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RESPONSES OF FEEDLOT LAMBS TO LIVE-YEAST CULTURE DIETARY SUPPLEMENTATION

(With 4 Tables)

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إستجابة حملان التسمين للغذاء المضاف إليه مستنبت الخميرة

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أجريت هذه الدراسة على عدد ١٦ من حملان الصوف الخشن متوسط أعمارها ٨ر٨ شهراومتوسط أوزانها ٥ر٢٥ كجم. وقد تم تقسيم هذه الحملان إلى مجموعتين ، أعتبرت الأولى مجموعة ضابطة (C)حيث تم تغذيتها على عليقة أساسية فقط دون إضافة خميرة أما المجموعة الثانية (YC) فقد أضيف إلى عليقتها الأساسية مستنبت الخميرة بنسبة ٥ ٪ (على اساس المادة الجافة). وقد إستمرت التجربة لمدة ٨٤ يوما سبقتها فترة تمهيدية إستغرقت ١٤ يوماً لأقلمة الحملان على الغذاء المستخدم.

تمت مقارنة المادة الجافة المستهلكة لحيوانات المجموعتين خلال فترة التجربة (٨٤ يوما) ووجد أنها نقصت بنسبة ٤ ٪ فى الحملان التى تناولت مستنبت الخميرة عنها فى المجموعة الضابطة وبلغت ذروة هذا النقص (P<.01) فى الفترة بين ٥٧ – ٧٠ يوما من التجربة (١٢ ٪). وقد وجد أن معدل النمو اليومي كان متماثلا فى المجموعتين (١٣٥ جم/ يوم). وقد وجد أن الكفاءة التحويلية (الزياة فى الوزن / الغذاء المأكول) لم تختلف معنويا ولكن كانت تميل إلى الزيادة فى الحملان التى تناولت خميرة (١١٥ر) بالمقارنة بالمجموعة الضابطة (١٠٤ر).

عند نهاية التجربة وجد أن مستوى الجلوكوز فى مصل الحملان التى تناولت خميرة كان يزيد ٢٣ ٪ (٩ر٨٦ مقابل ٩ر٧٠ جم/ ١٠٠ مل – P<0.05) والجليسريدات الثلاثية تزيد ٢٩ ٪ (٣ر٧٥ مقابل ٢ر٥٨ مجم/ ١٠٠ مل – P<0.06) بالمقارنة بالمجموعة الضابطة. أما مستوى الكوليسترول ، البروتين الكلى ، الالبيومين ، الجلوبيولين ، نيتروجين اليوريا فى مصل الدم فلم يختلف معنويا نتيجة المعاملة بالخميرة.

يتضح من هذه الدراسة أن اضافة مستنبت الخميرة بنسبة ٥ر ٪ من المادة الجافة لغذاء حملان التسمين يمكن أن يؤدى الى زيادتها فى الوزن بمعدل يماثل تلك الحملان التى لم تأخذ خميرة ولكن بكمية من الغذاء أقل منها مما يؤدى الى زيادة العائد الاقتصادى.

SUMMARY

Siteen coarse-wool lambs (age 8.8 mo; BW 25.5 kg) were divided into two groups: a control group (C) with no yeast culture in the basal diet, and a supplemented group (YC) recieving 0.5% yeast culture in the basal diet on dry matter (DM) basis. The trial included 14 d adjustment period and 84 d experimental period. Along the experimental period, DM intake was decreased by 4% in yeast culture-fed lambs (1204 vs 1253 g/d), but the highest decrease (12%) was recorded between 57 and 70 d (1340 vs 1519 g/d, p <0.01). Mean average daily gain (ADG) was the same for both groups (135 g/d). feed conversion efficiency (gain/ feed) did not differ significantly, in spite of slight increase in yeast culture-fed lambs (0.115) compared with control ones (0.104). At the end of the trial, lambs fed yeast culture had 23% more serum glucose (86.9 vs 70.9 mg/dl, p<0.05) and 29% more triglycerides (75.3 vs 58.2 mg/dl, p<0.06) than controls.Serum cholesterol, total protein, albumin, globulin and urea nitrogen concentrations did not differ significantly between treatments (p<0.10). it was concluded that feedlot lambs supplemeted with 0.5% yeast culture in their diet could attain the same gain with less feed than the unsupplemented control lambs.

(Key Words: Sheep, Yeast, Performance, Blood).

INTRODUCTION

The addition of live yeast culture to the diet of ruminants resulted in increased dry matter (DM) intake in some studies *(ADAMS et al., 1981 and WILIAMS et al., 1991).* Live weight gain of early weaned calves was also increased as a result of yeast culture feeding *(HUGHES, 1988).* Some other studies, however, revealed no significant effects of yeast culture feeding on DM intake, milk yield and milk composition of dairy cows *(QUINONEZ et al., 1988 and ARAMBEL & KENT, 1990)* as well as feed conversion efficiency of steers *(ADAMS et al., 1981).*

The effects of yeast culture are mediated through its ability to modify ruminal fermentation mechanisms. *HARRISON et al. (1988) and WILLIAMS et al. (1991)* reported that yeast culture decreased the ratio of acetate to propionate in the

rumen without affecting total volatile fatty acids (VFA) production. *MALCOLM and KIESLING (1990)* found a decrease in the molar proportions of butyrate due to yeast culture feeding. In addition, growth of cellulytic bacteria *(HARRISON* et al., *1988; DAWSON* et al., 1990) and rate of forage degradation were increased in yeast culture-fed animals. Data on the effects of yeast culture feeding on serum metabolites are lacking.

The objectives of this trial were to evaluate the effects of including yeast culture in the diet of feedlot lambs on their performance and to examine changes in serum metabolites associated with yeast culture feeding.

MATERIAL and METHODS

This trial was initiated on July 1, 1991 in the Experimental Farm of the Department of Animal Production to examine the effects of feeding 0.5% live-yeast culture on performance besides the changes in some selected serum metabolites of feedlot lambs. This level was determined on the basis of a study reported by *KOBEISY and IBRAHIM (1991)* in which they found, under similar conditions, that 0.5% yeast culture in the diet of water buffaloes increased ($P < 0.05$) milk protein percentage and tended to increase butterfat percentage compared with either those receiving no yeast culture or those receiving 1% yeast culture.

Sixteen coarse-wool lambs of Saidi breed (a breed originated in Upper Egypt) of both sexes were utilized in this study. Average age of lambs at the start of the trial was 8.8 $\pm$ 0.11 mo and average BW was 25.5 $\pm$ 1.0 Kg. Lambs were divided into two groups of eight animals each. The control group (C) was fed a basal diet with no yeast culture and the treated group was fed the basal diet with 0.5% yeast culture on dry matter (DM) basis.

The basal diet was commercially purchased and consisted of wheat bran (40.5%), cottonseed meal (10%), soybean meal (2%), molasses (9%), corn (12%), rice hulls (7.5%), flax straw (14%), limestone (3.5%) and mineralized salt (1.5%) on DM basis. Chemical analysis and a conventional digestion trial were conducted to evaluate the basal diet and results are shown in Table 1. Lambs of each group were randomly assigned to three pens (i.e. 3, 3 and 2 lambs per pen/treatment). Lambs were allowed a 14-d adjustment period followed by a 84-d experimental period. Feed was offered to lambs ad libitum and refusals were recorded daily over the 84-d experimental period. Lambs had free accesss to water. Dry matter intake per pen was obtained and average daily DM intake per head was calculated.

Body weights were obtained (after an overnight fast) every fortnight throughout the experimental period. Average daily gain (ADG) and feed efficiency (Kg gain/Kg DM intake) were calculated.

Blood samples were collected from all lambs at selected days (15, 57 and 84 d) of the experimental period. During each of these days blood samples were collected at 0900 by jugular venipuncture using a clean dry plastic syringe and then transferred to centrifuge tubes and allowed to clot at room temperature. Serum was then separated by centrifugation at 3000 rpm for 15 min. Serum was subsequently decanted into glass vials and stored at -20 °C until it was analyzed. Serum glucose, cholesterol, triglycerides, total protein, albumin concentrations (globulin was obtained by difference) using assay kits supplied by bioMerieus, France and serum urea nitrogen concentration was determined using assay kits of Diamond Diagnostic, Egypt.

Data were anlayzed using general linear model (GLM) procedures of *SAS (1987)* for personal computers. Effects of treatments on D.M. intake, ADG and feed efficiency (gain/feed) were analyzed on a pen basis and effects on serum constituents were analyzed on individual animal basis by split-plot analyses of variance for repeated measures *(GILL and HAFS, 1971)*. Treatments were included in the main plot and time periods as well as treatment x period interaction were included in the sub-plot. Treatment effects were tested against pen (treatment) or animal (treatment), whereas period effects and the interaction were tested against the residual error. Because treatment x period interactions were detected with some variables, treatment effect were also examined within time periods by one-way ANOVA *(STEEL and TORRIE, 1980)*.

RESULTS

Lamb Performance:

Means of feed intake (Table 2) in the two treatment groups increased gradually with time until almost the end of the trial. A consistent decrease in feed intake due to yeast culture feeding was noted over the course of the experiment, but differences were significant only between d 57 and 70 of the experiment. During this period, yeast culture lambs ate 179 g/head per day (about 12%) less than control lambs ($P < 0.01$). However, the decrease in feed intake over the whole period averaged 49 g/head per day (1204 vs 1253) i.e about 4% only.

Average daily gain was low in the two groups during the first and last 2 wk-periods of the trial (Table 2) compared to

Table 1. Chemical Composition and Digestible Nutrients of the Basal Diet

Item	Nutrient[a] %	Digestion coefficient %	Digestible Nutrients %
Dry matter	91.0	68.6	62.4
Crude protein	13.1	63.4	8.3
Crude fat	1.3	79.3	1.0
Crude fiber	10.8	19.6	2.1
NFE	58.1	85.7	49.8
Ash	7.7		
Organic matter	83.3	73.5	61.2
TDN%			62.0
Digestible energy (DE), Mcal/kg			2.73[b]

[a]As fed basis.
[b]Calculated as 1 kg TDN = 4.4 Mcal DE (NRC, 1985).

Table 2. Feed Intake, Average Daily Gain and Feed Efficiency of Lambs Fed Control and Yeast Culture Diets.

Period (days)	feed intake[a] (g/head/d)			Average daily gain (g/head/d)			Feed efficiency (gain/feed)		
	Treatment[b,c,d]			Treatment[b,c,d]			Treatment[b,c,d]		
	C	YC	SE	C	YC	SE	C	YC	SE
0 -14	1040	1032	31	40	73	32	0.041	0.071	0.030
15-28	1108	1057	53	214	172	39	0.193	0.162	0.032
29-42	1161	1146	62	150	192	20	0.092	0.168	0.017
43-56	1209	1187	16	177	158	39	0.146	0.134	0.033
57-70	1519[e]	1340[f]	30	196	167	51	0.131	0.125	0.037
71-84	1480	1463	43	36	47	20	0.024	0.032	0.013
0-84	1253	1204	31	135	135	18	0.104	0.115	0.012

[a]Dry matter basis.
[b]Values are least-squares means of three replicate pens/treatment.
[c]SE = Standard error of least-squares means.
[d]C = Control, basal diet; YC = basal + 0.5% live-yeast culture D.M. basis.
[e,f]Means are different (P<0.01).

other periods. Lambs receiving yeast culture exceeded the control at the begining, the middle and the end, whereas the control exceeded yeast culture lambs during the other three periods, which lead to both treatment groups having the same daily gain mean averaged across the whole experimental period.

Changes in feed efficiency means (gain/feed) coincided with those of average daily gain (Table 2). Feed conversion efficiency was not significantly affected by treatment, but the overal means tended to be higher in yeast culture-treated lambs (11.54%) compared with controls (10.44%) because they achieved the same gain but with less feed than controls.

Serum metabolites:

Serum glucose level (Table 3) remained unchanged over the course of the experiment ($P > 0.10$) when averaged across treatments (79.8, 79.8 and 78.9 $\pm$ 2.9 mg/dl at days 15, 57 and 84, respectively). The overall mean of serum glucose (79.5 $\pm$ 1.7 mg/dl) falls within ovine range reported by *HALLFORD and GALYEAN (1982); DUNCAN and PRESSE (1986) and SHETAEWI and ROSS (1990).* Comparable treatment means of serum glucose concentration were recorded at d 15 and d 57 of the experimental period (Table 3). But at the end of the trial (d 84) yeast culture lambs had about 23% more glucose in the serum than conrol lambs (86.9 vs 70.9 mg/dl). For the whole experimental period, yeast culture lambs had about 7.5% more serum glucose than control lambs.

The overall mean of serum cholesterol concentration was 111.2 $\pm$ 5.7 mg/dl (Table 3). Serum cholesterol tended to decrease with time in the control group and to increase with time in yeast culture-fed lambs. However, neither the effect of treatment nor the interaction between treatment and time was significant. Treatment overall means showed a slight increase in favor of the control group (115 vs 107 $\pm$ 0.06 mg/dl).

Triglycerides concentrations obtained in the present study (Table 3) agree with those obtained by *HALLFORD and GALYEAN (1982)* in ovine serum pool (54.2 mg/dl), but were higher than those obtained by *SHETAEWI and ROSS (1990)* in ewe lambs (17.7-21.6 mg/dl). The effect of sampling day on triglycerides concentration was highly significant ($P < 0.001$). Averaged across tratments, triglycerides concentration was 48.8 mg/dl at d 15, decreased by about 50% at d 57 and increased to the highest level (66.5 mg/dl) at the end of the test period. No explanation is available, at present, for the decrease in triglycerides concentrations at d 57. However, means were still within normal range reported by *SHETAEWI and ROSS (1990).* Inclusion of yeast culture in the diet resulted in 29% increase

in serum triglycerides concentration at the end of the trial (75.3 vs 58.2 mg/dl for yeast culture and cotrol groups, respectively). The pattern of change during the course of the experiment in both treatments was similar, but the difference ($P < 0.06$) noted at the last sampling day resulted primarily from the magnitude of change; being greater in yeast culture-fed lambs compared with the controls.

The overall means of serum total protein, albumin and globulin concentrations were 7.25 ± 0.08, 3.47 ± 0.05 and 3.78 ± 0.06 mg/dl, respectively (Table 4). Serum total protein, although did not differ significantly between treatments, tended to be consistently higher in the control than yeast culture-fed lambs. This slight increase (4%) was attributed mainly to globulin not to albumin because both treatment groups had comparable serum albumin means (Table 4).

DISCUSSION

Lamb Performance:

Studies on the effect of yeast culture on feed intake and animal performance are quite variable. *ADAMS ET AL. (1981)* found that DM intake of steers fed a diet containing 1.85% viable Yeast culture was greater ($P < 0.05$) than that of controls; but feed efficiency was not improved by yeast culture feeding. *HUGHES (1988)* reported that inclusion of yeast culture in the diet of early-weaned calves (age 1 wk, BW 52 Kg) at levels of 2 g/Kg starter and 1 g/kg rearer for 84 days, significantly increased live-weight gain over the control group (0.737 vs 0.831 Kg/d, respectively). *ARAMBEL and KENT (1990)* found that dairy cows receiving 90 g/d of Yeast culture in early lactation did not differ from controls in DM intake, digestibility and milk production and composition. *QUINONEZ et al. (1988)* found that DM intake and milk yield were unaffected by the addition of yeast culture (1.36 Kg/ton) in the diet of Holstein cows. Recently, *WILLIAMS et al. (1991)* found that supplementation with yeast culture (10 g/d) increased DM intake of dairy cows by a mean of 1.2 Kg/d; no significant effect was found on live weight changes of cows but there was a tendency for the live weight gains by cows given yeast culture to be greater than that by control cows. Differences in diet composition and in levels of yeast culture may account for these variabilities in results. This assumption is based, in part, on the findings of *WILLIAMS et al. (1991)* that responses of dairy cows to yeast culture were greatest in diets containing the higher level of rapidly fermentable carbohydrates. They reported that addition of yeast culture

Table 3. Serum Glucose, Cholesterol and Triglycerides Concentrations in Lambs Fed Control and Yeast Culture Diets

Day of Trial	Glucose mg/dl			Cholesterol mg/dl			Triglycerides mg/dl		
	Treatment[a,b,c]			Treatment[a,b,c]			Treatment[a,b,c]		
	C	YC	SE	C	YC	SE	C	YC	SE
15	78.7	81.0	4.7	122	88	21	48.8	48.5	10.0
57	80.2	79.4	5.0	112	105	08	21.5	22.9	03.5
84	70.9[d]	86.9[e]	4.7	111	129	08	58.2[f]	75.3[g]	05.9
Mean	76.6	82.4	1.7	115	107	06	42.8	49.8	02.6

[a]Values are least-squares means of 8 lambs/treatment.
[b]SE = Standard error of least-squares means.
[c]C = Control, basal diet; YC = basal + 0.5% live-yeast culture D.M. basis.
[d,e]Means are significantly different ($P<0.05$).
[f,g]Means tended to be different ($P<0.06$).

Table 4. Serum Total Protein, Albumin, Globulin and Urea Nitrogen (BUN) in Lambs Fed Control and Yeast Culture Diets

Day of Trial	T. protein g/dl			Albumin g/dl			Globulin g/dl			Urea nitrogen mg/dl		
	Treatment[a,b,c]			Treatment[a,b,c]			Treatment[a,b,c]			Treatment[a,b,c]		
	C	YC	SE	C	YC	SE	C	YC	SE	C	YC	SE
15	7.18	6.99	0.35	3.13	3.34	0.17	4.05	3.65	0.27	24.9	20.9	1.9
57	7.22	6.64	0.27	3.54	3.31	0.13	3.68	3.33	0.18	26.3	25.6	2.0
84	7.77	7.68	0.22	3.70	3.79	0.10	4.07	3.90	0.20	21.1	21.8	1.4
Mean	7.39	7.10	0.08	3.46	3.48	0.05	3.93	3.63	0.06	24.1	22.9	0.8

[a]Values are least-squares means of 8 lambs/treatment.
[b]SE = Standard error of least-squares means.
[c]C = Control, basal diet; YC = basal + 0.5% live-yeast culture D.M. basis.

increased rate of hay degradation and the effect was most marked when the diet contained both barely and hay rather than hay alone.

In the present study, the decrease in feed intake in yeast culture-fed lambs compared with controls (Table 2) could be attributed to increased serum glucose level in these lambs (Table 3). Increased glucose level is assumed to increase the degree of satiety according to glucostatic theory for regulation of voluntary feed intake *(GUYTON, 1981 and BEITZ, 1985)*. In addition, increased serum triglycerides concentration in yeast culture lambs might have had an inhibitory effect on feed intake; based on the lipostatic theory of appetite control *(GUYTON, 1981 and BEITZ, 1985)*. The lipostatic theory is believed to be responsible for long term regulation of feed intake and proposes some fat metabolites of unknown nature act in the same manner as glucose and amino acids to cause a negative feedback regulatory effect on feeding.

The tendency of yeast culture to improve efficiency of feed utilization (Kg gain/kg feed = 0.115 for yeast culture and 0.104 for control lambs; Table 2) could be due to increased ruminal propionate at the expense of acetate (*HARRISON* et al., *1988 and WILLIAMS* et al., *1991)*; propionate is used more efficiently than acetate by the ruminant animal, possibly by reducing heat increment *(BLAXTER and WAINMAN, 1964)*, sparing amino acids used normally for gluconeogenesis *(LENG* et al., *1967 and REILLY & FORD, 1971)* and stimulating body protein synthesis *(POTTER* et al., *1968 and ESKELAND* et al., *1974)*. On the other hand, yeast culture could improve efficiency of feed utilization by increasing rate of cellulolysis. *WILLIAMS* et al. *(1991)* indicated that yeast culture increases the initial rate of degradation of fibrous materials in the rumen as a result of elevated ruminal pH via reductions in lactic acid concentration.

Yeast culture feeding did not improve growth rate of lambs in the present study (Table 2) probably because 1) growth rate in Egyptian breeds is slow compared with foreign breeds of sheep and 2) growth rate of lambs at this stage (8.8 mo old) is slower than that at earlier stages.

Serum Metabolite Changes:

Studies on the effect of yeast culture feeding on serum metabolites are lacking. In the present trial, the increase in serum glucose level in yeast-fed lambs (Table 3) could be explained on the basis of previous findings of *HARRISON* et al. *(1988) and WILLIAMS* et al. *(1991)* that yeast culture feeding decreases the ratio of acetate to propionate in the rumen. Much

of propionate produced in the rumen is absorbed and transformed to glucose in the liver. Higher levels of glucose is then released into the peripheral circulation. *BERGMAN (1983)* reported that propionate is a potent glucogenic compound and can account for about two-thirds of the total glucose produced in animals fed large amounts of concentrates.

The increase in triglycerides concentration in yeast culture compared with control lambs could be due to increased glucose availability in yeast culture lambs (Table 3). Glucose is essential for triglycerides synthesis because it forms alpha glycerophosphate which is the specific precursor of glycerol with which fatty acids are esterified for triglycerides formation *(BERGMAN, 1983)*. In addition glucose furnishes NADPH which is required as a reducing agent in the synthesis of long chain fatty acids. In general, the increases in serum levels of both glucose and triglycerides indicate that yeast culture lambs were in better condition compared with control lambs.

In conclusion, feedlot lambs supplemented with 0.5% yeast culture in their diet could attain the same gain with less feed than the unsupplemented control lambs, which is economically important especially in countries, like Egypt, suffering from lack of feeding resources.

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REFERENCES

Adams, D.C.; Galyean, M.L.; Kiesling, H.E.; Wallace, J.D. and Finkner, M.D. (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.

Arambel, M.J. and Kent, B.A. (1990): Effect of yeast culture on nutrient digestibility and milk response in early to midlactation dairy cows. J. Dairy Sci. 73: 156-1563.

Beitz, D.C. (1985): Physiological and metabolic systems important to animal growth: An overview. J. Anim. Sci. 61 (Suppl. 2): 1-20.

Bergman, E.N. (1983): The pools of cellular nutrients: Glucose. In: Riis, P.M. (Ed.) Dynamic Biochemistry of Animal Production. pp 173-196. Elsevier, Amsterdam.

Blaxter, K.L. and Wainma, F.W. (1964): The utilization of the energy of different rations by sheep and cattle for maintenance and for fattening. J. Agr. Sci. (Camb.) 63: 113-128.

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

Duncan, J.R. and Prasse, K.W. (1986): In: Veterinary Laboratory Medicine (2nd Ed.). Iowa State Univ. Press. Ames, Iowa.

Eskeland, B.; Pfander, W.H. and Preston, R.L. (1974): Intravenous energy infusion in lambs: Effects on nitrogen retention, plasma free amino acids and plasma urea nitrogen. Br. J. Nutr. 31: 201.

Gill, J.L. and Hafs, H.D. (1971): Analysis of repeated measurements of animals. J. Anim. Sci. 33: 331-336.

Guyton, A.C. (1981): Dietary balances, regulation of feeding; obestity and starvation. In: Textbook of Medical Physiology, 6th Ed. pp 899-906. Saunders, Philadelphia.

Hallford, D.M. and Galyean, M.L. (1982): Serum profiles in fine-wool sheep. Bovine Practice 3(4): 26-32.

Harrison, G.A>; Hemken, R>W.; Dawson, K.A.; Harmon, R.J. and Barker, K.B. (1988): Influence of addition of yeast culture supplement to diets of lactating cows on ruminal fermentation and microbial popultions. J. Dairy Sci. 71: 2967-2975.

Hughes, J. (1988): The effect of a high-strengh yeast culture in the diet of early-weaned calves. Anim. Prod. 46: 526. (Abstr.).

Kobeisy, M.A. and Ibrahim, E.M. (1991): Effect of live yeast culture in lactating buffaloe's ration on milk yield, composition and some technological properties. Assiut J. Agr. Sci. 22(3): 151-163.

Leng, R.A.; Steel, J.W. and Luick, J.R. (1967): Contribution of propionate to glucose synthesis in sheep. Biochem. J. 103:785.

Malcolm, K.J. and Kiesling, H.E. (1965-1970): Effects of whole cottonseed and live yeast culture on ruminal fermentation and fluid passage rate in steers. J. Anim. Sci. 68.

NRC. (1985): Nutrient Requirements of sheep (6th Ed.). National Academy of Science. National Research Councel, Washington, D.C.

Potter, E.L.; Purser, D.B. and Clin, J.H. (1986): Effects of various energy sources upon plasma free amino acids in sheep. J. Nutr. 95: 665.

Quinonez, J.A.; Bush, L.J.; Nalsen, T. and Adams, G.D. (1988): Effect of veast culture on intake and production of dairy cows fed high wheat rations. J. Dairy Sci. 71 (Suppl. 1): 275 (Abstr.).

Reilly, P.E.B. and Ford, F.J.H. (1971): The effects of dietary contents of protein on amino acid and glucose production and contribution of amino acids to gluconeogenesis in sheep. Br. J. Nutr. 26: 24.

SAS. (1987): SAS/STAT Guide for Personal Computers (Version 6 Ed.). SAS Inst., Inc., Cary, N.C.

Shetaewi, M.M. and Ross, T.T. (1990): Effect of lasalocid on performance, serum chemistry and hormone profiles of feedlot lambs. SID Sheep Res. J. 6(3): 39-46.

Steel, R.G.D. and Torrie, J.H. (1980): Principles and Procedures of Statistics: A Biometrical Approach (2nd Ed.). McGraw-Hill Book Co., New York.

Williams, P.E.V.; Tait, C.A.G.; Innes, G.M. and Newbold, C.J. (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.