Productive And Reproductive Performance Of Friesian Cows Under Different Feeding System

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ABSTRACT: Thirty multiparous lactating cows weighing 450 to 500 kg used after calving and divided into three similar groups according to body weight and milk production (10 each). Cows fed R1 were grazed on fresh berseem throughout the day and little amount of rice straw, those fed R2 were fed on concentrate feed mixture and rice straw and grazing of fresh berseem for 6 hours, while those fed R3 were fed on concentrate feed mixture, rice straw, fresh berseem and corn silage. Results showed that the contents of CP, CF and ash were higher with grazing berseem only (R1), while EE and NFE contents were higher with feeding ration contained corn silage (R3). Cows fed R3 showed significantly ($P<0.05$) the highest digestibility coefficients of all nutrients and TDN value followed by those fed R2, while those fed R1 had the lowest values. However, cows fed R1 had the significantly ($P<0.05$) the highest DCP value followed by those fed R2, while those fed R3 had the lowest value. The intakes of DM, TDN and DCP were significantly higher ($P<0.05$) for cows fed R2 and R3 than that of cows fed R1. Milk yield for cows fed R2 and R3 increased by 2.20 and 2.62 kg / day or 16.01 and 19.07% compared with R1, respectively. The corresponding values for 4% FCM were 1.61 and 2.22 kg / day or 13.11 and 17.96%, respectively. Cows fed R1 showed significantly ($P<0.05$) the highest content of fat in milk. However, those fed R3 had significantly ($P<0.05$) the highest milk protein, lactose, solids not fat and total solids contents. Moreover, the yields of fat, protein, lactose, solids not fat and total solids in milk were significantly higher ($P<0.05$) fed R2 and R3 than those fed R1. The amounts of DM per kg 4% FCM was significantly higher ($P<0.05$) for R2 and R3 than R1. However, the amount of TDN per kg 4% FCM was higher fed R3 followed by R2, but those fed R1 had the lowest value, but there was opposite trend for DCP ($P<0.05$). Average daily feed cost, feed cost per kg 4% FCM and output of 4% FCM yield were significantly higher ($P<0.05$) fed R2 and R3 compared to R1. However, economic efficiency was significantly higher ($P<0.05$) fed R1 than that of R2 and R3. Cows fed R2 revealed the better reproductive performance, which recorded significantly ($P<0.05$) the fewer days to first estrus and service, service period, days open and calving interval, the lowest service per conception and the highest conception rate followed by those fed R3, however those fed R1 had the opposite trends.
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1. INTRODUCTION

Alfalfa is excellent and high palatability forage for high producing cows. Cows efficiently use the high levels of protein, calcium and high quality fiber in alfalfa for producing milk. Costs of feed production and manure handling are increasing more rapidly than the price of milk, placing an economic squeeze on dairy farmers. Decreasing profit is causing many to look for ways to reduce their costs. One option is the use of rotational grazing systems to reduce feed costs. A deterrent to the adoption of grazing is the lack of good information on the long-term economic benefits of grazing (Holden *et al*., 1994).

Rotational grazing can be an economical way to feed dairy cows in an environment of unstable milk prices and increasing input costs, but pasture alone cannot sustain profitable milk yield with high-producing cows (Kolver and Muller, 1998). Grazing dairy cows may be supplemented in various ways, including concentrates (grain and (or) protein), hay, silage, or a combination of feeds, depending on nutrient requirements, feed availability and cost, and management of the farm. Parker *et al*. (1993) reported that low adoption of grazing practices on dairy farms may be due, in part, to two factors: lack of confidence in the ability of pastures to provide high-quality forages to lactating dairy cows and the lack of available information on how to maintain acceptable levels of milk production in grazing systems.

Due to relatively unstable and low milk prices and increasing input costs, dairy farmers are searching for ways to decrease input costs, particularly feed expenses. When high quality pasture is available in adequate quantities, metabolizable energy is the most limiting factor for milk production (Kolver and Muller, 1998; Kolver *et al*., 1998). Supporting research has demonstrated a positive response in milk production to concentrate supplementation (Bernard and Carlisle, 1999; Polan *et al*., 1986).

To evaluate the economic and environmental impact of feed management decisions such as the level of supplement, a comprehensive, multidisciplinary systems approach is required (Rotz *et al.*, 1989, 1999). In order to obtain optimal performance of grazing high producing dairy cows, it is also important to understand the grazing and feeding behavior of these animals. Herbage abundance, ambient temperature, and grazing pressure are within the most important factors affecting the grazing behavior of ruminant animals (Parker *et al*, 1992).

Energy is the first limiting nutrient for high producing cows grazing high quality pastures as the only feed (Kolver and Muller, 1998). Compared with cows on a nutritionally balanced TMR, early lactation cows grazing high quality pasture with no supplement had lower total DM intake and milk production. While the intake of CP and NDF did not differ between cows fed pasture and TMR, the intake of DM and NEL was significantly lower in the pasture fed cows, suggesting that high producing dairy cows on pasture need supplemental energy to reach their genetic potential for intake and milk production. Substitution rate is defined as the decrease in pasture intake per kilogram of supplemental feed (Kellaway and Porta, 1993). Several animal, pasture, and supplement factors affect substitution rate, including pasture allowance, amount of concentrate fed, digestibility of pasture, chemical and physical properties of the concentrate, and stage of lactation. Among these factors, the amount of pasture offered per cow daily or pasture allowance has a major effect on substitution rate.

The aim of the present study was to investigate the effect of different feeding systems on productive and reproductive performance of lactating Friesian cows.

2. MATERIAL AND METHODS

The current work was carried out at Sakha Animal Production Research Station, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt.

2.1. Experimental animals and rations:

Thirty multiparous lactating cows weighing 450 to 500 kg used after calving and divided into three similar groups according to body weight and milk production (10 each). Cows were assigned randomly to fed the experimental rations for 150 days as shown in Table (1). Cows fed R1 were grazed on fresh berseem throughout the day with little amounts of rice straw. Those fed R2 were grazed on fresh berseem for 6 hours daily with concentrate feed mixture and rice straw, while those fed R3 were fed fresh berseem in stalls with concentrate feed mixture, corn silage and rice straw.

2.2. Management procedure:

Cows were individually fed according to Animal Production Research Institute (1997) to cover the recommended requirements for dairy cattle. Rations were recalculated every two weeks based on milk yield and body weight of animals. Cows in the first group (R1) were grazed berseem only from 8 a.m. to 4 p.m. and rice straw was given at 5 p.m. Those in the second group (R2) fed concentrate feed mixture two times daily at 8 a.m. and 4 p.m., grazed berseem from 9 a.m. to 2 p.m. and rice straw was given at 5 p.m. While, those in the third group (R3) fed concentrate feed mixture two times daily at 8 a.m. and 4 p.m., corn silage at 9 a.m, berseem at 11 a.m. and rice straw was given two time at 1 and 5 p.m. Cows were allowed to drink water three times a day at 7&12 a.m. and 5 p.m. and were kept under the routine veterinary supervision through the whole feeding trial.

2.3. Digestibility trials:

Three digestibility trials were conducted during the feeding trial with the experimental animals of the feeding trial (3 animal from each group) to determine nutrients digestibility coefficients and nutritive values of the experimental rations using acid insoluble ash (AIA) as a natural marker (Van Keulen and Young, 1977). Feces samples were taken from the rectum of each animal twice daily with 12 hours interval during the collection period. Samples of tested feedstuffs were taken at the beginning, middle and end of collection period. The samples of feedstuffs and feces were composted and representative samples were analyzed according to AOAC (1998).

2.4. Milk yield and samples

Individual morning and evening milk yield of lactating cows were recorded daily and corrected for 4% fat content (FCM) using the formula of 4% FCM = 0.4 x milk yield (kg) + 15 x fat yield (kg) as stated by Gains (1928). Milk samples from consecutive evening and morning milking were taken biweekly and mixed in proportion to milk yield. Milk fat, protein, lactose and total solids were determined using Milko-Scan (133B Foss Electric).

2.5. Feed conversion

Feed conversion was calculated as the amounts of DM, TDN (kg) and DCP (g) required to produce 1 kg 4% FCM.

2.6. Economic efficiency

Economic efficiency expressed as the daily feed cost, price of 4% FCM, feed cost per kg 4% FCM and the ratio between daily feed cost and price of 4% FCM. The price of one ton was 1800 LE for concentrate feed mixture, 120 LE for fresh berseem, 150 LE for corn silage and 90 LE for rice straw. While, the price of one kg 4% FCM was 2.5 LE according to prices of year 2009.

2.7. Reproductive parameters:

Reproductive parameters as the periods from calving to first estrus and first service, days open, calving interval, number of insemination per service and conception rate were recorded for each animal.

2.8. Statistical analysis

The data were subjected to statistical analysis using general linear models procedure adapted by SPSS for windows (2008) with one-way ANOVA. Duncan test within program SPSS was done to determine the differences between the means.

3. RESULTS AND DISCUSSION

3.1. Chemical composition of experimental rations

Chemical composition of tested feedstuffs and experimental rations used in feeding lactating cows are presented in Table (2). Chemical composition of tested feedstuffs that obtained in this study is commonly comparable to those recorded in the literature. The contents of CP, CF and ash were higher with grazing berseem only (R1). While, OM, EE and NFE contents were higher with feeding ration content corn silage (R3). These differences attributed to the differences in composition of tested feedstuffs.

3.2. Nutrients digestibility and nutritive values

The nutrients digestibility and nutritive values for the experimental groups are presented in Table (3). There were significant (P<0.05) differences in the digestibility coefficients of all nutrients and nutritive values among the different groups. Cows fed R3 showed significantly (P<0.05) the highest digestibility coefficients of all nutrients and TDN value followed by those fed R2, while those fed R1 had the lowest values. However, cows fed R2 had the significantly (P<0.05) the highest DCP value followed by those fed R1, while those fed R3 had the lowest value. These results reflect the differences fed chemical composition. These results agreed with those obtained by Fluharty *et al.* (1999) who found that lambs offered the concentrate diet had greater (P<0.01) DM and OM digestibilities than lambs offered alfalfa. Apparent and true N digestibilities were greater (P<0.001) for the concentrate diet than for alfalfa. Reis and Combs (2000) reported that digestibility of DM and OM increased with grain supplementation. Valadares *et al.* (2000) showed that there were linear increases in apparent digestibility of DM and organic matter, and a linear decrease in neutral detergent fiber (NDF) digestibility with increasing dietary non-fiber carbohydrates. Ahmed *et al*. (2003) revealed that corn silage increased digestibility of all nutrients and TDN value.

3.3. Feed intake

Average daily feed intake by lactating cows is shown in Table (4). Cows fed R1 showed the highest berseem intake followed by R2, but those in R3 had the lowest intake. While, cows fed R2 showed the highest intake of rice straw followed by R3, but those fed R1 had the lowest intake. In respect of concentrate feed mixture intake, it was higher fed R3 than R2. There were significant (P<0.05) differences in the intake of DM, TDN and DCP among the different groups. Cows fed R3 showed the highest DM and TDN intake followed by R2, but those in R1 had the lowest intake. The intakes of DCP was significantly higher (P<0.05) for cows fed R2 and R3 than that of cows fed R1. These results reflect the contents of TDN and DCP (Table 3). These results are in accordance with those obtained by Kellaway and Porta (1993) who reported that the intake of DM and NEL was significantly lower in the pasture fed cows, suggesting that high producing dairy cows on pasture need supplemental energy to reach their genetic potential for intake and milk production. While the intake of CP and NDF did not differ between cows fed pasture and TMR. Khorasani *et al*. (2001) found that DM intake was higher for cows fed diets with 50% concentrate.

3.4. Milk production and composition:

Average daily milk and 4% fat corrected milk yield and composition are shown in Table (5). The milk and 4% FCM yield increased significantly (P<0.05) with feeding concentrate feed mixture; however, the increase was greater with feeding corn silage. The milk yield for cows fed R2 and R3 increased by 2.20 and 2.62 kg / day or 16.01 and 19.07% compared with R1, respectively. The corresponding values for 4% FCM were 1.61 and 2.22 kg / day or 13.11 and 17.96%, respectively. These results are in agreement with those obtained by Kolver and Muller (1998) who found that rotational grazing pasture alone cannot sustain profitable milk yield with high-producing cows. Grazing dairy cows may be supplemented in various ways, including concentrates (grain and (or) protein), hay, silage, or a combination of feeds, depending on nutrient requirements. When high quality pasture is available in adequate quantities, metabolizable energy is the most limiting factor for milk production (Kolver and Muller, 1998; Kolver *et al*., 1998). Supporting research has demonstrated a positive response in milk production to concentrate supplementation (Bernard and Carlisle, 1999; Polan *et al*., 1986). Cows in confinement produced 19% more milk than those on pasture systems (Fontaneli *et al*., 2005).

As shown in Table (5), there were significant differences (P<0.05) in milk composition among the different groups. Cows fed R1 showed significantly (P<0.05) the highest content of fat in milk followed by R3, but R2 had the lowest content. However, those in R3 had significantly (P<0.05) the highest milk protein, lactose, solids not fat and total solids contents followed by R2, but R1 had the lowest contents. While, there was no significant differences in milk ash content among the different groups. Moreover, R3 showed significantly (P<0.05) the highest fat yield in milk followed by R2, but R1 had the lowest yield. While, the yields of protein, lactose, solids not fat and total solids in milk were significantly higher (P<0.05) in R2 and R3 than those fed R1. The decline in milk fat content with concentrate mixture feeding appeared related to decreased dietary fiber content, while the increase of milk lactose content might be due to increase NFE content (Table 2). Milk protein content increased with increasing DCP intake (Table 4). These results are in accordance with those obtained by Bargo *et al*. (2002) who reported that concentrate supplementation reduced milk fat percentage but increased milk protein percentage. Valadares *et al.* (2000) found that there were linear increases in yields of milk, protein, lactose, and solids not fat with increasing dietary non-fiber carbohydrates.

3.5. Feed conversion

Feed conversion expressed as the amounts of DM, TDN and DCP per kg 4% FCM are shown in Table (6). There were significant (P<0.05) differences in feed conversion among the different groups. The amount of DM per kg 4% FCM was significantly higher (P<0.05) for R1 compared to R2 and R3. However, the amount of TDN per kg 4% FCM was significantly higher (P<0.05) for R3 compared to R1 and R2. While, cows fed R1 showed the highest amounts of DCP per kg 4% FCM followed by R2, but those fed R3 had the lowest value. The differences in feed conversion might be due to the variations in feed intake (Table 4) and 4% FCM yield (Table 5) among the different groups. These results are in accordance with those obtained by Valadares *et al.* (2000) who found that feed efficiency (milk/DM intake) yielded a quadratic response with a minimum at 27% dietary non-fiber carbohydrates.

3.6. Economic efficiency

Economic efficiency is presented in Table (6). There were significant differences (P<0.05) in average daily feed cost, feed cost per kg 4% FCM, output of 4% FCM yield and economic efficiency among the different groups. Cows fed R3 recorded significantly (P<0.05) the highest average daily feed cost, feed cost per kg 4% FCM and output of 4% FCM yield and the lowest economic efficiency followed by those fed R2, while those fed R1 had the opposite trend. These results agreed with those obtained by Kolver and Muller (1998) who found that rotational grazing can be an economical way to feed dairy cows in an environment of unstable milk prices and increasing input costs. One option is the use of rotational grazing systems to reduce feed costs (Holden *et al*., 1994).

3.7. Reproductive performance

Results in Table (7) showed that cows fed R2 revealed the better reproductive performance, which recorded significantly (P<0.05) the shorter periods of first estrus and service, service period, days open and calving interval, the lowest service per conception and the highest conception rate followed by those fed R3, however those fed R1 had the opposite trends. The improvement of reproductive performance with feeding concentrate feed mixture may be due to increasing energy intake as well as covering mineral deficiency in fresh berseem and corn silage. These results are in agreement with those obtained by Tolla and Vijchulata (2006) who found that shorter intervals of days from calving to first estrus, days open and lowest number of services per conception were recorded for animals fed on concentrate diet. Grains are low in calcium content but higher in phosphorus. Legumes usually are good sources of calcium but not phosphorus, and grasses are much lower in calcium than legumes (Schroeder 2004).

Table 1: Rations formulation (% on DM basis) used by cows.

Feedstuffs	R1	R2	R3
Fresh berseem	85	50	30
Rice straw	15	15	10
Concentrate feed mixture*	00	35	40
Corn silage	00	00	20
Total	**100**	**100**	**100**

* Concentrate feed mixture consisted of 35% undecorticated cotton seed cake, 20% wheat bran, 24% yellow corn, 10% rice bran, 5% line seed cake, 3% molasses, 2% limestone and 1% common salt.

Table 2: Chemical composition of tested feedstuffs and experimental rations.

Item	DM %	Composition of DM %					
		OM	CP	CF	EE	NFE	Ash
Feedstuffs							
Fresh berseem	15.20	86.65	16.50	24.13	2.21	43.81	13.35
Rice straw	89.63	82.21	3.36	33.98	1.27	43.60	17.79
Concentrate feed mixture	91.10	91.55	16.30	11.50	3.10	60.65	8.45
Corn silage	27.86	93.17	8.40	22.05	2.31	60.41	6.83
Experimental rations							
R1	17.36	85.98	14.53	25.61	2.07	43.78	14.02
R2	26.03	87.70	14.46	21.19	2.38	49.67	12.30
R3	30.84	89.47	13.49	19.65	2.49	53.85	10.53

Table 3: Nutrients digestibility coefficients and nutritive values by cows fed experimental rations.

Item	Experimental groups			±MSE
	R1	R2	R3	
***Digestibility coefficients* %**				
DM	62.42^{c}	64.17^{b}	66.23^{a}	0.55
OM	63.68^{c}	65.48^{b}	67.59^{a}	0.57
CP	64.43^{c}	66.24^{b}	67.06^{a}	0.40
CF	63.68^{c}	65.67^{b}	66.80^{a}	0.46
EE	68.86^{c}	72.30^{b}	73.72^{a}	0.72
NFE	65.06^{c}	68.61^{b}	70.16^{a}	0.76
***nutritive values* %**				
TDN	57.36^{c}	61.44^{b}	64.08^{a}	0.98
DCP	9.36^{b}	9.58^{a}	9.04^{c}	0.08

a, b, c: Means in the same row with different superscripts differ significantly at 5% level.

Table 4: Feed intake (kg/head/day) by cows fed experimental rations.

Item	Experimental groups			±MSE
	R1	R2	R3	
Fresh berseem*	82.65	50.79	31.95	
Rice straw*	2.47	2.58	1.81	
Concentrate feed mixture*	0.00	5.93	7.11	
Corn silage	0.00	0.00	11.62	
Total DM	14.78^{c}	15.44^{b}	16.19^{a}	0.21
TDN	8.48^{c}	9.49^{b}	10.37^{a}	0.28
DCP	1.38^{b}	1.48^{a}	1.46^{a}	0.02

* As fed.

a, b, c: Means in the same row with different superscripts differ significantly at 5% level.

Table 5: Milk yield and composition of cows fed experimental rations.

Item	Experimental groups			±MSE
	R1	R2	R3	
Milk yield (kg/day)				
Actual yield	13.74[b]	15.94[a]	16.36[a]	0.48
4% FCM	12.36[b]	13.98[a]	14.58[a]	0.34
Milk constituents %				
Fat	3.34[a]	3.18[b]	3.27[ab]	0.05
Protein	2.55[c]	2.66[b]	2.75[a]	0.04
Lactose	4.22[c]	4.39[b]	4.48[a]	0.06
Solids not fat	7.47[c]	7.74[b]	7.91[a]	0.09
Total solids	10.81[c]	10.92[b]	11.18[a]	0.12
Ash	0.70	0.69	0.68	0.02
Milk constituents (kg/day)				
Fat	0.46[b]	0.50[ab]	0.53[a]	0.03
Protein	0.35[b]	0.42[a]	0.45[a]	0.02
Lactose	0.58[b]	0.70[a]	0.73[a]	0.03
Solids not fat	1.03[b]	1.23[a]	1.29[a]	0.05
Total solids	1.49[b]	1.74[a]	1.83[a]	0.06
Ash	0.10	0.11	0.11	0.01

a, b, c: Means in the same row with different superscripts differ significantly at 5% level.

Table 6: Feed conversion and economic efficiency of cows fed experimental rations.

Item	Experimental groups			±MSE
	R1	R2	R3	
Feed conversion				
DM kg / kg FCM	1.20[a]	1.10[b]	1.11[b]	0.02
TDN kg / kg FCM	0.69[b]	0.68[b]	0.71[a]	0.01
DCP g / kg FCM	111.94[a]	105.79[ab]	100.45[b]	1.67
Economic efficiency				
Average daily feed cost (LE)	10.14[b]	17.00[a]	18.54[a]	1.29
Feed cost (LE) / 1 kg 4% FCM	0.82[b]	1.22[a]	1.27[a]	0.07
Output of 4% FCM yield (LE)	30.90[b]	34.96[a]	36.46[a]	0.77
Economic efficiency	3.05[a]	2.06[b]	1.97[b]	0.16

a, b: Means in the same row with different superscripts differ significantly at 5% level.

Table 7: Reproductive performance of cows fed experimental rations.

Item	Experimental groups			±MSE
	R1	R2	R3	
Reproductive intervals (day)				
• First estrus	24.68[a]	20.46[b]	22.72[ab]	0.46
• First insemination	56.81[a]	47.51[c]	51.28[b]	1.02
• Service period	60.41[a]	44.53[c]	51.78[b]	1.73
• Days open	117.22[a]	92.04[c]	103.06[b]	2.75
• Calving interval	394.52[a]	367.45[c]	380.51[b]	2.95
No. of service per conception	3.08[a]	2.50[c]	2.90[b]	0.06
Conception rate %	60.00[c]	80.00[a]	70.00[b]	2.18

a, b, c: Means in the same row with different superscripts differ significantly at 5% level.

4. CONCLUSION

From these results it could be concluded that cows fed ration contained concentrate feed mixture, fresh berseem and corn silage showed the beast results for productive performance and those fed concentrate feed mixture and fresh berseem revealed the beast reproductive performance, while those fed fresh berseem only had the best economic efficiency.

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