Veterinary Research 5 (3): 63-67, 2012
ISSN: 1993-5412

Research about Indicate the Effect of Concentrate Feeding Strategy on Milk Production and Composition in Dairy Cows in Esfahan, Iran

Sepehr Shekarchian
Department of Food Hygiene, Azad Oloom Tahghighat University, Tehran, Iran

Abstract: The current study aimed to compare three strategies of distribution of concentre in 84 Holstein breed dairy cows divided into three equal groups (average initial liveweight: 553 kg, average stage of lactation: 122 days, row of lactation: 8 cows at the first and 20 at the second lactation in each group) on intake and milk yield and composition. They received a basal diet composed of oat hay, corn or grass silage and green ryegrass. The concentrate was distributed either in Total Mixed Ration (TMR) or Partially Mixed Ration (PMR) or Separate Ration (SR). Intake (3 times during the experiment) and individual dairy production (twice a month) were measured during 13 weeks experimental period. Also, milk composition (protein and fat) were analysed in milk samples taken in every control. The trial lasted 13 weeks, preceded by 3 weeks of adaptation. Results indicated that Dry Matter (DM) intake of concentrate was significantly but slightly ($p<0.05$) higher in SR than in PMR and in TMR (11.5, 11.3 and 11 kg). The same trend was almost observed in total diet DM intake. Animals from the group PMR produced significantly ($p<0.05$) more milk (31.4 kg day^{-1}) than the tow other groups which were similar (averaged: 26.5 kg day^{-1}). Milk from SR group was slightly higher ($p<0.05$) in protein than PMR and TMR which were similar (31.3, 30.2 and 29.9 g kg^{-1}, respectively). No significant differences were observed in fat (mean average: 32 g kg^{-1}). It was mainly concluded that with the current low-quality based diet, the mixed strategy (PMR) seamed to result in the highest milk production with no considerable effects on milk fat and protein content.

Key words: Holstein breed dairy cows, liveweight, dry matter, milk, protein content, Iran

INTRODUCTION

In Esfahan, feeding represent about 65% of milk production cost in dairy cows. Concentrate constitute about 70% of the feeding cost. The growing prices of concentrate row material such as soybean and corns during the last years increased considerably production financial charges. Consequently, many alternatives are carried out to reduce feeding cost. In addition to the use of some cost-effective substituting products and to the improve of feeding value of basal forages, a growing interest is given to the optimisation of concentrate distribution strategies, mainly in high sizes and potential of production herds. In the most of farms, herds are allotted according to the physiological stage and the production level of cows. Thus, basal diets and concentrate are offered separately in thoughts and the amount of given concentrate are periodically adjusted for the groups after every milk control. These practices resulted in concentrate wasting and frequent metabolic pathologies related to the consumption of high amounts of high starch concentrate such as acidosis. Currently, some farmers chose the utilisation of Total Mixed Ration (TMR) using a mixing-distributing tow. TMR had been largely investigated but never in Tunisia and no data are available in the cases of moderate or low quality basal diets. Some recent European studies suggested that there was no benefit in manipulating the proportion of concentrate in a TMR based on stage of lactation where the amount of concentrate offered during the entire lactation was the same (Yrjanen *et al*., 2003) or when silage and concentrate are fed separately (Aston *et al*., 1995). Yrjanen *et al*. (2003) did not found any differences in milk yield and composition between TMR or separate feeding of concentrate in dairy cows receiving a grass-silage based diet.

In contrast, several studies showed a higher milk yield in animals given TMR comparatively with separate feeding (Istasse *et al*., 1986; Gordon *et al*., 1995; Aaes, 1993). Moreover, TMR seemed to improve milk composition due to the synchronization between the supply of dietary fermentable energy and nitrogen in the rumen and to the minimised fluctuations in rumen fermentation patterns (Aaes, 1993). This could result in increased efficiency of microbial synthesis (Sinclair *et al*., 1993) and likely enhanced fibre degradation in the rumen. All of these reviewed trials where carried out on high quality forages. However, in Esfahan the main used

forages in dairy caws are based on moderate or low quality oat or oat-vetch hay or silage. The current research was designed to compare the use of TMR or Partially Mixed Ration (PMR) with fixed proportion of concentrate with Separate feeding Ration (SR) on milk yield and composition and blood metabolic profile in dairy cows in free stalls.

MATERIALS AND METHODS

Animals and experimental design: The study was carried out in the farm DOTOO in the North of Esfahan from December 2006 to March 2007 on 84 Holstein dairy cows in the 12th week of lactation at the starting of the trial. Treatments consisted of 3 feeding strategies: feeding Total Mixed Ration (TMR), Partially Mixed Ration (PMR) and Separate feeding Ration (SR). Cows were divided into 3 blocks according to calving date, parturition and lactation number. They were randomly allocated to the 3 treatments so every ration was distributed to 28 cows. Each block of caws was housed on a straw litter in free stall equipped with metallic attaches and linear mangers.

Feeds and feeding: Basal diet was composed averagely of 2 kg of oat hay, 20 kg of ryegrass, 2 kg of corn silage and 30 kg of grass silage. All forages were produced in the farm DOTOO (North of Esfahan) during 2006 and 2007. Concentrate (averagely 9.5 kg day^{-1} per cow) consisted of Corn (35%), soybean (16%), wheat bran (44%) and a Minerals and Vitamins Premix (MVP: 5%). Each group of cows received also nitrogenous (80% soybean and 15% corn grain and 5% MVP) and energetic (90% corn grain, 5% soybean and 5% MVP) concentrate supplements (1.9 and 2.6 kg day^{-1} per cow). A calibrated mixing lorry was used to make the mixed ration before each meal. Hay was shopped to facilitate mixing and added in the lorry with the other forages and concentrates. Every group of cows received the appropriate strategy 1 month before the beginning of measurements. The TMR group was fitted twice a day (6 and 15 h). The PMR group received tow equal meals of mixed ration containing the half of the daily amounts of concentrate (6 and 15 h) and tow equal meals in mangers to give the remaining amounts of concentrate (9 and 17 h). The SR group received the basal ration in tow equal meals (6 and 15 h) and concentrate was added at 3 times (6, 15 and 19 h).

Measurements sampling and calculation: Daily intake was measured by group of cows during 3 successive days every month by weighting the offered and refused amounts. Samples from hay, ryegrass and concentrate were collected once weekly and conserved for chemical analysis. Silage samples were collected every week. Dry matter content was determined (105°C, 24 h) and fresh material was stored at -20°C pending analysis. Cows were milked twice a day in a 2×6 herringbone milking room and individual milk productions were recorded twice monthly using graduated true-test tubes. During each milk control, individual milk samples where taken and conserved for fat and protein analysis. Individual total milk yield (kg) during the experimental period was calculated according to the Fleishmen Methods (Craplet, 1960) and also expressed as average daily production.

Laboratory analysis: Dry Matter (DM) content of food was determined by drying in a forced-air oven at 105°C for 24 h. Feeds were analyzed for ash (550°C, 6 h), CF using the Weende procedure and CP by the Kjeldahl Method (AOAC, 1984) as 6.25x N. NDF and ADF were analyzed in offered feeds as described by Van Soest *et al.* (1991). Milk samples were analyzed for fat and protein using an automatic infrared apparatus (MILKOSCAN4000).

Statistical analysis: The General Linear Model procedure (GLM) of SAS Institute (1990) was used to analyze data. The model included strategy, animal and strategy x animal effects. Duncan's multiple range test was used to compare treatment means.

RESULTS AND DISCUSSION

Chemical composition: Chemical composition of feed is shown in Table 1. Generally, the found values are in the ranges of those reported in Tunisian literature (Jeddi *et al*., 1992; Kraiem and Moujahed, 1997). Oat hay which constitutes one of the basal roughages used in cattle feeding in Tunisia is low in CP (61 g kg^{-1} DM) and high in ADF (454 g kg^{-1} DM). Corn silage presented a moderate CP content (114 g kg^{-1} DM) which was higher than grass silage one (65 g kg^{-1} DM). Ryegrass is high in CP (189 g kg^{-1} DM) and in ADF (434 g kg^{-1} DM). Concentrate N°7 presented a chemical composition which is in line with Tunisian norms fordairy cattle production concentrate commonly known as concentrate No. 7 (JORT No. 30, 2007). Nitrogenous supplement was particularly high in CP (463 g kg^{-1} DM) while energetic 1 was relatively low in CP (123 g kg^{-1} DM).

Table 1: Chemical composition of experimental feeds (g kg^{-1} DM) verifier le tableau

Feed	DM (%)	Ash	CP	CF	ADF	NDF
Oat hay	908	72	61	363	454	757
Corn silage	278	103	114	192	268	485
Grass silage	282	113	65	352	434	655
Ryegrass	186	122	189	158	289	557
Concentrate No. 7	929	57	169	35	53	342
Energetic supplement	920	54	123	32	72	229
Proteinic supplement	934	92	463	36	49	152

These 2 concentrates presented a chemical composition approximatively equivalent to their basal compound, soybean and corn grain (INRA, 2004).

Intake: Results relative to feed and total DM intake are shown in Table 2. No significant differences were observed in forages or basal diet DM intake (mean value: 9.86 kg DM day^{-1}). The low intake of silage in the 3 diets could be explained by the relatively high rate of concentrate in the 3 feeding strategies. Indeed as frequently reviewed high energy supplement resulted in a reduced intake of forage, mainly silage while total dry matter intake increased (Faverdin *et al*., 1992; Aston *et al*., 1995; Agnew *et al*., 1996). Huhtanen (2001) found that the increase of concentrate supply induced a decrease of silage DM intake of 0.54 kg DM by kg of consumed concentrate. Shingfield *et al*. (2002) showed that in cows receiving 3 kg day $^{-1}$ of concentrate a decrease in silage intake of 1.2 kg DM day^{-1} was noted.

By another hand although, the significant effect of feeding strategy on concentrate consumption, the differences between the 3 strategies were not very important and the average concentrate intake was around 11.3 kg DM day^{-1}. Some other studies showed that SR associated to a distribution of concentrate in several meals had no effect on intake comparatively with TMR (Gordon *et al*., 1995; Yan *et al*., 1998). However, Yrjanen *et al*. (2003) found that at the beginning of lactation, separate distribution of concentrate resulted in higher concentrate consumption, mainly in weeks 3 and 4 after calving when compared to TMR (10.9 and 7.5 kg of DM of concentrate, respectively).

In other studies, TMR resulted in a increased consumption of concentrate comparatively with SR when concentrate was added in 2-4 meals per day (Istasse *et al*., 1986; Agnew *et al*., 1996). These controversies in results may be related mainly to differences in concentrate types or/and basal diet composition.

Although, the significant effect of feeding strategy ($p<0.05$), the differences in total DM intake of rations were not very important and each group consumed averagely 21.2 kg DM day^{-1} of total diet. The small increase in total DM intake noted in SR and TMR comparatively with PMR by supposing that it was real would confirm the suggestion of Rico-Gomez and Faverdin (2001) who reported that offering mixed ration of concentrate and forages resulted in increased intake comparatively with separate distribution of concentrate associated to *ad libitum* distribution of forage. This effect could increase according to the proportion of concentrate in the ration and to the type of forage.

Table 2: Dry matter intake of forages, concentrates and total diets

DM intake (kg day^{-1})	SR	TMR	PMR	ESM
Forages				
Green ryegrass	4.9	4.9	5.0	0.64
Oat hay	1.3	1.4	1.3	0.24
Grass silage	3.2	3.2	3.1	1.07
Corn silage	0.4	0.4	0.4	0.15
Toatal basal diet	9.9	9.9	9.8	1.27
Concentrate	11.5^{a}	11.3^{b}	11.0^{c}	0.92
Toatal DM intake	21.5^{a}	21.3^{a}	21.0^{b}	1.54

SR: Separate Ration; TMR: Total Mixed Ration; PMR: Partially Mixed Ration; $^{a-c}$Values with different letters in the same line are significantly different ($p<0.05$), SEM: Standard Error of the Mean

Milk production and composition: Results concerning milk production and composition are shown in Table 3. The PMR strategy allowed significantly ($p<0.05$) the highest daily individual mean milk production (31.4 kg day^{-1}) while the lowest one was observed in SR (27 kg day^{-1}). The TMR strategy was intermediate and equivalent to the others (28.6 kg day^{-1}). The same trend was noted for total milk production during the experimental period. The results relatively agree with those reported by Yrjanen *et al*. (2003). In deed, in a trial carried out on 2 groups of cows receiving TMR or SR, they found no differences between the tow groups suggesting that no particular effect on rumen functioning had happened when changing the feeding strategies. Also, Agnew *et al*. (1996) did not find any difference in milk production between TMR and SR with low proportions of concentrate in the ration. In contrast with high proportions of concentrate such as in the current study (averaged 53.2% DM), Istasse *et al*. (1986) found higher milk production with TMR comparatively with SR (average increase of 1.3 and 2.4 kg day^{-1}, for concentrate rates of 0.60 and 0.65 in the ration). In the case, characterised with relatively low quality roughages, it seems that the PMR could represent the best strategy since it may result simultaneously in high intake of concentrate and improved rumen fermentation conditions. Including total concentrate in low quality ration could result in a decreased intake of concentrate since total intake may be limited. Consequently, it could be suggested that TMR may be recommended mainly when concentrate is associated to high quality roughages.

Results on fat and protein milk contents are shown in Table 3. No significant differences were

Table 3: Mean strategy effects on milk production

Parameters	SR	TMR	PMR	SEM
Mean daily milk production (kg/V/j)	27.0^{b}	28.6^{ab}	31.4^{a}	1.006
Total milk production (kg)	2852.3^{b}	2954.8^{ab}	3214.8^{a}	99.215
Fat (g kg^{-1})	32.3^{a}	31.2^{a}	32.5^{a}	0.567
Protein (g kg^{-1})	31.3^{a}	29.9^{b}	30.2^{b}	0.328

SR: Separate Ration; TMR: Total Mixed Ration; PMR: Partially Mixed Ration; $^{a-c}$Values with different letters in the same line are significantly different ($p<0.05$), SEM: Standard Error of the Mean

noted in milk fat content between the 3 feeding strategies (mean value: 32 g kg^{-1}). This result could be explained by the repartition of concentrate distribution among the day and the relatively equivalent rate of concentrate in the 3 strategies (53.7, 53 and 52.3%, in SR, TMR and PMR). It's worthy to note that the observed values are low; this was related to the relatively high concentrate rate in the 3 rations. In deed according to Journet and Chilliard (1985) and Hoden *et al.* (1988) the rate of fat in milk becomes unstable and tends to decrease when the proportion of concentrate in the ration exceeds 40%.

Milk protein rate was slightly higher in the case of SR ($p<0.05$) comparatively to the two other cows groups which were equivalent (mean value: 30.5 g kg^{-1}). The found result was in the range of the usual values generally found for milk protein content and may indicate that the feeding level was sufficient to provide enough precursors for milk protein synthesis since, protein content of milk is mainly related to energy level in the ration (Coulon and Remond, 1991) and the 3 groups were supplemented with energy and protein. By another hand, several researchers had noted the absence of differences in milk protein rate between separate and mixed strategy of distribution of concentrate (Gordon *et al.*, 1995; Agnew *et al.*, 1996; Yan *et al.*, 1998). Aaes (1993) and Istasse *et al.* (1986) noted an improve in milk protein content in cows receiving a total mixed ration which was attributed to an increase in DM intake comparatively to separate ration.

CONCLUSION

It was mainly concluded that with the current low-quality based diet, the mixed strategy (PMR) seamed to result in the highest milk production with no considerable effects on milk composition. Consequently, it could be suggested that TMR may be recommended mainly when concentrate is associated to high quality roughages.

ACKNOWLEDGEMENT

The researchers thank the DOTOO farm for logistic and financial support.

REFERENCES

AOAC., 1984. Official Methods of Analysis of the Association of Official Analytical Chemists. 14th Edn., AOAC, Arlington, VA.

Aaes, O., 1993. Total mixed rations versus separate feeding of concentrate rich rations fed restrictively or *ad libitum* to dairy cows. Nat. Inst. Anim. Sci. Denmark, 16: 23-23.

Agnew, K.W., C.S. Mayne and J.G. Doherty, 1996. An examination of the effect of method and level of concentrate feeding on milk production in dairy cows offered a grass silage-based diet. Anim. Sci., 63: 21-31.

Aston, K., J.D. Sutton and W.J. Fisher, 1995. Milk production from grass silage diets: Strategies for concentrate allocation. Anim. Sci., 61: 465-480.

Coulon, J.B. and B. Remond, 1991. Variation factors of milk protein rate in dairy cows. INRA Prod. Anim., 4: 303-309.

Craplet, C., 1960. LA Vachelaitier. Vigot Freres, Paris, Pages: 484.

Faverdin, P., J.P. Dulphy, J.B. Coulon, R. Verite, J.P. Garel, J. Rovel and B. Marquis, 1992. Forages-concentrate substitution in dairy caw. INRA Prod. Anim., 5: 127-135.

Gordon, F.J., D.C. Patterson, T. Yan, M.G. Porter, C.S. Mayne and E.F. Unsworth, 1995. The influence of genetic index for milk production on the response to complete diet feeding and the utilization of energy and nitrogen. Anim. Sci., 61: 199-210.

Hoden, A., P. Faverdin and J. Coulon, 1988. Feeding of Dairy Cows. In: Sheep and Goat Feeding, Bovine, A. (Ed.). INRA, Paris, pp: 135-156.

Huhtanen, P., 2001. Prediction of DM and ME intake of dairy cows fed grass silage based diets. Proceedings of the Nordic Association of Agric. Scientists (NJF): Production and Utilization of Silage. Lillehammer.

INRA, 2004. Table of Composition and Nutritive Value of Crude Material for Breeding Animals. INRA, Paris, pp: 301.

Istasse, L., G.W. Reid, C.A.G. Tait and E.R. Orskov, 1986. Concentrates for dairy cows: Effects of feeding method, proportion in diet and type. Anim. Feed Sci. Technol., 15: 167-182.

JORT No. 30, 2007. Cahier de charge technique pour la production des aliments concentres pour betail. J. Officiel de la Republique Tunisienne NE 30-13/04/07, pp: 1207-1211.

Jeddi, B., M. Zouaghi and N. Moujahed, 1992. Qulity and productivity of 9 varieties of ryegrass. Ann. INRAT, 7: 59-72.

Journet, M. and Y. Chilliard, 1985. Influence de lalimentation sur la composition du lait. Bull. Technol. CRZV Theix INRA, 60: 13-23.

Kraiem, K. and N. Moujahed, 1997. Effect of mode of utilisation and vegetative stade on intake and digestion of oat with or without supplementation. Ann. INRAT, 170: 35-55.

Rico-Gomez, M. and P. Faverdin, 2001. Protein nutrition modifies intake in dairy cows. A review. Renc Rech Rumin, 8: 285-288.

SAS Institute, 1990. SAS/STAT1 Users Guide. SAS Institute Inc., Cary, NC.

Shingfield, K.J., S. Jaakkola and P. Huhtanen, 2002. Effects of forage conservation method on feed intake, feeding behaviour and milk production. Anim. Sci., 74: 383-397.

Sinclair, L.A., P.C. Garnsworth, J.R. Newbold and P.J. Buttery, 1993. Effect of synchronizing the rate of dietary energy and nitrogen release on rumen fermentation and microbial protein synthesis in sheep. J. Agric. Sci. Cambridge, 120: 251-263.

Van Soest, P.J., J.B. Robertson and B.A. Lewis, 1991. Methods for dietary fiber, neutral detergent fiber and nonstarch polysaccharides in relation to animal nutrition. J. Dairy Sci., 74: 3583-3597.

Yan, T., D.C. Patterson and F.J. Gordon, 1998. The effect of 2 methods of feeding the concentrate supplement to dairy cows of high genetic merit. Anim. Sci., 67: 395-403.

Yrjanen, S., K. Kaustell, R. Kangasniemi, J. Sariola and H. Khalili, 2003. Effects of concentrate feeding strategy on the performance of dairy cows housed in a free stall barn. Livest. Prod. Sci., 81: 173-181.