Effect of Feeding Yeast Culture from Different Sources on the Performance of Lactating Holstein Cows in Saudi Arabia

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ABSTRACT : One hundred-fifty lactating, multiparous cow at post-peak of lactation were used to examine the effect of dietary yeast supplementation on milk production, milk composition and ruminal fermentation. The cows were randomly allocated to three groups of fifty cows each: a control group fed on a basal diet without yeast supplementation and two groups fed on basal diets supplemented with one of two commercial sources of yeast cultures, given at the rates of 15 g/head/d (YC_1) and 50 g/head/d (YC_2), respectively, as per manufacturers' recommendation. Daily milk production was recorded for all cows, while milk samples were taken randomly from ten cows per group for two consecutive days at two-week intervals for chemical analysis of the milk. Rumen fluids were also analyzed for ammonia nitrogen and volatile fatty acids. The results indicated that cows consuming diets supplemented with yeast culture tended to decrease their dry matter intake and to increase their milk yield. Cows fed YC_2 supplemented diet produced more milk and 4% fat corrected milk than those fed either YC_1-supplemented diet or the control. The highest milk fat percentage was obtained in cows fed YC_2 supplemented diet while the highest percentages of protein, lactose, total solids and solids not fat were recorded in cows fed YC_1. Rumen ammonia nitrogen concentration decreased significantly after yeast culture supplementation. Molar proportion of volatile fatty acids did not change significantly with yeast supplementation. ***(Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 3 : 352-356)***

Key Words : Dairy Cows, Yeast

INTRODUCTION

The use of yeast culture to improve livestock productivity, and the underlying mechanisms for such improvement, have attracted increasing attention during recent years (Williams and Newbold, 1990). Yeast cells are known to be a rich source of vitamins, enzymes and some unidentified cofactors that are helpful in increasing microbial activity in the rumen (Dawson et al., 1990), (Williams et al., 1991); hence, yeast culture supplementation has been shown to improve the growth rate (Panda et al., 1995; Rameshwar et al., 1998) and feed conversion efficiency (Mir and Mir, 1994; Rouzbehan et al., 1994). However, the effect of dietary yeast supplementation on milk yield and milk composition are varied. In some studies, yeast culture supplementation was shown to increase milk production and milk fat percentage (Willliams et al., 1991; Erasmus et al., 1992; Piva et al., 1993), while in other studies, neither of these parameters was shown to be significantly altered by yeast supplementation (Blauwiekel et al., 1995; Robinson, 1997). Furthermore, while several workers (Williams, 1989; Williams et al., 1991) have reported that dietary yeast culture supplements produce a range of effects in the rumen including increased pH, increased ruminal concentration of volatile fatty acids and acetate: propionate ratio, decreased methane production and increased total number of microorganisms and cellulolytic bacteria, others have demonstrated no effect of yeast culture supplementation on ruminal pH, ammonia-N and VFA patterns (Adams et al., 1981; Robinson; Garrett, 1999).

The objectives of the following study were to examine the effect of adding yeast culture from two different commercial sources on milk yield, milk composition and patterns of ruminal fermentation of lactating Holstein cows in Saudi Arabia.

MATERIALS AND METHODS

One hundred-fifty lactating, multiparous Holstein cows at post peak of lactation (118-134 days) were randomly allocated in a complete randomized design to one of three treatment groups, based on parity, days in milk and previous mean milk yield. The first group (control) was fed on a yeast culture-free basal diet (table 1), the concentrate pellets contains (corn 60%, barely 4.22%, soya bean meal 22.79%, molasses 8%, protected fat 0.8%, limestone 1.5%, di calcium phosphate 0.8%, sodium chloride 0.23%, sodium bi-carbonate 1%, vitamin and mineral premix 0.2%, binder 3%) to meet or slightly exceed NRC recommendation (NRC, 1989). The second and third groups were fed the basal diet supplemented with one of two commercial sources of yeast culture providing 15 g/head/day of YC_1 (a vialble culture of *saccharomyces cervisiae* with concentration 2.6×10^4/gm) or 50 g/head/day of YC_2 (a fermented extracted of a vialble culture of *saccaromyces cerevisiae*) as per manufacturers' recommendations. Cows

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Table 1. Ingredients and chemical constituents of basal diet

Ingredient	%DM basis
Alfalfa hay	36.80
Cotton seed	12.06
Maize grain	7.62
Concentrate	39.81
Molasses	3.34
Buffer	0.17
Salt	0.16
Urea	0.04
Chemical analysis	
Dry matter	94.22
Crude protein	17.50
Fat	4.03
ADF	18.60
Ca	1.0
P	0.50
Vitamine A (IU/kg)	10,000 IU/kg
Vitamine D (IU/kg).	1,000 IU/kg
Vitamine E (mg/kg)	20 mg/kg

were fed ad libitum as a group feeding, three times a day, and feed refusals collected and weighted once a daily. Fresh water was freely available, and meter gauges were placed to measure daily water consumption for each group. All cows received control diet for a two weeks preliminary period, followed by the treatment diets for ten weeks during which the animal data were collected. The basal diet was sampled weekly for dry matter determination. Ether extract and crude protein (N×6.25) content were determined according to AOAC (1990). Acid detergent fiber (ADF) was assayed using the method of Van Soest et al. (1991). Dietary minerals including calcium and phosphorous were determined by atomic absorption spectrophotometry procedure (Model PU 9100, Philips Scientific, Cambridge). The cows were machine-milked thrice daily and individual daily milk yields was recorded for all cows. Samples for milk composition analysis were collected from the three daily milkings on two consecutive days every two weeks throughout the experimental period. The samples were analyzed for fat percentage by Gerber method, protein by Kjeldahl method (N×6.38) and total solids (TS) by the Standard Method for the Examination of Dairy Products (Case et al., 1985). Lactose was calculated by difference.

For ammonia-N and volatile fatty acid (VFA) determinations, ruminal digesta were taken from randomly selected ten cows in each group three hours after morning feeding via a stomach tube. Ammonia was determened using MgO method (AOAC, 1990). Volatile fatty acid (VFA) was determined using gas liquid chromatography (Model 404, Pye Unicam, Philips Scientific, Cambridge).

The data were analyzed using the statistical analysis system (SAS, 1995). The data were subjected to the analysis of variance using a general linear model procedure using the following model:

$$Y_{ijk}=\mu+T_j+bW_k+e_{ijk}$$

Where, Y_{ij} is the recorded milk yield and composition of ith cow of the jth treatment, kth week of lactation μ is the over all mean, T_j is the effect of jth treatment (J=1, 2 and 3), b regression coefficient of milk yield on week of lactation, W_k is the effect of week of lactation (k=1 to 10) and e_{ijk} is the error term.

RESULTS AND DISCUSSION

Cows fed diets supplemented with yeast culture tended to decrease their dry matter intake (table 2). Because of group feeding of cows we couldn't analyzing it statistically. This result agrees with Blauwiekel et al. (1995) who reported that dry matter intake decreased by an amount of 0.6 kg in cows consuming yeast effluent. However, other researchers (Rameshwar et al., 1998; Robinson and Garrett, 1999) reported that the addition of yeast culture to the total mixed ration did not affect daily dry matter intake. In contrast, dry matter intake was reported to increase in response the addition of yeast culture to the diets (Erasmus et al., 1992; Dann et al., 2000). Water consumption tended to be higher for cows receiving diets supplemented with yeast culture.

The average daily milk yield was 21.54, 21.96 and 22.84 kg/head/d for control diet, YC_1 and YC_2 respectively (table 2), indicating that milk yield increased with cows receiving yeast-supplemented diets, and that the highest milk yield was that of cows fed diet supplemented with YC_2 ($p<0.05$). Also, the average daily milk yield tended to be higher in cows fed diet supplemented with YC_1 than control cows, even though this increase did not attain a statistically

Table 2. Effect of yeast culture supplementation on dry matter intake, milk yield and production efficiency (mean±SE)

Item	Control	YC_1	YC_2
DMI (kg/h/d)	24.56^{a} ±0.015	20.45^{b}±0.015	21.16^{c}±0.01
Water consumption (l/d)	100.690^{a}±0.038	130.390^{b}±0.039	128.734^{b}±0.038
Milk yield (kg/h/d)	21.538^{a}±0.275	21.959^{a}±0.287	22.837^{b}±0.303
4% FCM (kg/h/d)	18.18^{a}±0.464	17.89^{a}±0.479	20.98^{b}±0.452
PE 4% FCM/DMI	0.740^{a}±0.021	0.875^{b}±0.022	0.996^{c}±0.024

Different supscripts in same raw show significant differences ($p<0.05$).

significant level. These results support previous studies by Williams and Newbold (1990), Erasmus et al. (1992) and Piva et al. (1993) indicating that cows provided with dietary yeast supplements produced more milk than non-supplemented cows. However, the present data contrast those of other workers e.g., Soder and Holden (1999) and Dann et al. (2000) who were unable to find the supplemontry effect yeast culture on milk yield of dairy cows. These discrepancies could well be associated with differences in breeds, stage of lactation, type of forage given, the source of the yeast culture and feeding strategy in these different studies.

The average 4% FCM for the control, YC_1 and YC_2 groups were 18.2, 17.9 and 21.0 kg/d, indicating once more a significantly ($p<0.05$) higher 4% FCM in cows fed YC_2-supplemented diets than either cows given the YC_1-supplement or control diet. While Piva et al. (1993) reported that cows fed yeast culture produced more 4% FCM (23.6 vs 21.6 kg/d) than cows fed the control diet, others (Blauwiekel et al., 1995) reported that 3.5% FCM were not significantly affected by yeast culture addition. The conditions under which the responses of dairy cows to yeast culture are difficult to identify given difference in management procedures, climate and dietary conditions as well as the yeast source. In the present study, production efficiency in terms of 4% FCM/DMI was increased significantly ($p<0.05$) with cows fed diet supplemented with yeast culture. The percentages of milk fat, protein, lactose, total solids and solids not fat were also significantly higher ($p<0.05$) in cows fed on diets supplemented with yeast culture than the control group (table 3). The highest milk fat percentage ($p<0.05$) was recorded in cows fed YC_2, whereas other milk constituents including protein, lactose, total solids and solids not fat were significantly ($p<0.05$) higher in cows fed diet supplemented with YC_1 than those were fed YC_2 or the control group. The control diet showed the lowest values for all of these parameters. Our results are concordant with those of Harris and Webb (1990) who reported increased milk fat and milk protein percentages in cows supplemented with yeast culture, but some investigators (Piva et al., 1993; Robinson 1997; Soder and Holden 1999; Dann et al., 2000) have reported no significant change in milk composition following intake of supplemented yeast culture. Disagreement of these results could be due to different management practices and variability in provoking environmental conditions associated these trials.

In the present study, daily fat, protein, lactose, total solids and solids not fat yields (table 4) were higher in cows receiving diets supplemented with yeast culture than cows receiving control diet, thus confirming the results of Robinson (1997) and Robinson and Garrett (1999) that cows tended to produce more milk and numerically more milk components in response to supplementation of their rations with yeast culture.

We have also found that the mean concentration of rumen ammonia nitrogen decreased significantly ($p<0.05$) after yeast supplementation, being 16.7 vs 14.6 and 13.0 mg NH_3-N/100 ml ruminal liquor (R.L) for control, YC_1 and YC_2 groups, respectively (table 5). These results agree with those of Erasmus et al. (1992) and Piva et al. (1993) who reported a much lower concentration of rumen ammonia-N with yeast culture supplemented diets. The reduced concentration of ammonia in the rumen appear to be the result of increased incorporation of ammonia into microbial protein which may, in turn, be the direct result of stimulated microbial activity (Williams and Newbold, 1990). Although Adams et al. (1981) were unable to show that yeast culture supplementation affects ammonia level in the rumen, other workers have reported a significant increase in ammonia levels of the rumen following dietary yeast supplementation (Steckley et al., 1979; Blauwiekel et al., 1995).

Ruminal VFA patterns acetateto propionate ratio did not show significant changes (table 5). This finding agree with those results reported by William et al., (1991) and Erams et al. (1992).

In conclusion, the present study indicated that the addition of yeast culture significantly increased milk yields of lactating cows.

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Table 3. Effect of yeast culture supplementation on milk composition (mean±SE)

Item	Control	YC_1	YC_2
Fat (%)	2.882^{a}±0.074	2.887^{a}±0.076	3.179^{b}±0.074
Protein (%)	3.415^{a}±0.009	3.888^{b}±0.009	3.795^{c}±0.009
Lactose (%)	4.255^{a}±0.109	5.117^{b}±0.115	4.382^{a}±0.107
Total solids (%)	11.569^{a}±0.035	12.834^{b}±0.036	12.211^{c}±0.035
Solids not fat (%)	8.423^{a}±0.109	9.707^{b}±0.116	8.918^{c}±0.108

Different subscripts in same raw show significant differences ($p<0.05$).

Table 4. Effect of yeast culture supplementation on milk fat. Protein lactose, milk total solids and solids not fat yield (mean±SE)

Item	Control	YC_1	YC_2
Milk fat (g/h/d)	620.725^{a}±21.933	633.956^{a}±22.680	725.988^{b}±24.382
Milk protein (g/h/d)	735.523^{a}±0.010	853.766^{b}±0.010	866.664^{c}±0.0100
Milk lactose (g/h/d)	916.44^{a}±0.034	1123.64^{b}±0.036	1000.717^{b}±0.036
Milk total solids (g/h/d)	2491.73^{a}±0.034	2818.22^{b}±0.036	2788.626^{b}±0.036
Milk solids not fat (g/h/d)	1814.145^{a}±0.052	2131.56^{b}±0.054	2036.604^{b}±0.056

Different subscripts in the same raw show significant differences ($p<0.05$).

Table 5. Effect of yeast culture supplementation on ruminal fermentation characteristics (mean± SE)

Item	Control	YC_1	YC_2
NH_3-N, mg/100 ml	16.707^{a}±0.468	14.607^{b}±0.468	13.020^{c}±0.468
Acetate, mol/100 mol	63.402^{a}±1.885	63.293^{a}±1.885	63.250^{a}±1.885
Propionate, mol/100 mol	19.676^{a}±0.725	21.319^{a}±0.725	20.682^{a}±0.725
ISO butyrate, mol/100 mol	1.045^{a}±0.115	0.798^{a}±0.115	0.937^{a}±0.115
Butyrate, mol/100 mol	12.125^{a}±0.748	11.331^{a}±0.748	10.732^{a}±0.748
ISO valerate, mol/100 mol	1.528^{a}±0.108	1.128^{b}±0.108	1.441^{ab}±0.108
valerate, mol/100 mol	1.468^{a}±0.103	1.699^{a}±0.103	1.626^{a}±0.103
Acetate: propionate	3.222^{a}±0.161	2.969^{a}±0.161	3.058^{a}±0.161

Different subscripts in the raw show significant differences ($p<0.05$).

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