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The impacts of taking care of fluid corrosive whey in the eating routine of lactating dairy cows on milk creation and structure

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Abstract

Eighteen Holstein dairy cows averaging 141 days in milk were used in a complete randomized design to determine the effects of feeding liquid acid whey (LAW) on milk production and composition. Animals received a diet consisting of berseem clover (*Trifolium alexandrinum*., L), wheat straw and concentrate (Control). Treatments were control and control plus 40 liters/cow/day of LAW. Daily individual Dry Matter Intake (DMI) and milk production were measured. Diet digestibility was determined using the total collection method. Results showed that LAW increased (P<0.05) DMI. However, *in vivo* dry and organic matter digestibilities were not affected by whey feeding. 4% fat corrected milk (FCM) and milk fat and protein yields were higher (P<0.05) for cows fed the whey (15.4 and 14.6 kg/day and 592 vs. 555 g/day and 486 vs. 462 g/day for milk and yields of milk fat and proteins, respectively) . Milk composition was similar (P>0,05) for both treatments. It can be concluded that including LAW in dairy diets, in a partial replacement of the concentrate, significantly improved FCM and milk fat and protein yields without affecting milk composition.

Keywords: Dairy cow, whey, milk yield, milk composition

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INTRODUCTION

Cheese production in Tunisia has more than doubled during the last years. Such increase generated large amounts of whey. Research conducted on feeding whey and whey products to livestock in many countries showed that whey is a highly nutritious by-product of the cheese making industry that can be utilized in feeding large ruminants to produce milk (Schingoethe, 1976; Remond et al., 1978; Coulon et al., 1979; Schingoethe et al., 1983, 1986, 1988; Stock et al., 1986; Casper and Schin-goethe, 1986). However, all the whey produced in Tuni-sia is currently dumped into municipal waste disposal systems. Today, with new anti-pollution regulations, this constitutes a major disposal problem for cheese plants. Direct feeding to large ruminants offers promise for the utilization of maximum quantities of Liquid whey nutria-ents for milk production, particularly by dairy farmers in close proximity to cheese plants, while disposal prob-lems and water pollution are alleviated with no added cost for further processing or drying. However, research work on feeding wheys in combination with commonly fed diets to dairy cows in Tunisia, such as the dietary berseem clover-concentrate diet, is lacking.

Specific information on whey feeding with such a com-bination is needed. Moreover, most of the previous stu-dies mainly used dried whey and only limited research had evaluated LAW as a feed for lactating cows. The objective of our study was therefore to evaluate the use of LAW as a feed for dairy cows and determine its effects on DMI, diet digestibility, milk production and milk composition in lactating cows fed a berseem clover and concentrate diet.

MATERIALS AND METHODS

Animals, feeding and management of cows

Eighteen Holstein cows averaging 141 ± 21 days in milk were pai-red according to milk production, days postpartum, and lactation

Table 1. Chemical composition of liquid acid whey.

			Percent dry matter				
Whey	pH	%DM	CP	Lactose	Ash	Ca	P
	4.44	6.27	11.7	69.3	8.0	1.84	1.36

DM : dry matter ; CP : crude protein.

Table 2. Chemical composition (% DM) and nutritive values[1] of forage and concentrate feeds.

Item	Berseem	Concentrate
Chemical composition Dry matter (DM, %)	15.65	91.77
Organic matter (%DM)	89.6	93.2
Crude proteins (% DM)	15.4	17.7
Ether extract (% DM)	2.70	2.85
Crude fiber (% DM)	26.5	4.4
Calcium	1.60	1.73
Phosphorous *Nutritive values* (/kg DM)	0.28	0.35
UFL[2]	0.68	0.91
PDIE[3] (g)	108	110
PDIN[4] (g)	112	135

[1] Estimated from chemical composition; [2] UFL, feed unit for lactation [3] PDIE, true protein truly digested in the small intestine when degraded nitrogen in the rumen is not limiting; [4] PDIN, true protein truly digested in the small intestine when energy in the rumen is not limiting.

number with one cow from each pair randomly assigned to one of two treatment diets in a complete randomized design to evaluate LAW as a feed for lactating cows. The first treatment, designated control (C), consist of berseem clover, wheat straw and a commercial concen-trate. The second, designated LAW, contained 40 liters of LAW (pH = 4.44) which replaced kg of the concentrate. Fresh LAW was obtained every other day from a near by cheese plant. The experiment was carried over a period of 8 weeks, with the first two weeks for adaptation. Cows were housed in tie stalls bedded with straw and were individually fed green berseem twice daily for adlibitum intake, wheat straw, and concentrate. All cows, including those fed the whey had similar free access to fresh drinking water. Concentrate and whey were allocated in two equal portions daily. Corn, barley, soybean meal, mineral and vitamin supplement were the feed ingredients in the com-mercial concentrate mixture. Chemical composition and the nutritive values of whey and feeds are shown in Tables 1 and 2. Nutritive values were calculated based on chemical composition of forages and concentrate feeds according to formula developed by INRA France (1978; 1981a, 1981b).

Measurements and sampling

Over the collection period, daily DMI was measured. Amounts of the feed offered and refusals were weighed daily. Samples were taken daily and a portion was used for dry matter (DM) determination by drying at 105°C in a forced air oven for 24 h. Remainder of each feed and refusal samples were stored and later composited by a- week period. Composites were dried at 50°C then ground through a 1 mm-screen for subsequent analyses.

Cows were milked twice daily at 7:00 and 16:00 h, and individual yields were recorded daily at each milking during the collection period. Milk yield during this period was used to calculate 4% FCM. Yields of milk fat and protein were calculated from contents of milk fat and CP and milk yield. Two 24-h (p.m. and a.m.) milk samples were collected from each cow on days 1, 3, and 5 of each week during the collection period. Milk samples taken each morning and afternoon were com-posited daily as a percentage of the amount of milk produced by each cow at each milking. Samples were preserved with potassium dichro-mate and stored frozen until analyzed.

Diet digestibility

Total tract dry matter and organic matter digestibilities of the diet were determined the last week of the trial from total fecal collection using 10 cows (5 per treatment). Over the 7 days, feed refusals and feces void-ed by each cow were recorded daily at 8:00 h. DM contents of feed offered, individual refusals and feces were determined daily after dry-ing grab samples at 105°C for 24 h. Samples of feed offered and refu-sals and feces were collected daily from each animal and stored at – 5°C. At the end of the collection period, feed refusals and fecal sam-ples were pooled for each cow.

Representative samples were then taken for analysis. Feed offered, refusals and fecal samples were then dried in a forced-air oven at 50°C for 48 h and grind through a 1 mm-screen and stored until sub- sequent analyses. Digestibilities of nutrients were calculated as the difference between nutrient intake, orts and fecal excretion of nut-rients, respectively.

Laboratory analyses

The feed offered, individual refusals and feces were analyzed for DM, ash, crude protein (CP), crude fiber (CF) and ether extract (EE) ac-cording to the AOAC (1990). Feeds were also analyzed for calcium and phosphorous by atomic absorption spectroscopy (Model Spectr AA, Unicam, 919) with an acetylene protoxide flame. Composite milk samples were analyzed for contents of CP and fat by automated infra-red analysis using a Foss 4000 milko Scan (Foss electronic, France) at the office of livestock and pasture central milk testing laboratory. Total solids in milk were determined according to Atherton and New-lander (1977).

Statistical analysis

Data were subjected to least square analysis of variance for a com-plete randomized design by the General Linear Model procedure of SAS (1987), with results expressed as least square means. Compari-sons with $P<0.05$ were considered to be statistically significant.

RESULTS AND DISCUSSION

Feed intake

Average DMI is given in Table 3. All cows consumed daily-allocated concentrate and whey without any health problem indicating that the acceptability of the whey was satisfactory. Actual DMI of berseem clover and straw were nearly identical ($P>0.05$) for both treatments which suggests that the use of LAW had no significant

Table 3. Effect of Acid Whey on dry matter intake and dietary dry and organic matter *in vivo* digestibilities.

Item	Control	Liquid Acid Whey
Dry matter intake, kg/d		
Concentrate	5.5^{a}	$.^{b}$
Berseem	9.2^{a}	9.5^{a}
Straw	$1.^{a}$	1.65^{a}
Whey	0.0	2.51
Total	$16.^{b}$	$17.^{a}$
Digestibiliy, %		
Dry Matter	75.4^{a}	75.9^{a}
Organic matter	77.5^{a}	77.9^{a}

[a,b] Means within the same row with no common superscript letter differ (P < 0.05).

Table 4. Effect of liquid acid whey on milk production and milk composition.

Item	Control	Liquid Acid Whey
Milk yield, kg/d	15.64^{b}	16.4^{a}
4% FCM, kg/d	14.6^{b}	15.4^{a}
Fat, %	3.62^{a}	3.68^{a}
Fat, g/d	555^{b}	592^{a}
Crude protein, %	2.95^{a}	2.96
Crude protein, g/d	462^{b}	487^{a}
Total solids (g/kg)	123.5^{b}	128.4^{a}

[a,b] Means within the same row with no common superscript letter differ (P < 0.05).

effect on forage intakes.

However, concentrate DMI was lower (P<0.05) for cows fed the whey diet (- .7 kg DM/cow/day). Total DMI was higher for cows fed the whey diet (17.2 Vs 16.4 kg). King and Schingoethe (1983) reported higher DMI for steers fed dried whey at 86% of the concentrate mix compared with a corn-soybean meal control diet.

Similarly, Casper and Schingoethe (1986) reported increased DMI for cows fed urea-dried whey compared with cows fed urea diet in early lactation. In contrast, other studies reported no effects on cows DMI when liquid whey or whey products replaced either part of the con- centrate diet (Remond et al., 1978; Coulon et al*.,*1979) or of other ration ingredients (Schingoethe et al*.,* 1976; Schingoethe et al*.,* 1980; Schingoethe and Skyberg, 1981a,b).

Apparent total tract dry and organic matter digestibilities

Feeding whey to dairy cows did not affect digestibility values. Apparent digestibilities of dry matter and organic matter were similar (P>0.05) for both treatments (Table 3).

However, digestibility values were slightly higher for the whey ration (75.4 Vs 77.5% and 75.9 Vs 77.9% for dry and organic matter and control and LAW treatments, respectively). Digestibility of dry matter was 75.9% for the whey diet. This was lower than the value of 81.5% digestible dry matter reported by Rogers et al. (1977) for liquid whey fed to cattle. Schingoethe et al. (1980) reported higher digestibilty of dry matter for steers fed dried whey ration as compared to control ration. The lack of a significant effect on dry and organic matter digestibilities in our study could have resulted from the small difference in the fiber contents between the 2 rations. We replaced a corn soybean concentrate with whey as opposed to replacing forages.

Milk yield

Total milk production and milk composition are presented in Table 4. Yields of milk and 4% FCM were higher (P<0.05) for cows fed the whey (15.6 Vs16.4 kg/d and 14.6 Vs15.4 kg/d for milk and 4% FCM milk, respectively). The differences may reflect true dietary treatment response. Indeed, there was no significant difference (P>0.05) on milk production between cow groups at the beginning of the experiment (16.8 kg vs 16.5 kg of milk for the control and the experimental groups; respectively). The improved milk yield observed for the whey fed cows probably occurred because of the increase in DMI for these cows and the slightly higher digestibility of the LAW diet. Different experiments have studied the effect of feeding liquid whey on milk production and com-position in dairy cows. However, reported data are con-flicting. Our results are in agreement with those of Cou-lon et al. (1979) who reported, in a similar study, 0.5 kg of milk increase per cow/d when mid lactating dairy cows received 37 liters of whey in replacement of 2.25 kg of the concentrate feed.

Moreover, Schingoethe and Beardsley (1975) reported higher milk production for dairy cows receiving a diet composed of corn silage, 0.5% urea and 1% of dried whey, as compared to cows receiving the same diet without whey. Casper and Schingoethe (1986) indicated that cows fed diets containing nitrogen in more readily soluble form can support milk production equal to/or more than that of all natural protein supplements if the diet contains also more fermentable carbohydrates. In the present study, the addition of whey to a berseem clo-ver based diet may have resulted in a better synchroni-zation between dietary energy and protein within the rumen, mainly between the lactose from the whey and the soluble and degradable nitrogen from the berseem. Windschitl and Schingoethe (1984) reported that dry whey increased nitrogen utilization through stimu-lation of increased microbial protein synthesis.

Therefore, it is most probably that the positive effect of liquid whey on milk production observed in the present work is a reflection of an increased microbial activity and nutrient utilization for milk synthesis.

Percentages of milk fat (3.62 and 3.68%) and protein (2.95 and 2.96%) were similar (P>0.05) for both treatments. Yields of milk fat (555 Vs 592 g/cow/d) and protein (462 Vs 487 g/cow/d) were, however, higher for cows fed the whey. This could be due in part to their greater milk yield.

Several studies (Casper and Schingoethe, 1986; Schingoethe, 1976; Schingoethe and Skyberg, 1981a,b) indicated that cows fed dried whey often have similar or increased milk fat percentages compared with cows fed diets without whey. This is most probably related to rumen fermentation characteristics of cattle diets containing whey. Indeed, increased concentrations of butyric acid, a milk fat precursor; were observed when whey was substituted for maize in cattle diets (Susmel et al., 1995). The similar milk protein content for both treatments was consistent with results of Casper and Schingoethe (1986).

Conclusion

Based on present results, it can be concluded that whey can be an economical alternative for the partial substitution of the concentrate in dairy rations without any negative effects on milk production and composition.

A practical recommendation would be to adapt the cows for at last two to three weeks. Research should continue to clearly determine optimum levels of whey to be used with different basal diets, evaluate its economical benefits and define the role this by-product can play a great part in reducing the use of concentrates in dairy rations, while solving its disposal problem for cheese plants and preventing environmental pollution.

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