The effects of partial replacement of corn silage on biochemical blood parameters in lactating primiparous dairy cows

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ABSTRACT: The aim of this experiment was to investigate the effects of partial replacement of corn silage with long alfalfa hay and/or coarse chopped wheat straw on biochemical parameters in late lactating Holstein primiparous dairy cows. Twelve late lactating Holstein primiparous cows including four cows equipped with a rumen cannula, averaging 210 ± 20 days in milk and weighing 575 ± 50 kg were randomly assigned in a 4 × 4 Latin square design. During each of four 21-days periods, cows were fed four total mixed diets that were varied in the forage sources: (1) 50% corn silage (CS), (2) 35% corn silage + 15% wheat straw (CSW), (3) 35% corn silage + 15% alfalfa hay (CSA), (4) 25% corn silage + 10% wheat straw + 15% alfalfa hay (CSWA). At the end of the feeding period, blood samples were taken from jugular vein. Serum glucose, total protein, albumin/globulin, creatinine, creatinin kinase, urea and uric acid levels were determined by using Auto Technicon DAX 72 autoanalyzer. While serum glucose, albumin, globulin, urea, uric acid and creatinine kinase activity were not found significantly different among groups, serum total protein (between CS and CSA, CS and CSWA) and creatinine (between CSA and CSWA) levels had statistical significance at the levels of $P < 0.05$. It is concluded that rumen propionate and ammonia levels may be good indicator for glucose and BUN, respectively.

Keywords: forage sources; corn silage; blood; cows

Ruminants require roughage in their diets to maximize production and to maintain health by sustaining a stable environment in the rumen. To meet the energy requirements of high producing lactating dairy cows, diets typically contain relatively high proportions of concentrate and high quality forages. Corn silage is one the most popular forages fed to dairy cows because it has good agronomic characteristics, yields high concentrations of nutrients, ensiles well, and incorporates easily into total mixed ration (TMR) (Neylon and Kung, 2003). Most commercial dairy rations contain high levels of concentrate and high quality corn silages that are often finely chopped (Beauchemin and Buchanan-Smith, 1990). While this practice encourages maximal milk production, it can also lead to one or more of a variety of metabolic disorders, including subclinical ruminal acidosis, reduced fiber digestion, milk fat depression, displaced abomasum, laminitis, and fat-cow syndrome. Therefore, adequate particle length of forages is necessary for proper ruminal function as coarse particles stimulate chewing activity and hence increase saliva output. Recently, interest in the feeding of processed corn silage to lactating dairy cows has increased. Effects of corn silage crop processing and chop length on intake, digestion, and milk production were evaluated (Michael, 1997; Bal, 2000; Beauchemin et al., 2003).

To our knowledge, the scientific information about biochemical blood parameters of lactating primiparous dairy cows fed partial replacement of corn silage are not sufficient. Therefore, the aim of this experiment was to investigate the effects of partial replacement of corn silage with long alfalfa hay and/or coarse chopped wheat straw on biochemical parameters, in late lactating Holstein primiparous dairy cows.

MATERIAL AND METHODS

Forages

Corn silage was obtained from Uludag University, Faculty of Veterinary Medicine farm. Whole plant corn (hybrid C955, Monsanto Company, St. Louis, MO, USA) was harvested at about 26.5% DM using a self-propelled forage harvester without kernel processing (Tosun Tarim, Izmir, Turkey) set to obtain a 10.0 mm theoretical cut length (TCL). The chopped forage was placed in a horizontal silo (300 t capacity), covered with nylon plastic, and ensiled for approximately three months. Alfalfa was harvested during second cutting in a middle flowering stage and preserved as alfalfa hay in small rectangular bales of 20 kg. The hay was stored in barns. Wheat straw was chopped using a miller rotary hay mill (Model No: S8002, Tosun Tarim) equipped with a 5-cm screen.

Cows and diets

Twelve lactating Holstein primiparous cows averaging 210 ± 20 days in milk and weighing 575 ± 50 kg were randomly assigned in a 4 × 4 Latin square design. One of the three cows in each group was cannulated ruminally with soft plastic cannulas of 10 cm internal diameter (Ankom, pliable Rumen cannula 29.4 inches, NY, USA). Cows were housed in individual tie stalls and all diets were formulated for a 600 kg cow producing 20 kg/day of milk with 3.6% fat and 3.0% true protein by using the NRC guidelines (NRC, 2001). Throughout the experiment, cows were fed twice daily (09:00 and 21:00 h) at 110% of expected intake with TMR that was mixed daily by hand. Each period consisted of 14 days of adaptation to diets and seven days of experimental measurements. Cows were fed diets with 50 : 50 forage to concentrate ratio (DM basis). During each period, animals were offered one of the four diets that varied in the forage source, proportion and particle size (Table 1): (1) 50% corn silage (CS), (2) 35% corn silage + 15% wheat straw (CSW), (3) 35% corn silage + 15% alfalfa hay (CSA) and (4) 25% corn silage + 10% wheat straw + 15% alfalfa hay (CSWA). Feeds offered and orts were measured and recorded daily during the last seven days of each period to calculate feed intake. The TMR samples were dried in a forced-air oven at 55°C for 48 h for chemical analyses.

Chemical analyses

The dietary samples were dried in forced-air oven at 55°C for 48 h for measurement of DM content and then ground through a 1-mm diameter screen using a laboratory 3303 Mill (Hundenge, Sweden). Analytical DM content of the dietary samples was determined by drying at 105°C for 12 h, and crude protein was determined by the Kjeldahl method (AOAC, 1990). Ash was determined by combustion at 550°C for 6 h. The NDF, Acid Detergent Fiber (ADF) and Acid Detergent Lignin contents were determined using the methods described by Van Soest et al. (1991) with heat-stable amylase (Sigma No: A-3306, Sigma Chemical Co., St Louis, MO, USA) and sodium sulfite used in the NDF procedure. Starch was measured on composited samples as described by Bal et al. (2000).

Sample collection and measurements

At the end of the feeding period, blood samples were taken from jugular vein using heparinised vacutainer blood collection tubes and, transported on ice chest to a laboratory for analyses. Blood samples were centrifuged at 3 000 rpm for 5 min, and serum separated stored at –20°C for later analyses. Serum glucose, total protein, albumin, globulin, creatinine, urea, uric acid levels and creatinine kinase activity were determined by using Auto Technicon DAX 72 autoanalyzer.

Statistical analysis

All biochemical blood parameters were statistically analyzed by software program named "SPSS 13.0 for Windows" using Friedman Test to determine if there are any significances among the values of each group. Differences among groups were determined by the Wilcoxon Signed Ranks Test. Differences at the levels of 5% were considered statistically significant (Version 13.0, SPSS Inc, Chicago, USA).

RESULTS AND DISCUSSION

The ingredients and chemical composition of the total mixed diets were shown in Table 1 and glucose, total protein, albumin, globulin, creatinine,

urea, uric acid levels and creatinine kinase activity were shown in Table 2. While serum glucose, albumin, globulin, urea, uric acid and creatinine kinase activity were not found significantly different among groups, serum total protein (between CS and CSA, CS and CSWA) and creatinine (between CSA and CSWA) levels had statistical significance at the levels of $P < 0.05$.

The blood glucose concentrations were not affected by dietary treatments. The propionate produced in the rumen fermentation has generally been considered the major substrate for gluconeogenesis (Ford, 1965). Wiltrout and Satter (1971) reported that the propionate contributes to a minimum of 45% of the blood glucose entry rate in the lactating cows. In the current study, the concentration

Table 1. Ingredients and chemical composition of the total mixed diets

Item	CS[1]	CSW[2]	CSA[3]	CSWA[4]
Ingredients (% of DM)				
Corn silage[5]	50.00	35.00	35.00	25.00
Wheat straw[6]	0.00	15.00	0.00	10.00
Alfalfa hay[7]	0.00	0.00	15.00	15.00
Barley grain ground	10.81	13.74	14.39	13.19
Wheat grain ground	14.27	16.82	14.27	17.92
Soybean meal ground (44% CP)	16.47	11.47	12.89	10.72
Sunflower meal ground	7.15	6.74	7.15	6.91
Calcium carbonate	1.07	1.01	1.07	1.04
Vitamin-mineral premix[8]	0.05	0.05	0.05	0.05
Salt (NaCl)	0.18	0.17	0.18	0.17
Total (%)	100	100	100	100
Chemical composition				
Dry matter, DM (%)	59.05	67.71	67.21	73.51
Crude protein (% of DM)	16.13	15.19	17.38	16.45
Ether extract (% of DM)	3.18	3.08	2.98	2.54
Neutral detergent fiber (% of DM)	39.57	43.21	38.17	41.53
FNDF[9] (% of DM)	27.82	31.06	26.96	29.11
Acid detergent fiber (% of DM)	23.31	23.36	23.18	25.63
Acid detergent lignin (% of DM)	3.85	4.71	4.51	5.10
NFC[10] (% of DM)	35.82	32.46	34.85	32.60
Starch (% of DM)	27.61	24.78	26.00	25.39
Ash (% of DM)	5.30	6.06	6.62	6.88
NEL[11] (Mcal/kg of DM)	1.63	1.58	1.61	1.57
DMI[12] (kg/day)	15.32	16.00	15.53	15.84

[1]CS = 50 % corn silage and 50 % concentrate, [2]CSW = 35% corn silage + 15% wheat straw and 50 % concentrate, [3]CSA = 35% corn silage + 15% alfalfa hay and 50% concentrate, [4]CSWA = 25% corn silage + 10% wheat straw + 15% alfalfa hay and 50% concentrate

[5]Corn silage analysis (DM basis): NDF = 55.64%, [6]Wheat straw (DM basis): NDF = 77.22%, [7]Alfalfa hay (DM basis): NDF = 49.89%, [8]Supplied per kilogram of premix (Kavimix VM, Kartal Kimya A.S., Gebze, Turkey): Vitamin A 12 000 000 IU, Vitamin D3 3 000 000 IU, Vitamin E 30 g, Mn 50 g, Fe 50 g, Zn 50 g, Cu 10 g, I 0.8 g, Co 0.1 g, Se 0.15 g, antioxidant 10 g

[9]FNDF = percentage neutral detergent fiber from forage, calculated from ingredient analysis;[10]NFC = nonfiber carbohydrate (%), calculated as: 100 – [(NDF (%) + CP (%) + EE (%) + ash (%)]; [11]NEL = net energy lactation, calculated from NRC [18]; [12]DMI = dry matter intake (Gencoglu and Turkmen, 2006)

Table 2. The biochemical parameters in lactating primiparous cows of partial replacement of corn silage (mean ± SD, n = 12)

Biochemical parameters	CS[1]	CSW[2]	CSA[3]	CSWA[4]	P
Glucose (mg/dl)	62.50 ± 5.83	62.75 ± 2.50	66.37 ± 2.50	65.50 ± 5.50	NS
Total protein (g/dl)	7.85 ± 0.58[a]	7.97 ± 0.57[ab]	8.19 ± 0.67[b]	8.21 ± 0.58[b]	< 0.05
Albumin (g/dl)	3.41 ± 0.25	3.11 ± 0.26	3.25 ± 0.40	3.21 ± 0.43	NS
Globulin (g/dl)	2.95 ± 0.30	3.10 ± 0.15	3.01 ± 0.22	2.97 ± 0.13	NS
Creatinine (mg/dl)	1.02 ± 0.12[ab]	1.04 ± 0.11[ab]	1.05 ± 0.09[a]	0.99 ± 0.10[b]	< 0.05
Urea (mg/dl)	40.75 ± 5.17	42.25 ± 5.72	45.08 ± 8.56	40.08 ± 7.27	NS
Uric acid (mg/dl)	1.08 ± 0.15	1.21 ± 0.11	1.01 ± 0.08	1.19 ± 0.13	NS
Creatinine kinase (IU/l)	66.41 ± 22.10	68.66 ± 22.93	66.08 ± 33.04	66.58 ± 27.75	NS

[1]CS = 50% corn silage and 50% concentrate, [2]CSW = 35% corn silage + 15% wheat straw and 50% concentrate, [3]CSA = 35% corn silage + 15% alfalfa hay and 50% concentrate, [4]CSWA = 25% corn silage + 10% wheat straw + 15% alfalfa hay and 50% concentrate
[a,b]means in the same row with different superscripts differ according to P value indicated
NS = not significant

of propionate in rumen fluid did not differ among diets and ranged from 16.7 to 18.3 mol/100 mol (Gencoglu and Turkmen, 2006). Therefore blood glucose concentrations might also be unchanged by the dietary treatments.

The blood urea nitrogen (BUN) did not differ between the diets. In ruminants, BUN can be influenced by dietary N-to-energy ratio, level of forage intake, and protein degradability in the rumen (Hammond et al., 1994), dietary carbohydrate amount, liver and kidney function. The BUN is a good indicator of concentrations of rumen ammonia and this is related closely solubility of nitrogen containing compounds fed. And also insufficient available dietary energy can increase rumen ammonia and BUN by limiting microbial protein synthesis. In this study, the numeric increase in BUN which cows fed with alfalfa hay was expected because alfalfa hay has more rumen degradable protein (RDP) than corn silage (NRC, 2001) but the BUN might be compensated by similar starch and fermentable energy content of diets. DePeters and Ferguson (1992) reported that concentrations of ruminal NH_3 and BUN are highly correlated. In this study, the concentrations of ruminal NH_3 was not affected by the dietary treatments and ranged from 17.4 to 20.7 mg/dl (Gencoglu and Turkmen, 2006). There may be another explanation for the similar BUN concentrations.

In our study, serum total protein levels of lactating primiparous dairy cows fed CS, CSW, CSA and CSWA were found as 7.85, 7.97, 8.19 and 8.21 g/dl, respectively. The serum total protein levels of CSA and CSWA were higher than (P < 0.05) than CS diet. The crude protein content of alfalfa hay was high relative to the other forages, therefore CSA and CSWA diets also higher crude protein content compare with the other diets (Table 1). The increasing crude protein content of diets may be among the factors affecting serum total protein content of dairy cattle. The values recorded in this study are similar to those reported by Karagul et al. (1999) and Mert (1996). The protein concentration will increase when protein intake exceeds the requirement for maintenance and growth. Total protein measurements can reflect nutritional status, kidney disease, liver disease, and many other conditions. Serum creatinine levels in the present study were found lower (0.99 mg/dl) in CSWA than CS, CSW and CSA. These values between CSA and CSWA for serum creatinine levels found to be statistically significant (P < 0.05). The data were identical when compared with results obtained from a study reported by Polat et al. (2009) in lactating dairy cows fed (26.20%) corn based diet and, (16.10%) corn and (7.09%) wheat based diet.

CONCLUSION

It is looking at the chewing activity, ruminal pH, and milk fat percentage in the scientific articles. But it isn't thought that these feedings can be of the positive or negative effects on biochemical blood

parameters. These results suggest that replacing corn silage with alfalfa hay and/or wheat straw may affect biochemical parameters investigated in lactating primiparaous cows, but these differences, when observed, are small. It is concluded that rumen propionate and ammonia levels maybe good indicator for glucose and BUN levels, respectively.

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