# 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 $2.6\times10^4$/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 $\mu$ 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 ammionia 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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## REFERENCES

Adams, D. C., M. L. Galyean, H. E. Kiesling, J. D. Wallace and M. D. Finkner. 1981. Influence of viable yeast culture, sodium bicarbonate and monensin on liquid dilution rate, rumen fermentation and feedlot performance of growing steers and digestibility in lambs. J. Anim. Sci. 53:780-789.

AOAC, Association of Official Analytical Chemists. 1990. Official Methods of Analysis. 15th ed., Washington. DC.

Blauwiekel, R., K. A. Loney and E. Riley. 1995. Baker's yeast effluent as a liquid feed for dairy cows and heifers J. Dairy Sci. 78:397-403.

Case, R. A., A. L. Bradley, Jr. and R. R. Williams. 1985. Chemical and physical methods. In: Standard Method for the Examination of Dairy Products. (Ed. G. H. Richardson). Am. Publ. Health Assoc. 15th ed. Washington, DC. pp. 327-404.

Dann, H. M., J. K. Drackley, G. C. McCoy, M. F. Hutjens and J. E. Garrett. 2000. Effects of yeast culture (Saccharomyces cerevisiae) on prepartum intake and postpartum intake and milk production of Jersey cows. J. Dairy Sci. 83:123-127.

Dawson, K. A., K. A. Newman and J. A. Boling. 1990. Effect of microbial supplements containing yeast and lactobacilli on roughage-fed ruminal microbial activities. J. Anim. Sci. 68:3392-3398.

Erasmus, L. J., P. M. Botha and A. Kistner. 1992. Effect of yeast culture supplement on production, rumen fermentation and duodenal nitrogen flow in dairy cows. J. Dairy Sci. 75:3056-3065.

Harris, B., Jr. and D. W. Webb. 1990. The effect of feeding a concentrated yeast culture product to lactating dairy cows. J. Dairy Sci. 73(Suppl. 1):266(Abstr.).

Mir, Z. and P. S. Mir. 1994. Effect of the addition of live yeast (Saccharomyces cerevisiae) on growth and carcass quality of steers fed high forage or high grain diets and on feed digestibility and in situ degradability. J. Anim. Sci. 71:537-545.

NRC. 1989. Nutrient Requirements of Dairy Cattle- 6th rev. ed. Natl. Acad. Sci. Washington, DC.

Panda, A. K., R. Singh and N. N. Pathak. 1995. The effect of dietary inclusion of yeast cell suspension on growth performance of crossbred calves. J. App. Anim. Res. 7:195-200.

Piva, G., S. Belladonna, G. Fisconi and F. Ssicbaldi. 1993. Effect of yeast on dairy cows performance, ruminal fermentation, blood components, and milk manufacturing properties. J. Dairy Sci. 76:2717-2722.

Rameshwar Singh, L. C. Chaudhary, D. N. Kamra and N. N. Pathak. 1998. Effect of dietary supplementation with yeast cell suspension (Saccharomyces cerevisiae) on nutrient utilization and growth response in crossbred calves. Asian-Aus. J. Anim. Sci. 11:268-271.

Robinson, P. H. 1997. Effect of yeast culture (Saccharomyces cerevisiae) on adaptation of cows to diets postpartum. J. Dairy Sci. 80:1119-1125.

Robinson, P. H. and J. E. Garrett. 1999. Effect of yeast culture (Saccharomyces Cerevisiae) on adaptation of cows to postpartum diets and on lactational performance. J. Anim. Sci. 77:988-999.

Rouzbehan, Y., H. Galbraith, J. A. Rooke and j. G. Parrot. 1994. A note on the effects of dietary inclusion of yeast culture on growth and ruminal metabolism of lambs given diets containing unground pelleted molasses, dried sugarbeet pulp and barley in various proportions. Anim. Prod. 59:147-150.

SAS Institute, Inc. 1995. SAS. For linear models: a guide to the ANOVA and GLM procedures. SAS. Inst. Inc., Cary, NC.

Soder, K. J. and L. A. Holden. 1999. Dry matter intake and milk yield and composition of cows fed yeast prepartum and postpartum. J. Dairy Sci. 82:605-610.

Steckley, J. D., D. G. Grieve, G. K. Macleod and E. T. Moran. 1979. Brewer`s yeast slurry. II. A source of supplementary protein for lactating dairy cattle. J. Dairy Sci. 62:947-953.

Van Soest, P. J., T. 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.

Wallace, R. J. and C. J. Newbold. 1993. Rumen fermentation and its mainpulation: The development of yeast cultures as feed additives. In: Biotechnology in Feed Industry (Ed. T. P. Lyons). Alltech Technical publications Nicholasville, Kentucky. pp. 172-192.

Williams, P. E. V. 1989. The mode of action of yeast culture in ruminal diets: a review of the effect on rumen fermentation patterns. In: Biotechnology in the Feed Industry. Alltech Tech. Publ. Nicholasville, KY.

Williams, P. E. V. and Newbold. 1990. Rumen probiosis: The effects of novel microorganisms on rumen fermentation and ruminal productivity. In: Recent Advances in Animal Nutrition (Ed. W. Haresign and D. J. A. Cole). Butterworths. London, England.

Williams, P. E. V., C. A. G. Tait, G. M. Innes and C. J. Newbold. 1991. Effects of the inclusion of yeast culture (Saccharomyces cerevisiae plus growth medium) in the diet of dairy cows on milk yield and forage degradation and fermentation patterns in the rumen of steers. J. Anim. Sci. 69:3016-3026.