk Acidity (°SH)	ns	ns	ns	ns	ns	ns	ns
Milk Urea	0.496**	-0.478*	ns	ns	ns	ns	ns

**:P<0.05; **:P<0.01; ns: not significant.*

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REFERENCES - Beauchemin, K.A., Yang, W.Z., Rode, L.M., 2003. Effects of particle size of alfalfa-based dairy cow diets on chewing activity, ruminal fermentation and milk production. J.Dairy Sci. 86:630-643. **Hutjens**, 2001. Evaluating Nutritional Management Changes. Proceedings of the 5th Western Dairy Management Conference, Las Vegas, Nevada. **Kononoff**, P.J., Heinrichs, A.J., 2003a. The effect of reducing alfalfa haylage particle size on cows in early lactation. J.Dairy Sci. 86:1445-1457. **Kononoff**, P.J., Heinrichs, A.J., Buckmaster, D.A., 2003. Modification of the Penn State forage and TMR separator and the effects of moisture content on its measurements. J.Dairy Sci. 86:1858-1863. **Mertens**, D.R., 1997. Creating a system for meeting the fiber requirements of dairy cattle. J.Dairy Sci. 80:1463-1482. **Poutiainen**, E., 1966. The proportion of saliva in the fluid flowing through the reticulo-rumen of the cow. Ann.Agr.Fenniae 5:342. **Sudweeks**, E.M., Ely, L.O., Mertens, D.R., L.R., Sisk, 1981. Assessing minimum amounts and form of roughages in ruminant diets: roughage value index system. J.Anim.Sci. 53(5):1406-1411. **Tafaj,** M., Steingrass, H., Drochner, W., 2001. Influence of hay particle size at different concentrate and feeding levels on digestive processes and feed intake in ruminants. 2. Passage, digestibility and feed intake. Arch. Tierernahr. 54 (3): 243-59. **Teimouri Yansari** A., Valizadeh, R., Naserian, A., Christensen, D.A., Yu, P., Eftekhari Shahroodi, F., 2004. Effects of alfalfa particle size and specific gravity on chewing activity, digestibility, and performances of holstein dairy cows. J.Dairy Sci. 87:3912-3924. **Yang**, W.Z., Beauchemin, K.A., Rode, L.M., 2002. Effects of particle size of Alfalfa-Based Dairy cow diets on site and extent of digestion. J.Dairy Sci. 85:1958-1968.