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Effect of In-activated and Dried Yeast on Productive Performance of Barki Lambs

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ABSTRACT

The present study aims to evaluate the effets of in-activated and dried yeast on Barki lambs. For that purpose thirty growing Barki male lambs (averaged 27 kg body weight, 9 months old) were divided into 3 groups (10 in each) according to live body weight for 90 days trial to study the effects of yeast supplementation on digestibility, growth performance, blood and rumen liquor parameters. The treatments contained 0 yeast (T1), 5 g h^{-1} day^{-1} either of inactivated yeast (T2) or dried yeast (T3). Results showed that the digestibilities of most nutrients and fiber fraction, nutritive value as TDN, total and average daily gain and feed conversion efficiency were improved by supplementation of inactivated yeast, followed by dried yeast compared to control. However, no differences ($p<0.05$) were observed in rumen pH and ammonia N. There were any adverse effects on blood parameters due to yeast supplementation. Based on this experiment, yeast supplementation (5 g h^{-1} day^{-1}) especially with inactivated yeast could be recommended to improve growth performance of growing lambs.

Key words: Lambs, digestibility, performance, yeast supplementation

INTRODUCTION

In animal feeding, probiotics such as live yeast are being explored as a substitute of antibiotic feed additives that improves gut media, promotes animal performance and limits excretion of pollutants.

Active yeast supplementation had positive effects on performance of young ruminants through increasing dry matter intake, body weight gain and feed efficiency (Lesmeister *et al*., 2004; Stella *et al*., 2007). Many researchers investigated the mode of action of yeast which could be summarized by: (1) Improvement in rumen development parameters, such as papillae length and width and/or rumen wall thickness (Lesmeister *et al*., 2004); (2) Increasing animal production by increasing the net energy of the ration (Robinson, 1997); (3) Reducing effect on diarrhea (Galvao *et al*., 2005) by stabilization of rumen microbial communities (Chaucheyras-Durand and Fonty, 2001, 2002); (4) Maintaining a higher rumen pH (Bach *et al*., 2007) in ruminants fed high grain ration as a result of increasing lactate utilizing bacteria counts and (5) Production of one or more extracellular compounds which inhibit some pathogenic bacterial strains such as proteases (Comitini *et al*., 2005).

On the other hand, Agarwal *et al*. (2002), Erasmus *et al*. (2005), Mahender *et al*. (2005), Kim *et al*. (2006), Kawas *et al*. (2007) and Tripathi *et al*. (2008) found similar or reduced growth rate compared to the control. The variable and inconsistent results could be attributed to biotic factors such as strain and viability of yeasts and a biotic factors such as nature of the diet and

animal management conditions (Chaucheyras-Durand *et al*., 2008). Nikpiran *et al*. (2013) found that prebiotic (Thepax) has positive effects on performance in Japanese quails.

The objective of this study was to investigate the effects of yeast supplementation either inactivated (Thepax®) or dried yeasts (Yeastmax®) in sheep ration on digestibility, nutritive value, performance, some blood and rumen liquor parameters.

MATERIALS AND METHODS

Experimental animals and ration: Ninety days of growth trial, thirty Barki lambs averaged (27 kg) body weight; 9 months old were divided into 3 groups (10 animals each) according to their live body weight. The experimental groups were offered concentrate feed mixture and clover hay (divided into 70% CFM and 30% roughage) to cover total requirements according to NRC (1985). Animals in the control group T1 were fed clover hay plus concentrate feed mixture (CFM) without additives. While, animals in T2 and T3 group were fed control ration plus inactivated yeast (Thepax®) and dried yeast (Yeastmax®), respectively.

The concentrate feed mixture (CFM) consisted of 65% whole yellow corn, 15% wheat bran, 15% soybean meal, 1.2% premix, 0.8% common salt and 3% limestone.

The commercial inactivated yeast (Thepax®) and dried yeast (Yeastmax®) used in this study were mixed manually with CFM daily at the ratio of 5 g h^{-1} day^{-1}.

Dry yeast Yeastmax® (1×105 CFU g^{-1}) was from Unipharma company, Egypt and the patent new inactivated *Saccharomyces cerevisiae Var. ellipsoideus Doxal strain's* Thepax®, (1×10^{10} CFU g^{-1}) was from Doxal company, Italy and Elyoser medicine trading company, Egypt. Thepax® is made of killed and stabilised suspension of *Saccharomyces cerevisiae Var. ellipsoideus*. It included enzymes, vitamins (B1, B2, B6, B12, PP, pantothenic acid, biotin), amino acids and minerals (calcium, magnesium, sodium, potassium, phosphor, copper, iron, zinc and manganese) (Ayed and Ghaoui, 2011). The chemical composition of concentrate feed mixture, clover hay and calculated experimental ration are presented in Table 1.

Table 1: Chemical composition of the concentrate feed mixture, clover hay and experimental ration

	Feedstuffs		
Item	CH	CFM	Experimental ration
DM	93.05	91.09	91.93
Chemical composition (%) (DM basis)			
OM	92.69	94.10	93.50
Ash	7.31	5.90	6.50
CP	15.99	13.59	14.62
EE	1.55	6.02	4.11
CF	38.73	6.39	20.21
NFE	36.42	68.11	54.57
Fiber fraction (%)			
NDF	49.83	19.23	32.30
ADF	42.97	8.98	23.50
ADL	9.41	2.66	5.54
Cellulose	33.55	6.32	17.95
Hemi-cellulose	6.87	10.25	8.81

CFM: Concentrate feed mixture (65% whole yellow corn, 15% wheat bran, 15% soybean meal, 1.2% premix, 0.8% common salt and 3% limestone), CH: Clover hay

Feeding procedures: The growing lambs were fed (in groups) CFM and forage twice daily and water was allowed freely all the day round. Orts were collected just before offering the next day's feed. Lambs were weighed every two weeks before morning feeding after 15 h of fasting. The CFM was adjusted every two week according to body weight changes. Feed intake was recorded, daily body weight gain and feed efficiency (g feed/g gain) were calculated.

Digestion trials: At the end of growth trial, three rams from each group was used to evaluate the experimental rations through digestion trials (21 days for adaptation and 7 days for sampling collection). The animals were fed individually in metabolic cages.

Feces was collected daily, then one tenth of daily feces weight was taken. Feces samples were dried at 60-70°C in a hot air oven. The orts were weighted daily, meanwhile feed intake was calculated. The dried samples of feces and feeds were grinded to pass through 1 mm screen and then these samples of rations and feces were stored for chemical analysis. Consequently, the nutrients digestibility and nutritive values of the experimental rations were calculated.

Sampling and analytical procedures

Chemical analysis: Feeds and feces were analyzed for proximate analyses and gross energy according to AOAC (2000). Nitrogen free extract was calculated by difference method. Fiber fractions were analyzed according to Van Soest *et al.* (1991).

Rumen liquor sampling: Rumen liquor samples were taken just before morning feeding, then after at three and six hours post feeding. Rumen liquor samples were collected through rubber stomach tube attached to electric suction pump. Samples of rumen liquor were strained through two layers of cheesecloth and its pH was immediately measured by Beckman pH meters. Strained Rumen Liquor (SRL) samples were acidified with 0.1 N hydrochloric acid and concentrated orthophosphoric acid and stored by freezing for determination of total volatile fatty acids (TVFA's). Concentration of ammonia-N in rumen liquor was determined according to Conway (1957). The concentration of total VFA's was determined in rumen liquor by steam distillation method (Warner, 1964) using Mrkham micro distillation apparatus.

Blood parameters: At the end of growth trial, blood samples were withdrawn from all the experimental animals. The blood samples were taken from jugular vein into dry clean glass tubes using heparin as anticoagulant and then centrifuged for 15 min at 4000 rpm to obtain plasma. Blood plasma constituents were determined using commercial kits. The total protein and creatinine as described by Tietz (1986, 1990), albumin was determined according to Doumas *et al.* (1971), blood plasma urea was determined according to Patton and Crouch (1977). Alanine transaminase (ALT) and activity of aspartate transaminase (AST) were determined by the methods of Young (1997).

Statistical analysis: Data was analyzed using the general liner model procedure of SAS (2000). One way ANOVA procedure was used to analyze data following the next model:

$$Y_i = \mu + T_i + E_i$$

were, μ is the overall mean of Y_i, T_i is the treatment effect; E_i is the experimental error. The differences among means were separated according to Duncan New Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Nutrients digestibility and nutritive values: Data concerning nutrients digestibilities and nutritive values Table 2, showed that yeast supplementation either inactivated (T2) or dried (T3) increase the digestibilities of all dietary nutrients beside the NDF and cellulose significantly compared with the control.

The increase in the population and/or activity of rumen cellulolytic bacteria and ciliate protozoa number which represent more than 90% of rumen fibrolysis activity (Kamel *et al*., 2004; Tripathi and Karim, 2011) by providing rumen microflora with vitamins or other growth factors or by scavage oxygen entered in rumen (Chaucheyras-Durand *et al*., 2008) may explain the increase in CF digestion when ration was supplemented with yeast. Also, the increase in CP digestibility with yeast supplementation may have been due to an increase in proleolytic bacteria counts (Tripathi and Karim, 2011). In the same trend, El-Ashry *et al*. (2001), Haddad and Goussous (2005) and Kholif and Khorshed (2006) recorded increases in OM, CF and CP digestibilities with yeast supplementation.

Meanwhile, inactivated yeast (T2) was significantly ($p<0.05$) highest in digestion of ADF and hemicellulose, while dried yeast (T3) had the highest cellulose digestibility compared with those fed control (T1).

Regarding the nutritive values, there were significant differences ($p<0.05$) in total digestible nutrients (TDN) values being T2 (73.30%) the highest followed by T3 (68.05%) and T1 (62.83%). This could be attributed to high digestibilities of CP, EE, CF and NFE for both rations supplemented with yeast (T2 and T3). On the other hand, no significant differences ($p<0.05$) in digestible crude protein (DCP) was detected with yeast supplementation.

Rumen liquor parameters: Although yeast supplementation had no significant effect on rumen pH (Table 3), it tended to be higher with lambs fed ration supplemented with inactivated

Table 2: Effect of yeast supplementation on nutrients digestibility and nutritive values of the experimental rations

	Experimental rations			
Item	T1	T2	T3	±SE
Apparent digestibility (%)				
DM	73.92^{c}	80.00^{a}	76.11^{b}	0.57
OM	76.40^{c}	82.47^{a}	78.62^{b}	0.72
CP	71.08^{c}	80.42^{a}	77.08^{b}	1.20
EE	69.54^{c}	81.80^{a}	77.74^{b}	0.58
CF	64.37^{c}	74.45^{a}	67.47^{b}	1.01
NFE	60.47^{c}	71.35^{a}	65.98^{b}	0.59
Fiber fractions				
NDF	55.49^{c}	66.50^{a}	58.94^{b}	1.55
ADF	61.78^{b}	72.63^{a}	56.51^{c}	2.02
Cellulose	57.95^{c}	61.32^{b}	77.55^{a}	3.20
Hemi-cellulose	50.62^{b}	65.45^{a}	50.62^{b}	0.56
Nutritive values (%)				
TDN	62.83^{c}	73.30^{a}	68.05^{b}	1.01
DCP	10.39	11.76	11.27	0.54

^{a,b}Means in the same row with different superscript are significantly different ($p<0.05$), T1: Control ration (Concentrate feed mixture + Clover hay), T2: Control ration supplemented with 5 g h^{-1} day^{-1} inactivated yeast (Thepax®), T3: Control ration supplemented with 5 g h^{-1} day^{-1} dried yeast (Yeastmax®), DM: Dry matter, OM: Organic mater, CP: Crude protein, EE: Ether extract, CF: Crude fiber, NFE: Nitrogen free extract, NDF: Neutral detergent fiber, ADF: Acid detergent fiber and ADL: Acid detergent lignin

Table 3: Effect of yeast supplementation on rumen parameters of growing lambs

	Experimental rations			
Item and sampling time (h)	T1	T2	T3	±SE
pH				
0	7.02	6.89	7.00	0.09
3	6.05^{ab}	6.34^{a}	5.48^{b}	0.17
6	6.24	6.43	6.27	0.18
Mean	6.44	6.55	6.25	0.11
NH_3-N mg/100 mL rumen liquor				
0	49.00	44.80	46.20	1.75
3	60.20^{a}	65.00^{ab}	50.60^{b}	1.68
6	51.80	47.60	44.80	2.51
Mean	53.67	52.47	47.20	2.35
TVFA mL eq/100 mL rumen liquor				
0	9.20^{b}	14.40^{a}	12.10^{ab}	1.35
3	12.40^{b}	17.80^{a}	19.20^{a}	0.78
6	15.70	15.90	17.20	1.10
Mean	12.43^{b}	16.03^{a}	16.17^{a}	1.03

^{a,b}Means in the same row with different superscript are significantly different ($p<0.05$), T1: Control ration (Concentrate feed mixture + Clover hay), T2: Control ration supplemented with 5 g h^{-1} day^{-1} inactivated yeast (Thepax®) and T3: Control ration supplemented with 5 g h^{-1} day^{-1} dried yeast (Yeastmax®)

yeast (T2). Average rumen pH ranged from 6.25-6.55. These values are higher than the critical level to be considered rumen acidosis or to affect the microbial diversity in rumen (Tripathi and Karim, 2011).

The insignificant effect of yeast supplementation on rumen pH might be attributed to high roughage intake by animals which acted as a buffer (Al-Dabeeb and Ahmed, 2002). This result is parallel with those obtained by Kawas *et al.* (2007) and Oeztuerk (2009). On the other hand, a pH stabilization effect was reported either when sheep received active yeast during their adaptation to a high-concentrate diet (Fonty and Chaucheyras-Durand, 2006).

The rumen ammonia values were insignificantly decreased either with inactivated yeast (T2) or dried yeast (T3) compared to control being 52.47, 47.20 and 53.67 mg/100 mL rumen liquor, in the same order. The decrease in rumen ammonia N with yeast supplementation is in agreement with results obtained by Newbold *et al.* (1996). The reduced concentrations of ammonia N in rumen appear to be a result of increased incorporation of ammonia into microbial protein and may be the direct result of stimulated microbial activity. However, Oeztuerk (2009) recorded an increase in rumen NH3-N concentration with yeast supplementation.

Rumen TVFA concentration was significantly ($p<0.05$) higher with yeast supplementation (T2 and T3) being 16.03 and 16.17 mL eq/100 mL rumen liquor , respectively compared to control (12.43 mL eq). Al-Dabeeb and Ahmed (2002) observed similar effects when added yeast culture either to high-roughage or high-concentrate rations. On the other hand, Kawas *et al.* (2007) found that yeast supplementation had no significant effects on rumen TVFA concentration. However, Tripathi and Karim (2011) noticed a decrease in TVFA concentration. The differences between this study and other studies could be attributed to differences in quantities used and/or different strains of yeast as suggested before (Al-Dabeeb and Ahmed, 2002).

Blood parameters: Data in Table 4 showed that no significant differences among treatments in blood parameters, except total protein and urea concentrations which were high with animals fed

Table 4: Effect of yeast supplementation on blood parameters of growing lambs

	Experimental rations			
Item	T1	T2	T3	±SE
Total proteins (g dL^{-1})	8.35[a]	9.10[a]	8.99[ab]	0.20
Albumin (g dL^{-1})	4.44	4.69	4.52	0.11
Globulin (g dL^{-1})	3.91	4.41	4.47	0.17
Triglyceride (mg dL^{-1})	0.65	0.77	0.76	0.09
Total lipid (mg dL^{-1})	1227.64	1166.66	1168.03	51.66
Glucose (g dL^{-1})	55.87	69.48	58.37	8.48
Urea (mg dL^{-1})	23.23[b]	33.48[a]	30.49[ab]	2.74
Creatinine (mg dL^{-1})	1.24[a]	1.03[b]	1.04[ab]	0.06
[1]AST (IU L^{-1})	24.94	23.58	25.64	2.60
[2]ALT (IU L^{-1})	15.81	15.66	16.88	0.65

[a,b]Means in the same row with different superscript are significantly different ($p<0.05$), T1: Control ration (Concentrate feed mixture + Clover hay), T2: Control ration supplemented with 5 g h^{-1} day^{-1} inactivated yeast (Thepax®) and T3: Control ration supplemented with 5 g h^{-1} day^{-1} dried yeast (Yeastmax®), [1]Aspartate aminotransferase and [2]Alanine transaminase

inactivated yeast (T2) than T3 and T1. These results may be due to the improvement in metabolic process as a result of yeast supplementation (Kholif and Khorshed, 2006).

The insignificant increase in glucose concentration with yeast supplementation may be due to the increase in total DM intake and digestibility of most nutrients. Not only concentration of glucose in blood is influenced by energy consumption resulting in greater glucose abosorption but also, by utilization by tissues (Magalhaes *et al*., 2008). Also, Abo El-Nor and Kholif (1998) reported higher blood glucose concentration in cows fed diets containing yeast. This increase in glucose concentration in the yeast supplemented group might be related to a temperate improvement in gluconeogenesis and increased lactose absorption (De Valdez *et al*., 1997). While, Beauchemin *et al*. (2003) did not observe any changes in glucose concentration with yeast supplementation.

The results concerning both AST and ALT concentration indicated that yeast supplementation to sheep ration had no adverse effect on animal health. These results are in accordance with El-Ashry *et al*. (2001) and Kholif and Khorshed (2006).

Growth performance: Results in Table 5 showed that total body weight gain and average daily gain of lambs fed inactivated yeast (T2) were significantly ($p<0.05$) higher being 17.58 kg and 195.33 g than those fed dried yeast (T3) being 17.22 kg and 191.33 g or those fed control (T1) being 15.62 kg and 173.56 g, in the same order. These results could be attributed to the increase in digestibilities of most nutrients and nutritive values as TDN and DCP with yeast supplementation. Present findings are in consistent with the findings of Haddad and Goussous (2005) and Tripathi and Karim (2011). While, no significant change in average daily gain was observed with yeast addition by Beauchemin *et al*. (2003), Kawas *et al*. (2007), Magalhaes *et al*. (2008) and Titi *et al*. (2008).

A significant ($p<0.05$) increase in daily total dry matter intake was recorded for T3 (1.13 kg day^{-1}). While, T2 was similar to control being 1.06 kg day^{-1} for both groups. The same notice could be observed with both TDN and DCP intakes. Beauchemin *et al*. (2003), Kawas *et al*. (2007), Titi *et al*. (2008) and Tripathi and Karim (2010, 2011) did not find a significant effect of yeast supplementation on dry matter intake. It is established that dry matter intake may be improved when yeast culture is added to low protein rations, while intake remains unaffected or reduced with high protein rations (Ando *et al*., 2004; Castillo *et al*., 2006).

Table 5: Effect of yeast supplementation on growth performance of growing lambs

	Experimental rations			
Item	T1	T2	T3	±SE
Live body weight				
Initial body weight (kg)	27.08	27.02	27.13	1.20
Final body weight (kg)	42.70	44.60	44.35	1.52
Total weight gain (kg)	15.62^{b}	17.58^{a}	17.22^{a}	0.48
Average daily gain* (g)	173.56^{b}	195.33^{a}	191.33^{a}	5.36
Feed intake/day				
Concentrate (kg)	0.62	0.61	0.66	0.01
Roughage (kg)	0.44	0.45	0.47	0.01
Total DMI (kg)	1.06^{b}	1.06^{b}	1.13^{a}	0.02
TDN intake (kg)	0.65^{b}	0.76^{a}	0.77^{a}	0.02
DCP intake (g)	10.70^{c}	12.23^{b}	12.74^{a}	0.31
Feed conversion (g intake/g gain)				
DMI	5.93^{a}	5.32^{b}	5.91^{a}	0.10
TDN	3.75^{c}	3.89^{b}	4.02^{a}	0.04

^{a,b}Means in the same row with different superscript are significantly different ($p<0.05$), T1: Control ration (Concentrate feed mixture + Clover hay), T2: Control ration supplemented with 5 g h^{-1} day^{-1} inactivated yeast (Thepax®) and T3: Control ration supplemented with 5 g h^{-1} day^{-1} dried yeast (Yeastmax®), *Average daily gain: Total gain, g/90 days

The feed conversion ratio indicated that supplementation with inactivated yeast (T2) was improved by 10.29%. Haddad and Goussous (2005), Kawas *et al.* (2007) and Tripathi and Karim (2010) recorded an improvement in feed conversion efficiency with yeast supplementation. While, no change was observed by Magalhaes *et al.* (2008) and Titi *et al.* (2008).

CONCLUSION

Supplementation with two yeast products (inactivated or dried) by 5 g h^{-1} day^{-1} increased digestibilities of most nutrients, nutritive value as TDN and DCP, average daily gain and improved feed conversion efficiency but did not affect rumen pH and ammonia N. Blood parameters indicated that yeast supplementation to sheep ration had no adverse effect on animal health. Supplementation with inactivated yeast had the potential to improve digestibilities and growth and can be effectively used as growth promoters.

REFERENCES

AOAC, 2000. Official Methods of Analysis of the AOAC. 17th Edn., Association of Official Analytical Chemists, Washington, DC., USA.

Abo El-Nor, S.A.H. and A.M. Kholif, 1998. Effect of supplementation of live yeast culture in the diet on the productive performance of lactating buffaloes. Milchweissenschaft, 53: 663-666.

Agarwal, N., D.N. Kamra, L.C. Chaudhary, I. Agarwal, A. Sahoo and N.N. Pathak, 2002. Microbial status and rumen enzyme profile of crossbred calves fed on different microbial feed additives. Lett. Applied Microbiol., 34: 329-336.

Al-Dabeeb, S.N. and B.M. Ahmed, 2002. Effect of dry yeast (*Saccharomyces cerevisiae*) in sheep rations differing in their roughage to concentrate ratio on digestion, nitrogen balance and rumen fermentation. Egypt. J. Nutr. Feeds, 5: 1-11.

Ando, S., R.I. Khan, J. Takahasi, Y. Gamo, R. Morikawa, Y. Nishiguchi and K. Hayasaka, 2004. Manipulation of rumen fermentation by yeast: The effects of dried beer yeast on the *in vitro* degradability of forages and methane production. Asian-Aust. J. Anim. Sci., 17: 68-72.

Ayed, M.H. and F. Ghaoui, 2011. Efficiency of supplementing *Saccharomyces cerevisiae* var. *ellipsoideus* for improved growth performance and carcass yield in broilers. Res. Opin. Anim. Vet. Sci., 1: 371-374.

Bach, A., A. Iglesias and M. Devant, 2007. Daily rumen pH pattern of loose-housed dairy cattle as affected by feeding pattern and live yeast supplementation. Anim. Feed Sci. Technol., 136: 146-153.

Beauchemin, K.A., W.Z. Yang, D.P. Morgavi, G.R. Ghorbani, W. Kautz and J.A. Leedle, 2003. Effects of bacterial direct-fed microbials and yeast on site and extent of digestion, blood chemistry and subclinical ruminal acidosis in feedlot cattle. J. Anim. Sci., 81: 1628-1640.

Castillo, C., J. Hernandez, J. Mendez, P. Garcia-Partida and V. Pereira *et al.*, 2006. Effects of monensin and yeast supplementation on blood acid-base balance in finishing feedlot steers fed a high-grain, high-protein diet. Anim. Sci., 82: 653-659.

Chaucheyras-Durand, F. and G. Fonty, 2001. Establishment of cellulolytic bacteria and development of fermentative activities in the rumen of gnotobiotically-reared lambs receiving the microbial additive *Saccharomyces cerevisiae* CNCM I-1077. Reprod. Nutr. Dev., 41: 57-68.

Chaucheyras-Durand, F. and G. Fonty, 2002. Influence of a probiotic yeast (*Saccharomyces cerevisiae* CNCM I-1077) on microbial colonization and fermentations in the rumen of newborn lambs. Microbial. Ecol. Health Dis., 14: 30-36.

Chaucheyras-Durand, F., N.D. Walker and A. Bach, 2008. Effects of active dry yeasts on the rumen microbial ecosystem: Past, present and future. Anim. Feed Sci. Technol., 145: 5-26.

Comitini, F., R. Ferretti, F. Clementi, I. Mannazzu and M. Ciani, 2005. Interactions between *Saccharomyces cerevisiae* and malolactic bacteria: preliminary characterization of a yeast proteinaceous compound(s) active against *Oenococcus oeni*. J. Applied Microbiol., 99: 105-111.

Conway, E.J., 1957. Microdiffusion Analysis and Volumetric Errors. 4th Edn., Croly Lockwood and Sons, London, UK.

De Valdez, D.F., G. Martos, M.P. Taranto, G.L. Lorca, G. Oliver and A.P.R. Holgado, 1997. Influence of bile on â-Galactosidase activity and cell viability of *Lactobacillus reuteri* when subjected to freeze-drying. J. Dairy Sci., 80: 1955-1958.

Doumas, B.T., W. Watson and H.G. Biggs, 1971. A method for determination of Albumin. Clin. Chem. Acta, 31: 87-96.

Duncan, D.B., 1955. Multiple range and multiple *F* tests. Biometrics, 11: 1-42.

El-Ashry, M.A., A.M. Kholif, H.A. El-Alamy, H.M. El-Sayed and T.A. El-Hamamsy, 2001. Effect of different yeast cultures supplementation to diet on the productive performance of lactating buffaloes. Egypt. J. Nutr. Feeds, 4: 21-33.

Erasmus, L.J., P.H. Robinson, A. Ahmadi, R. Hinders and J.E. Garrett, 2005. Influence of prepartum and postpartum supplementation of a yeast culture and monensin, or both, on ruminal fermentation and performance of multiparous dairy cows. Anim. Feed Sci. Technol., 122: 219-239.

Fonty, G. and F. Chaucheyras-Durand, 2006. Effects and modes of action of live yeasts in the rumen. Biologia, 61: 741-750.

Galvao, K.N., J.E. Santos, A. Coscioni, M. Villasenor, W.M. Sischo and A.C. Berge, 2005. Effect of feeding live yeast products to calves with failure of passive transfer on performance and patterns of antibiotic resistance in fecal *Escherichia coli*. Reprod. Nutr. Dev., 45: 427-440.

Haddad, S.G. and S.N. Goussous, 2005. Effect of yeast culture supplementation on nutrient intake, digestibility and growth performance of Awassi lambs. Anim. Feed Sci. Technol., 118: 343-348.

Kamel, H.E.M., J. Sekine, A.M. El-Waziry and M.H.M. Yacout, 2004. Effect of *Saccharomyces cerevisiae* on the synchronization of organic matter and nitrogen degradation kinetics and microbial nitrogen synthesis in sheep fed Berseem hay (*Trifolium alexandrinum*). Small Rumin. Res., 52: 211-216.

Kawas, J.R., R. Garcia-Castillo, F. Garza-Cazares, H. Fimbres-Durazo, E. Olivares-Saenz, G. Hernandez-Vidal and C.D. Lu, 2007. Effects of sodium bicarbonate and yeast on productive performance and carcass characteristics of light-weight lambs fed finishing diets. Small Rumin. Res., 67: 157-163.

Kholif, S.M. and M.M. Khorshed, 2006. Effect of yeast or selenized yeast supplementation to rations on the productive performance of lactating buffaloes. Egypt. J. Nutr. Feeds, 9: 193-205.

Kim, H.S., B.S. Ahn, S.G. Chung, Y.H. Moon and J.K. Ha *et al*., 2006. Effect of yeast culture, fungal fermentation extract and non-ionic surfactant on performance of Holstein cows during transition period. Anim. Feed Sci. Technol., 126: 23-29.

Lesmeister, K.E., A.J. Heinrichs and M.T. Gabler, 2004. Effects of supplemental yeast (*Saccharomyces cerevisiae*) culture on rumen development, growth characteristics and blood parameters in neonatal dairy calves. J. Dairy Sci., 87: 1832-1839.

Magalhaes, V.J.A., F. Susca, F.S. Lima, A.F. Branco, I. Yoon and J.E.P. Santos, 2008. Effect of feeding yeast culture on performance, health and immunocompetence of dairy calves. J. Dairy Sci., 91: 1497-1509.

Mahender, M., V.L.K. Prasad and G.V.N. Reddy, 2005. Effect of yeast culture based complete diets on the performance of lactating murrah buffaloes. Indian J. Anim. Nut., 22: 173-176.

NRC, 1985. Nutrient Requirements of Sheep. 6th Edn., National Academy of Sciences, Washington, DC., USA., pp: 45.

Newbold, C.J., R.J. Wallace and F.M. McIntosh, 1996. Mode of action of the yeast *Saccharomyces cerevisiae* as a feed additive for ruminants. Br. J. Nutr., 76: 249-261.

Nikpiran, H., T. Vahdatpour, D. Babazadeh and S. Vahdatpour, 2013. Effects of *Saccharomyces cerevisiae*, thepax and their combination on blood enzymes and performance of japanese quails (*Coturnix japonica*). J. Anim. Plant Sci., 23: 369-375.

Oeztuerk, H., 2009. Effects of live and autoclaved yeast cultures on ruminal fermentation *in vitro*. J. Anim. Feed Sci., 18: 142-150.

Patton, C. and G. Crouch, 1977. Enzymatic colorimetric determination of urea. Anal. Chem., 49: 464-469.

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

SAS, 2000. Statistical Analysis System User's Guide. Version 8, SAS Institute Inc., Cary, NC., USA..

Stella, A.V., R. Paratte, L. Valnegri, G. Cigalino and G. Soncini *et al*., 2007. Effect of administration of live *Saccharomyces cerevisiae* on milk production, milk composition, blood metabolites and faecal flora in early lactating dairy goats. Small Rumin. Res., 67: 7-13.

Tietz, N.W., 1986. Text Book of Clinical Chemistry. W.B. Saunders, Philadelphia, PA., Pages: 1271.

Tietz, N.W., 1990. Clinical Guide to Laboratory Tests. 2nd Edn., W.B. Saunders Company, Philadelphia, USA., pp: 554-556.

Titi, H.H., R.O. Dmour and A.Y. Abdullah, 2008. Growth performance and carcass characteristics of awassi lambs and shami goat kids fed yeast culture in their finishing diet. Anim. Feed Sci. Technol., 142: 33-43.

Tripathi, M.K. and S.A. Karim, 2010. Effect of individual and mixed live yeast culture feeding on growth performance, nutrient utilization and microbial crude protein synthesis in lambs. Anim. Feed Sci. Technol., 155: 163-171.

Tripathi, M.K. and S.A. Karim, 2011. Effect of yeast cultures supplementation on live weight change, rumen fermentation, ciliate protozoa population, microbial hydrolytic enzymes status and slaughtering performance of growing lamb. Livestock Sci., 135: 17-25.

Tripathi, M.K., S.A. Karim, O.H. Chaturvedi and D.L. Verma, 2008. Effect of different liquid cultures of live yeast strains on performance, ruminal fermentation and microbial protein synthesis in lambs. J. Anim. Physiol. Anim. Nutr., 92: 631-639.

Van Soest, P.J., J.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.

Warner, A.C., 1964. Production of volatile fatty acids in the rumen: Methods of measurement. Nutr. Abstr. Rev., 34: 339-352.

Young, D.S., 1997. Effects of Preanalytical Variables on Clinical Laboratory Tests. 2nd Edn., AACC Press, Washington, DC., USA., Pages: 1285.