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# Digestion Coefficients, Nitrogen Balance, Ruminal Fermentation and Blood Constituents of Barki Sheep Fed Rations Containing Rymi Yeast

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**Abstract:** In a group feeding trail that lasted for 84 days using twenty one of growing male Barki lambs aged 5-6 months with an average weights (27.200 ± 1.938 kg). Lambs randomly divided into three equal groups each contains 7 animals to investigate the impact of inclusion Rymi yeast (RY) at different levels on their growth performance nutrient digestibility coefficients, nitrogen balance, ruminal fermentation and blood constituents. RY was added to concentrate feed mixture (CFM) at 0, 0.10 or 0.20% that equals (0, 1 and 2 grams per one kg CFM) for $R_1$, $R_2$ and $R_3$, respectively. Experimental rations were offered at 4% dry matter of live body weight, tested rations were distributed as 60% concentrate feed mixture (CFM) and 40% roughage, main roughage source used was wheat straw. The results showed that generally with increasing level of addition from RY in the ration occurred an increasing in values of final weight (FW), total body weight gain (TBWG) and average daily gain (ADG). Dietary treatment had no significantly ($P>0.05$) effect in voulantary intake. All calculated parameters of feed intake that expressed as g/h/day, g/kg$W^{0.75}$ or kg/ 100 kg live body weight (LBW) of DM, DCP were not affected by adding RY in the rations. Feed conversion that expressed as g. intake/ g. gain of DM, DCP or TDN were insignificantly ($P>0.05$) improved. Incorporation 0.20% RY ($R_3$) recorded the highest value of feed conversion, followed by sheep that fed 10% RY. All nutrient digestibility coefficients; cell wall constituents digestibility and nutritive values (TDN and DCP) were improved. Dietary treatments ($R_2$ and $R_3$) significantly ($P<0.05$) improved values of nitrogen retention (NR), NR, % of Nitrogen intake (NI) and NR, % of digested nitrogen (DN) comparing to control. Adding 0.20% RY ($R_3$) significantly increased ($P<0.05$) values of ruminal pH, ammonia nitrogen and total volatile fatty acids concentrations comparing to the control ($R_1$). Except for values of iso-butyric and iso-valeric acids the other values of different molar proportion of volatile fatty acids includes (acetic, propionic, butyric and valeric acids, in addition acetic: propionic ratio) were not affected. Also, dietary treatments not affected ($P>0.05$) on ruminal nitrogen fractions. by adding RY at 0.10% or 0.20% ($R_2$ and $R_3$) comparing to control ($R_1$). Incorporation RY had no significant ($P>0.05$) on values of glucose, red blood cell count, albumin, globulin, albumin: globulin ratio, total cholesterol, total lipids, GPT, GOT and Alkaline phosphatase. Generally, adding RY occurred decreasing in total cholesterol, total lipids, triglycerides, GPT, GOT, urea, createnin and alkaline phosphatase. So, it can be mentioned that incorporation RY in sheep rations useful because it occurred an improvements in sheep health throughout decreasing their lipids contents, liver and kidneys functions.

**Key words:** Feed additive · Rymi yeast · Sheep · Performance · Digestibility · Nutritive values · Nitrogen balance · Ruminal fermentation · Blood constituents

## INTRODUCTION

Feed additives are groups of feed ingredients that are required in quantity and can cause desired animal response. In the past two decades, the potential roles of using products containing living microorganisms as specific microbial supplements have been better feed supplements for ruminants. Feed additives are useful for dairy producers to improve nutritive value of the diets for dairy animals and increased profits when used correctly.

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Additives should be viewed as enhancements of good feeding programs and it should not be considered as replacements of balanced rations and good feeding practices [1].

Yeast derived products, such as yeast cultures and extracts, are natural feed additives that can be classified as probiotics (live yeast) or prebiotics (non-living yeast). Supplementing cattle with live yeast, especially *Saccharomyces cerevisiae*, has been shown to improve feed intake, dietary digestibility, body weight gain and feed efficiency by promoting rumen function. More specifically, live yeast derivatives reduce ruminal lactate production, alleviate dietary protein loss as ammonia and stabilize ruminal pH [2-5].

Benefits of yeast supplements for ruminants are shifts in microbial population numbers and species, favorable changes in volatile fatty acids contents of rumen, positive effects on rumen ammonia disappearance, positive effects on rumen pH, promotes metabolism digestion, increase in fiber digestibility and changes in microbial protein and amino acids in large intestine. In addition, benefits of Yeast supplements for ruminants are improving the overall intestinal bacteria balance, reducing digestive problems, lower risk of acidosis and reduction in the humidity of bedding resulting in lower stress levels [6-7].

Various feed additives are in widespread use in diets of ruminants modulate rumen metabolism which ultimately enhance nutrient utilization and animal performance. Denev *et al*. [8] mentioned that some microbial additives such as direct-feed microbial (DFM), yeast cultures (YC), live yeast cultures (LYC). In addition, a list of accepted microorganism for use in animal feeds was developed. Some of the major hypotheses on how DFM may benefit animals can be found in an excellent discussion by [9]. Both microbial increase milk yield in dairy cows and the body weight gain and feed conversion ratio in beef cattle as noted by [10]. Furthermore, Krehbiel *et al.* [11] reported that the yeast supplementation increased total volatile fatty acids (VFA's), stabilization of rumen PH and decreased lactate concentration. The increase in feed utilization and improvement of rumen fermentation along with increased dry matter may also enhance milk production and animal performance [12] However, Greenquist *et al.* [13] and Petersonet *et al.* [14] noted that that supplementation of DFM resulted in no measurable impact on growth rate in finishing cattle. Also, Mohammed *et al.* [1] observed that adding yeast (*Saccharomyces cerevisiae*) as a probiotic in small amounts of Awassi lamb rations improved their performance.

Microbial feed additives are used in ruminant feeds for different purposes. First is for the same reason that probiotics are used in non-ruminants, namely stabilization of the intestinal flora; this is applicable only in young pre-ruminant animals, however, lactobacilli, enterococci and yeast have been reported to be helpful in improving live weight gain in calves and lambs [15]. Several excellent reviews have described the role of *Saccharomyces cerevisiae* and fungal fermentation extracts from *Aspergillus oryzae* in animal feeds [16-17]. Moreover, Salim [18] mentioned that lambs fed Iraqi probiotic significantly increased daily intake of dry matter, organic matter and metabolizabe energy. While, Seo *et al.* [19] noted that lactic acid bacteria (LAB), lactic utilizing bacteria (LUB) or other microorganisms including species of *lactobacillus*, bifido bacterium, enterococcus, streptococcus, bacterium, strains of *Megasphaera elsdenii* and *Prevotella bryantii* and yeast products containing *Saccharomyces* and *Aspergillus*. Lactic acid bacteria may have beneficial effects in the intestinal tract and rumen both LAB and LUB potentially moderate rumen conditions and improve dry matter intake, feed efficiency and weight gain in calves. On the other hand, Luebbe *et al.* [20] cleared that, numeric advantages were observed for average daily gain (ADG) and feed efficiency when cattle were fed a DFM. The use of additives from cultures of live microorganisms as activators of ruminal fermentation has gained great scientific and productive interest [21].

The microbial additive as a product of biological activity, rich in lactobacilli, yeasts, carbonated short-chain organic acids and low pH [22] stabilizes the microbial flora of the ruminal ecosystem, at the time that increases the digestibility and that of the cell wall [23].

Supplemented yeast stimulated the growth of beneficial microorganisms in the rumen, the numbers of total ruminal anaerobic and cellulolytic bacteria increased with YC as noted by [24]. Yeast have been shown to provide vitamins (especially thiamin) to support the growth of rumen fungi [25]. The ability of different strains of *Saccharomyces cerevisiae* to stimulate the viable count of bacteria in the rumen appears to be related to their ability to remove oxygen from rumen fluid, since respiration-deficient mutants of *Saccharomyces cerevisiae* failed to stimulate bacterial numbers [26]. Total volatile fatty acids were significantly higher in the wheat straw plus yeast [27]. Moreover, Xiao *et al*. [28] noticed that ruminal pH, ammonia-N and total volatile fatty acids were not altered by *Saccharomyces cerevisiae* fermentation products.

In addition to, Patra [29] mentioned that Various feed additives are in widespread use in diets of ruminants to modulate rumen metabolism which ultimately may enhance nutrient utilization and animal performance. Yeast products such as *Saccharomyces cerevisiae* and *Aspergillus oryzae* are often utilized in ruminants to improve nutrient utilization, rumen fermentation characteristics, milk production and daily gain. Yeast additives may exert positive effects on digestibility especially fiber components, probably by stimulating the cellulolytic microbial populations in the rumen. Rumen fermentation characteristics such as increased total volatile fatty acids, stabilization of rumen pH and decreased lactate concentration might be observed due to yeast supplementation. The discrepancies of responses of yeast inclusion as a feed additive in different experiments might be attributed to dose, type of diets, strains of yeast, physiological stage and feeding systems. Therefore, yeast products should be added in diets by taking consideration of various interaction factors to achieve the consistent beneficial responses of yeasts in ruminant nutrition.

So this work aimed to investigate the impact of adding rumi yeast in Barki sheep rations on their nutrient digestibility coefficients, nitrogen balance, ruminal fermentation and blood constituents.

## MATERIALS AND METHODS

This work was carried out at the Sheep and Goats' Units in El-Bostan area in Nubaria (located on the desert road, 112 km North Cairo city, near from Alexandria) which belongs to the Animal Production Department, National Research Center, Dokki, Giza, Egypt.

**Animals and Feeds:** Twenty one of growing male Barki lambs aged 5-6 months with an average weights (27.200 ± 1.938 kg) were randomly divided into three equal groups each contains 7 animals to investigate the impact of inclusion Rymi yeast (commercial product) at different levels on their growth performance digestibility coefficients, nitrogen balance, ruminal fermentation and blood constituents

Rymi yeast (RY) was added to concentrate feed mixture (CFM) at 0, 0.10 or 0.20% that equals (0, 1 and 2 grams per one kg CFM) for $R_1$, $R_2$ and $R_3$, respectively.

Experimental animals were housed in semi-open pens and fed as group feeding for 84 days and the experimental rations were offered for all experimental group animals at 4% dry matter of live body weight (LBW), tested rations were distributed as 60% concentrate feed mixture (CFM) and 40% roughage, main roughage source used was wheat straw.

Each group received one of the three tested rations that classified as the following:

$R_1$: 1st experimental ration assigned as control and it contained 0% Rymi yeast (RY).
$R_2$: 2nd experimental contained 0.10% RY (1 g / kg CFM).
$R_3$: 3rd experimental ration replace ration contained 0.20% RY (2 g / kg CFM).

Daily amounts of different tested rations were adjusted biweekly according to body weight changes and it were offered twice daily in two equal portions at 800 and 1400 hours, while feed residues were daily collected, sun dried and weekly weighed. Fresh water was always freely available in plastic containers. Individual body weight change was recorded weekly before receiving the morning ration. Composition and chemical analysis (%) of tested rations are presented in (Table 1).

**Digestibility Trials:** At the end of feeding trial that hasted to 84 days, twelve digestibility trials were carried out using four animals from each group and housed in individual metabolic cages. Cages allowed catching feces separately from the urine which was collected in attached glass containers containing 50 ml sulphoric acid 10%. Tested rations were offered at 8.00 a.m. and water was available all times. The digestibility trial consisted of 7 days as a preliminary period (adaptation period) followed by 5 days for feces and urine collection (collection period). During the collection period, feces and urine were quantitatively collected from each animal once a day at 7.00 a.m. before feeding. Actual quantity of feed intake and water consumption were recorded. A sample of 10% of the collected feces from each animal was sprayed with 10% sulphoric acid and 10% formaldehyde solutions and dried at 60°C for 48 hrs. Samples were mixed and stored for chemical analysis. Composite samples of feeds and feces were finely ground prior to analysis. Also 10% of the daily collected urine from each animal was preserved for nitrogen determination. The nutritive values expressed as the total digestible nutrient (TDN) and digestible crude protein (DCP) of the experimental rations was calculated by classical method that described by Abou-Raya [30].

**Rumen Fluid Parameters:** Rumen fluid samples were collected from four animals at the end of the digestibility trials at 4 hrs post feeding via stomach tube and strained through four layers of cheesecloth. Samples were separated into two portions, the first portion was used for immediate determination of ruminal pH and ammonia nitrogen ($NH_3$-N) concentration, while the second portion was stored at-20°C after adding a few drops of toluene and a thin layer of paraffin oil till analyzed for volatile fatty acid's (TVFA's).

**Blood Parameters:** Blood samples were collected at the end of digestibility trials from 20 animals (four animals from each group) at 4 hours post feeding from the left jugular vein in heparinized test tubes and centrifuged at 5.000 rpm for 15 minutes. Plasma was kept frozen at -20°C for subsequent analysis.

**Analytical Procedures:** Chemical analysis of the experimental ration samples were analyzed according to AOAC (2005) methods. Ruminal pH was immediately determined using a digital pH meter.

Ruminal ammonia nitrogen ($NH_3$-N) concentrations were determined applying $NH_3$ diffusion technique using Kjeldahle distillation method according to AOAC [31]. Meanwhile, ruminal total volatile fatty acids (TVF'A) concentrations were determined by steam distillation according to Warner [32]. Molar proportion of volatile fatty acids were determined according to Erwin *et al.* [33].

Blood samples were analyzed using commercial diagnostic kits from Biomerieux, France and Quimica Clinica Aplicada (QCA), Amposta, Spain, were used for assay of serum biochemical parameters. Glucose red blood cell count (RBCs) and white blood cell count. of collected blood samples were described by Weiss and Wardrop [34]; hemoglobin as described by [35, 36]; plasma total protein was determined according to [37, 38]; albumin was determined according to [39, 40]; triglycerides were determined according to [41]; total lipids were determined according to Postma and Stroes [42]; total cholesterol was determined according to [43, 44]; alkaline phosphates activity was measured according to the method of Beliefield and Goldberg [45]; urea according to Patton and Crouch [46]; creatinine according to Husdan [47]; plasma glutamic oxaloacetic transaminase (GOT) and glutamic pyruvic transaminase (GPT) activities were determined as described by [48, 49]; while globulin was calculated by difference between total protein and albumin. Albumin: globulin ratio (A: G ratio) was also calculated.

Cell wall constituents includes neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were determined according to [50, 51]. Meanwhile, hemicellulose and cellulose content were calculated by difference using the following equations:

Hemicellulose = NDF - ADF. Meanwhile, Cellulose =ADF - ADL

**Statistical Analysis:** Data collected of live weight, average daily gain, daily dry matter intake, feed conversion, digestion coefficients, cell wall constituents digestibility, nutritive values, nitrogen balance, ruminal fluid parameters and blood parameters. were subjected to statistical analysis as one-way analysis of variance according to SPSS [52]. Duncan's Multiple Range Test [53] was used to separate means when the dietary treatment effect was significant according to the following model:

$$Y_{ij} = \mu + T_i + e_{ij}$$

where:
$Y_{ij}$ = observation.
$\mu$ = overall mean.
$T_i$ = effect of experimental rations for i = 1-3, 1 = ($R_1$: 1st experimental ration assigned as control and it contained 0% Rymi yeast (RY), 2= {$R_2$: 2nd experimental contained 0.10% RY (1 gram /kg CFM) and 3 = ($R_3$: 3rd experimental ration replace ration contained 0.20% RY (2 grams / kg CFM).

$e_{ij}$ = the experimental error.

## RESULTS AND DISCUSSION

Data of Table (1) mentioned that basal ration that composed of 60% CFM and 40% Roughage (wheat straw) showed that it contained 11.48% CP, 18.28% CF, 2.67% EE, 57.33% NFE; 10.24% ash. The depression in basal diet contents of crude protien and increasing in CF and ash contents. This ralated to incorporation wheat straw (WS) at 40% of total ration fed to sheep, with observation, chemical analysis of WS lower in CP content (3.26%) and higher in their content of CF and ash (37.41 and 15.21%) comparing to CFM that contained 16.97, 5.53 and 6.94 of CP, CF and ash, respectively. On the other hand, WS was supperior in their contents of NDF, ADF, ADL and cellulose in comparison with the CFM.

Table 1: Composition and chemical analysis of the concentrate feed mixture and the experimental rations

| Item | | | Experimental rations | | |
|---|---|---|---|---|---|
| | | | $R_1$ | $R_2$ | $R_3$ |
| Level of rumi yeast (RY) addition | CFM | WS | 0% RY | 0.10 % RY | 0.20 % RY |
| Composition (kg/ ton) | | | | | |
| Yellow corn | 550 | | Basal ration cmposed of | Basal ration + | Basal ration + |
| Soybean meal | 200 | | 60 % CFM + 40 % WS | 1 gram RY / kg CFM | 2 grams RY / kg CFM |
| Barly grain | 220 | | | | |
| Lime stone | 10 | | | | |
| Sodium chloride | 10 | | | | |
| Vitamin and mineral mixture[1] | 10 | | | | |
| Rymi yeast | - | | | | |
| Clculated of chemical analysis (%) | | | | | |
| Moisture | | | 8.99 | 6.04 | 7.81 |
| Chemical analysis on DM basis (%) | | | | | |
| Organic matter (OM) | | | 93.06 | 84.79 | 89.76 |
| Crude protein (CP) | | | 16.97 | 3.26 | 11.48 |
| Crude fiber (CF) | | | 5.53 | 37.41 | 18.28 |
| Ether extract (EE) | | | 3.28 | 1.76 | 2.67 |
| Nitrogen free extrct (NFE) | | | 67.28 | 42.36 | 57.33 |
| Ash | | | 6.94 | 15.21 | 10.24 |
| Cell wall constituents (%) | | | | | |
| Neutral detergent fiber (NDF) | | | 36.57 | 75.31 | 52.06 |
| Acid detergent fiber (ADF) | | | 18.88 | 58.26 | 34.63 |
| Acid detergent lignin (ADL) | | | 3.93 | 9.32 | 6.09 |
| Hemicellulose[2] | | | 17.69 | 17.05 | 17.43 |
| Cellulose[3] | | | 14.95 | 48.94 | 28.43 |

[1]Vitamin & Mineral mixture: Each kilogram of Vit. & Min. mixture contains: 2000.000 IU Vit. A, 150.000 IU Vita. D, 8.33 g Vit. E, 0.33 g Vit. K, 0.33 g Vit. $B_1$, 1.0 g Vit. $B_2$, 0.33g Vit. $B_6$, 8.33 g Vit.$B_5$, 1.7 mg Vit. $B1_2$, 3.33 g Pantothenic acid, 33 mg Biotin, 0.83g Folic acid, 200 g Choline chloride, 11.7 g Zn, 12.5 g Fe, 16.6 mg Se, 16.6 mg Co, 66.7 g Mg and 5 g Mn.
CFM: concentrate feed mixture. WS: Wheat straw. [2]Hemicellulos = NDF – ADF.
[3]Cellulose = ADF – ADL. [4]Cell soluble-NDF = 100 – NDF.

Table 2: Productive performance of the experimental groups

| | Experimental rations | | | |
|---|---|---|---|---|
| | 0 % RY | 0.10 % RY | 0.20 % RY | |
| Item | $R_1$ | $R_2$ | $R_3$ | SEM |
| Initial weight (kg) | 27.300 | 27.100 | 27.200 | 1.938 |
| Final weight (FW, kg) | 39.900$^{b}$ | 40.960$^{ab}$ | 42.750$^{a}$ | 2.580 |
| Total body weight gain (TBWG, kg) | 12.600$^{c}$ | 13.860$^{b}$ | 15.550$^{a}$ | 1.416 |
| Experimental duration period | 84 days | | | |
| Average daily gain (ADG, g/day) | 150$^{c}$ | 165$^{b}$ | 185$^{a}$ | 16.81 |
| Average body weight, kg* | 33.600 | 34.030 | 34.975 | 2.169 |
| Metabolic body weight ($kgW^{0.75}$) | 13.956 | 14.090 | 14.382 | 0.666 |
| Feed intake | | | | |
| Concentrate feed mixture (CFM), g | 816 | 811 | 839 | 43.22 |
| Wheat straw (WS), g | 411 | 407 | 426 | 4.23 |
| Dry matter intake (DMI) as | | | | |
| g/h/day | 1227 | 1218 | 1265 | 40.62 |
| $g/kgW^{0.75}$ | 87.92 | 86.44 | 87.96 | 2.84 |
| kg/ 100 kg live body weight (LBW) | 3652 | 3579 | 3617 | 117.35 |
| Digestible crude protein intake (DCPI) as | | | | |
| g/h/day | 89.08 | 93.42 | 99.18 | 3.37 |
| $g/kgW^{0.75}$ | 6.38 | 6.63 | 6.9 | 0.23 |
| g/ 100 kg live body weight (LBW) | 265 | 275 | 284 | 9.22 |
| Total digestible nutrients intake (TDNI) as | | | | |
| g/h/day | 850 | 869 | 922 | 30.27 |
| $g/kgW^{0.75}$ | 60.91 | 61.67 | 64.11 | 2.06 |
| g/ 100 kg live body weight (LBW) | 2530 | 2554 | 2636 | 84.23 |
| Feed conversion expressed as g. intake / g. gain of | | | | |
| Dry matter | 8.18 | 7.38 | 6.84 | 0.31 |
| Digestible crude protein | 0.59 | 0.57 | 0.54 | 0.019 |
| Total digestible nutrients | 5.667 | 5.267 | 4.984 | 0.198 |

a, b and c: Means in the same row having different superscripts differ significantly ($P<0.05$).
SEM: Standard error of mean. *Average body weight, kg = (Initial weight + final weight) / 2

**Productive Performance of the Experimental Groups:** Data of Table (2) showed that adding rymi yeast at 0.10 (R2) or 0.20% (R2) in barki sheep rations significantly increased both total body weight gain (TBWG) and average daily gain (ADG) in comoarison with the control one (R1) that containing 0% RY). Furthermore, the level of addition was significantl affected on values of TBWG and ADG. Group sheep that received 0.20% RY recorded the highest values of final weight (FW), TBWG and ADG, folled by that received 0.10% RY containing ration, meanwhile, sheep that received R1 that not contained any addition (% RY) recorded the lowest values of FW, TBWG and ADG. Generally with increasing level of addition from RY in the ration an increasing in values of FW, TBWG and ADG were recorded. Dietary treatment had no significantly (P>0.05) effect in voulantary intake of concentrate feed mixture (CFM) that ranged from 811 to 839 g/h/day and wheat straw (WS) that ranged from 707 to 426 g/h/day. All calculated parameters of feed intake that expressed as g/h/day, g/kgW0.75 or kg/ 100 kg live body weight (LBW) of DM, DCP were not affected by adding RY in the rations. This mentioned that dietary treatment had no effect on sheep palatability. On the other hand, values of feed con version that expressed as g. intake/ g. gain of DM, DCP or TDN were insignificantly (P>0.05) improved. Incorporation 0.20% RY (R3) recorded the highest value of feed conversion, followed by sheep that fed 10% RY. These result in agreement with those obtained by McPeake *et al.* [54] who noted that steers fed a various combinations and concentrations of *Lactobacillus acidophilus* strains and *Propionibacterium freudenreichii* PF-24 had greater final weight, average daily gain, dry matter intake in comparison with control steers. In addition to, Krehbiel *et al.* [11] mentioned that a summary of results of several studies which showed that feeding a microbial feed supplements (combination of live cultures of *L. acidophilus*, *L. plantarum*, *L. casei* and *S. faecium*) at processing, throughout the receiving period resulted in a 13.2% increase in daily gain, 2.5% increase in feed consumption and a 6.3% improvement in feed gain. Also, Swinney-Floyd *et al.* [55] reported that feedlot calves which treated with Propionibacterium P-63 alone or in combination with L. acidophilus LA53545 had higher average daily gain than those of the control. Moreover, Umesh Sontakke [56] reported that fungal feed additives based on Saccharomyces cerevisiae increase feed intake rather than alter feed conversion efficiency. The main effects of fungal feed additives are therefore regarded as being intake-driven. Many factors are known to influence appetite like palatability, the rate of fiber digestion, the rate of digesta flow and protein status. The fungal products certainly have a pleasant odour and the ability of yeast to produce glutamic acid could benefit the taste of feedstuffs supplemented with yeast culture. Some studies have shown increased dry matter intake and milk production when yeast was fed during periods of heat stress, possibly reflecting the role in aiding appetite during time of stress. Furthermore, Habeeb *et al.* [7] reported that dry matter intake (DMI) is often considered to be a function of the initial rate of fibber digestion; early stimulation of ruminal activity can be expected to have a major impact on the feed consumption and can provide a driving force for improved animal performance. In addition to, Saleh *et al.* [56] observed that adding active dry yeast (ADY) to male lambs tended to increase insignificantly DMI from concentrate feed mixture (CFM) and rice straw (RS).

The positive effect on animal production, when observed, is better explained by an increase of feed intake rather than a better feed digestibility. Moreover, Pedro et al. [57] noted that yeast culture stimulated the rate of degradation of solid feeds in the rumen within the first 6 to 8 hrs after the meal; the animals can ingest more dry matter to fill their digestive compartment at the same level and this physical regulation could be involved to explain the higher feed intake in treatment animals..

**Nutrients & Cell Wall Digestibility Coefficients and Nutritive Values of the Experimental Rations:** Data presented in Table (3) showed that adding Rymi yeast (RY) in sheep rations improved all nutrient digestibility coefficients includes (DM, OM, CP, CF, EE, NFE), cell wall constituents digestibility (NDF, ADF, hemicellulose and cellulose) and nutritive values (TDN and DCP). Incorporation 0.10 or 0.20% in sheep rations significantly (P<0.05) increased nutrient digestibility coefficients that includes (DM, OM, CP, EE, NFE) comparing to control one that contained (0% RY). Meanwhile sheep received 0.20% RY ($R_3$) had significantly increasing in CF digestibility in comparison with that received 0 or 0.10% RY. Increasing level of adding from RY caused significantly (P<0.05) increasing in their values determined of cell wall constituents digestibility (NDF, ADF, hemicellulose and cellulose) and nutritive values (TDN and DCP).

Best values of digestibility coefficients, cell wall constituents digestibility and nutritive valued were realized wit adding 0.20% RY ($R_3$) followed by that containing 0.10% RY ($R_2$) compared to that fed ration containing 0% RY ($R_1$, control). Different factors influence the response of yeast cells in ruminants such as dose,

Table 3: Nutrients & cell wall digestibility coefficients and nutritive values of the experimental rations

| | Experimental rations | | | |
|---|---|---|---|---|
| Item | 0 % RY $R_1$ | 0.10 % RY $R_2$ | 0.20 % RY $R_3$ | SEM |
| Nutrient digestibility (%) of | | | | |
| Dry matter (DM) | 76.14$^c$ | 78.09$^b$ | 79.16$^a$ | 1.378 |
| Organic matter (OM) | 78.43$^b$ | 79.56$^a$ | 80.22$^a$ | 0.895 |
| Crude protein (CP) | 63.24$^c$ | 66.81$^b$ | 68.33$^a$ | 2.292 |
| Crude fiber (CF) | 72.36$^b$ | 73.09$^b$ | 74.35$^a$ | 0.998 |
| Ether extract (EE) | 82.17$^c$ | 83.32$^b$ | 84.15$^a$ | 0.929 |
| Nitrogen-free extract (NFE) | 76.45$^c$ | 79.09$^b$ | 80.87$^a$ | 1.926 |
| Cell wall constituents digestibility of | | | | |
| Neutral detergent fiber (NDF) | 64.20$^c$ | 66.18$^b$ | 68.34$^a$ | 1.850 |
| Acid detergent fiber (ADF) | 42.23$^c$ | 44.11$^b$ | 45.96$^a$ | 1.635 |
| Hemicellulose | 68.13$^c$ | 70.21$^b$ | 72.53$^a$ | 1.934 |
| Cellulose | 77.14$^c$ | 79.33$^b$ | 82.95$^a$ | 2.529 |
| Nutritive values (%) | | | | |
| Total digestible nutrient (TDN) | 69.26$^c$ | 71.38$^b$ | 72.85$^a$ | 1.605 |
| Digestible crude protein (DCP) | 7.26$^b$ | 7.67$^a$ | 7.84$^a$ | 0.300 |

a, b and c: Means in the same row having different superscripts differ significantly ($P<0.05$).

SEM: Standard error of mean RY: Rymi yeast (RY)

$R_1$: 1st experimental ration assigned as control and it contained 0% RY.

$R_2$: 2$^{nd}$ experimental contained 0.10% RY (1 g / kg CFM).

$R_3$: 3$^{rd}$ experimental ration replace ration contained 0.20% RY (2 g / kg CFM).

diets, strains and physiological conditions. A particular dose of yeast culture may be required after which there may not be further effects on digestibility in a particular feeding condition. For example, [58] noted that, supplementation of *Saccharomyces cerevisiae* culture at (0, 2.5, 5 g day$^{-1}$) in Nubian kids ration increased OM digestibility by 12.1 and 10.1% and NDF digestibility by 13.3 and 10.5% for 2.5 and 5 g day$^{-1}$ yeast culture, respectively, comparing to control ration (0% yeast culture). In addition to, [59] recorded that, digestibility of DM, NDF and ADF of berseem hay were increased when the basal ration (berseem hay) was supplemented with *Saccharomyces cerevisiae* (22.5 g day$^{-1}$), meanwhile sheep that received, 11.25 g day$^{-1}$ of *Saccharomyces cerevisiae containing ration* had no effect in sheep. Degradation rate of NDF and ADF was increased by addition *Saccharomyces cerevisiae* at the both levels of supplementation. Shorter lag time was noticed in the digestion of NDF and ADF at both levels of *Saccharomyces cerevisiae* supplementation. performed An experiment feeding containing three levels of yeast culture (09, 4 or 8 g yeast/day) to sheep was carried out by [60]. They reported that digestion coefficients of DM improved at both levels of yeast comparing to control, meanwhile, CP digestibility was significant only between control and the group fed with 8 g yeast/day as noted by. Also, Wohlt *et al*. [61] found that, digestibility of CP and ADF was significantly improved by the adding 10 or 20 g of yeast per day to early lactating cows fed with diets based on corn silage. The CP digestibilities with 0, 10 or 20 g of yeast per day were 78.5, 80.8 and 79.5% and ADF digestibility with 0, 10 or 20 g of yeast day$^{-1}$ were 54.4, 60.2 and 56.8%, respectively. DM and fiber digestibilities were similar for all cows in control and yeast supplemented diet. On the other hand, Tang *et al*. [62] studied the impact of yeast culture on *in vitro* fermentation characteristics of rice straw, wheat straw and maize stover. They recorded that adding yeast culture at different levels (0, 2.5, 7.5 g kg$^{-1}$ DM of straw) increased their *in vitro* DM digestibility for each type of straw. Also, [63] investigated the impact of adding yeast culture (*Saccharomyces cerevisiae,* 5x10$^9$ live organisms/g of growth medium) at 10 g/steer daily to three diets composed of 75% alfalfa silage and 25% barley, 96% corn silage and 4.0% soybean meal or 75% dry-rolled barley and 25% alfalfa hay in steers in separate trials for over 2 years. They noted that the digestibility coefficients of the DM, CP, ADF, NDF did not differ due to inclusion of yeast, except for the high-grain diet in the second year, in which yeast supplementation increased DM and CP digestibility. furthermore, Jouany *et al*. [64] used two probiotics, *Saccharomyces cerevisiae* and *Aspergillus oryzae* in defaunated and refaunated sheep. They noticed that apparent digestibility of plant cell walls was similar in

defaunated sheep, but was increased with the addition of *Saccharomyces cerevisiae* (+16%) in refaunated sheep. Simultaneously, the effect of *Saccharomyces cerevisiae* or *Aspergillus oryzae* on *in situ* ADF digestion was either not significant or negative in defaunated animals, whereas, it became positive in refaunated rumen after a residence time of 12 h. Sometimes, the response of yeast culture on the digestibility depends upon the type of strain of cultures as noted by [65]. For instance, Miller-Webster *et al*. [66] carried out a study to established the effect of two different yeast cultures on rumen microbial metabolism. The treatments were (a) control lactation ration, (b) yeast culture 1 (YC1, Diamond-V XP) and (c) yeast culture 2 (YC2, A-Max), both fed at an equivalent of 57 g day$^{-1}$. They found that both yeast culture products realize an increasing in their DM digestion, propionic acid production and protein digestion in comparison with the control. YC1 demonstrated an increase in molar percentage of propionic acid, a reduction in acetic acid and a lower mean nadir (daily low) pH compared with YC2. Ruminal cultures treated with YC digested more protein and contributed less bypass N than control. Supplementing YC2 resulted in a tendency for higher microbial N kg$^{-1}$ DM digestion than YC1. YC1 resulted in production of rumen microbes containing less protein than YC2. All these results confirm that several factors might influence the variability observed between experiments and that many other experimental parameters might have to be tested in such databases to determine more precisely the conditions in which yeasts are the most effective as noted by [2]. Meanwhile, Kawas *et al*. [67] reported that addition yeast in finishing diets for lambs had no effect on DM, NDF or non-fibrous carbohydrates digestibility. On the other hand, the present results in agreement with those found by [68] who noted that, OM and CP digestibility increased when they fed dairy cows with yeast culture (*Saccharomyces cerevisiae*) (57 g day$^{-1}$) along with a basal diet containing 32.5% corn silage, 17.5% alfalfa hay, 35.3% corn grain and 12.7% soybean meal. Also, [69, 70] reported a positive effect of yeast supplementation on digestion of CF, ADF, NDF, hemicellulose and cellulose. Wiedmeier *et al*. [71] showed that DM and hemicellulose digestibility was increased when yeast culture added at 90 g day$^{-1}$ and *A. oryzae* 2.63 g day$^{-1}$ along with a basal diet in non-lactating cows. Nutrient digestibility increases due to yeast supplementation which might be attributed to the stimulation of growth of rumen microbial populations [72]. It has been suggested that yeasts may scavenge available oxygen on the surfaces of freshly ingested feeds to maintain metabolic activity thus deceasing redox potential in the rumen [73]. This change creates better conditions for the growth of strict anaerobic cellulolytic bacteria, stimulates their attachment to forage particles [74]. In addition, *Saccharomyces cerevisiae* may provide growth factors, such as organic acids or vitamins, thereby stimulating ruminal populations of cellulolytic bacteria as noted by [75]. Furthermore, occurring increasing in the number of total bacteria [76], cellulolytic bacteria [72, 76] and proteolytic bacteria [68] was observed when the yeast culture was used as a feed supplement in ruminants causing encouragements in CF and cell wall constituents digestibility. On the other hand, Enjalbert *et al*. [77] observed that, receiving non lactating cows ration containing 0.5% yeast culture along with basal diet containing corn silage, wheat grain and protein concentrate did not change the degradation of DM, NDF or ADF from hay suspended in nylon bags or coefficients of degradation kinetics. Also, [78] noted that when early lactating Holstein cows fed ration containing 10 g day$^{-1}$ yeast culture had no effect on ruminal digestibility. Also, Harrison *et al*. [72] reported that, there is no significant improvement in apparent nutrient digestibility when yeast culture added in lactating cows that fed 40% corn silage and 60% concentrate (DM basis). Moreover, rate of disappearance of cellulose *in vitro* was lower in cows receiving yeast. In addition to, Arambel and Kent [79] noticed no significant differences in digestibility of CP, ADF and NDF in early lactating dairy cows supplemented with 90 g day$^{-1}$ of yeast culture *Saccharomyces cerevisiae*. However, [80] observed a tendency toward increase in OM digestibility (+0.5%) due to supplementation of yeast.

**Nitrogen Utilization by the Experimental Groups:** Data illustrated in Table (4) cleared that inclusion Rymi yeast (RY) at 010 or 0.20% in Barki sheep rations had no significantly ($P<0.05$) effect on nitrogen intake (NI) and digested nitrogen (DN). Meanwhile, it significantly ($P<0.05$) decreased fecal nitrogen (FN), urinary nitrogen (UN) and total nitrogen extraction (TNE). On the other hand, it significantly ($P<0.05$) improved values of nitrogen retention (NR), NR, % of NI and NR, % of DN in comparison with that fed 0% RY containing ration. The improvements in NR reach to 123.5% and 138.5% for ($R_1$ and $R_2$), respectively, meanwhile it improved their values of (NR, % of NI) by 124.4% and 134.7% for ($R_1$ and $R_2$), but it improved their values of (NR, % of DN) by 121.6% and 129.4% for ($R_1$ and $R_2$) comparing to control one ($R_1$), that contained 0% RY with assuming that it

Table 4: Nitrogen utilization by the experimental groups

| | Experimental rations | | | |
|---|---|---|---|---|
| Item | 0 % RY $R_1$ | 0.10 % RY $R_2$ | 0.20 % RY $R_3$ | SEM |
| Nitrogen intake (NI) | 22.56 | 22.40 | 23.20 | 0.250 |
| Fecal nitrogen (FN) | 4.36[a] | 3.92[b] | 3.71[b] | 0.105 |
| Digested nitrogen (DN) | 18.20 | 18.48 | 19.49 | 0.263 |
| Urinary nitrogen (UN) | 8.03[a] | 5.92[b] | 5.40[c] | 0.350 |
| Total nitrogen extraction (TNE) | 12.39[a] | 9.84[b] | 9.11[b] | 0.443 |
| Nitrogen retention (NR) | 10.17[c] | 12.56[b] | 14.09[a] | 0.531 |
| NR, % of NI | 45.08[c] | 56.07[b] | 60.73[a] | 2.049 |
| NR, % of DN | 55.88[c] | 67.97[b] | 72.29[a] | 2.146 |

a, b and c: Means in the same row having different superscripts differ significantly (P<0.05).

SEM: Standard error of mean. RY: Rymi yeast (RY).

$R_1$: 1st experimental ration assigned as control and it contained 0% RY.

$R_2$: 2nd experimental contained 0.10% RY (1 g / kg CFM).

$R_3$: 3rd experimental ration replace ration contained 0.20% RY (2 g / kg CFM).

Table 5: Ruminal fluid parameters of the experimental groups

| | Experimental rations | | | |
|---|---|---|---|---|
| Item | 0 % RY $R_1$ | 0.10 % RY $R_2$ | 0.20 % RY $R_3$ | SEM |
| pH | 6.31[b] | 6.43[ab] | 6.51[a] | 0.036 |
| Ammonia nitrogen ($NH_3$-N), mg/dl | 22.21[c] | 22.70[b] | 22.93[a] | 0.94 |
| Total volatile fatty acids (TVFA's), meq/dl | 9.02[b] | 9.17[ab] | 9.31[b] | 0.52 |
| Molar proportion of volatile fatty acids | | | | |
| Acetic acid % | 60.21 | 60.43 | 60.63 | 0.134 |
| Propionic acid % | 24.92 | 24.82 | 24.71 | 0.140 |
| Butyric acid % | 10.16 | 10.25 | 10.41 | 0.108 |
| Iso-Butyric acid % | 1.42[a] | 1.38[ab] | 1.35[b] | 0.013 |
| Valeric acid % | 2.46 | 2.41 | 2.38 | 0.020 |
| Iso-Valeric acid % | 0.83[a] | 0.71[a] | 0.52[b] | 0.043 |
| Acetic: Propionic acids ratio | 2.42 | 2.43 | 2.45 | 0.016 |
| Ruminal nitrogen fractions (mg/ 100 ml) | | | | |
| Total nitrogen (TN) | 43.86 | 44.11 | 44.21 | 0.149 |
| Non protein nitrogen (NPN) | 21.13 | 21.29 | 21.31 | 0.078 |
| True protein nitrogen (TPN) | 22.73 | 22.82 | 22.90 | 0.154 |

a, b and c: Means in the same row having different superscripts differ significantly (P<0.05).

SEM: Standard error of mean. RY: Rymi yeast (RY).

$R_1$: 1st experimental ration assigned as control and it contained 0% RY.

$R_2$: 2nd experimental contained 0.10% RY (1 g / kg CFM).

$R_3$: 3rd experimental ration replace ration contained 0.20% RY (2 g / kg CFM).

equals 100%. Cunha *et al.* [81] studied the impact of live and inactive sugarcane yeast on beef cattle, they observed that effects of treatments were not observed (P>0.05) for the evaluated variables nitrogen intake (NI), fecal excretion of nitrogen (FEN), urinary excretion of nitrogen (UEN), nitrogen balance (NB), urinary urea nitrogen (UUN), efficiency of nitrogen utilization in relation to nitrogen intake (ENU1) and to absorbed nitrogen (ENU2) and microbial efficiency (MICEF). Also, they mentioned that rumen microbiota had sufficient $NH_3$-N for microbial protein synthesis. Urinary urea excretion values were slightly high as noted by [82], although serum urea concentrations were within 17-45 mg/dl, considered normal as described by [83]. On the other hand, Kowalik *et al.* [84] noted that nitrogen excreted in feces and urine, as well as N retained, was not modified by addition of live *Saccharomyces cerevisiae*. Tripathi *et al.* [85] showed a non significant decrease in

N retention in lambs fed live cell yeast. Moreover, Mwenya *et al.* [86] reported that live yeast added to the ration for cows significantly increased the amount of nitrogen in urine and non significantly decreased nitrogen excreted in feces and final nitrogen retention when compared with animals fed live yeast mixed with galacto-oligosaccharides. Our results in agreement with those obtained by [87] who found a significant improvement in nitrogen retention in sheep fed 2 and 4 g day–1 live *Saccharomyces cerevisiae* compared to the control group. Also, they suggested that the increase in nitrogen retention in rams fed live yeast was probably caused by higher proteolytic activity of the rumen microorganisms. According to [86] the differences in the results may be caused by the type of ration, animal species and age and mode of production of strain of live yeast, i.e. mass production vs. laboratory preparation.

**Ruminal Fluid Parameters of the Experimental Groups:** Data presented in Table (5) showed that adding 0.20% Rumi yeast (RY) significantly increased ($P<0.05$) values of ruminal pH, ammonia nitrogen ($NH_3$-N) and total volatile fatty acids (TVFA's) concentrations ($R_3$) in comparison with the control one ($R_1$). Meanwhile sheep that received 0.10% RY containing ration ($R_2$) caused a significant ($P<0.05$) increasing in value of $NH_3$-N only, but it recorded in significant ($P>0.05$) increasing in values of pH and TVFA's comparing to the control ($R_1$). On the other hand, except for values of iso-butyric and iso-valeric acids the other values of different molar proportion of volatile fatty acids includes (acetic, propionic, butyric and valeric acids, in addition acetic: propionic ratio) were not affected ($P>0.05$) by adding RY in sheep rations ($R_2$ and $R_3$) compared to the control ($R_1$). Also, data of (Table 5) mentioned that values of ruminal nitrogen fractions includes {total nitrogen (TN), non protein nitrogen (NPN) and true protein nitrogen (TPN)}were not affected ($P>0.05$) by adding RY at 0.10% or 0.20% ($R_2$ and $R_3$) comparing to control ($R_1$). Rumen pH is one of the most critical determinants of rumen function, particularly for the cellulolytic bacteria, which fail to grow at pH 6.0 and below [88]. Ruminal pH was not affected by *Saccharomyces cerevisiae* (Sc) supplementation [60]. The highest and the lowest ruminal pH values were recorded by sheep that received rations containing 2.5 g Sc and control groups that not contained Sc as obtained by [89]. Furthermore, Abdel-Ghani [10] recorded that ruminal pH of dairy cows and goat were respectively increased by adding Yc Probiotics and yeast culture have many benefits when added to the ration.

Dole_ali *et al*. [90] observed that addition of yeast culture into the feeding ration in sheep decreasing in pH and fluctuated near the lower limit as compared with control group. Guedes *et al*. [91] reported that the inclusion of Sc increased ruminal pH and decreased lactate concentration. Meanwhile, [92] noted that ruminal pH was not affected by yeast culture. Otherwise, [93] reported that ruminal pH reductions associated with feeding high dietary concentrate (70%) diets in dairy.

Rumen ammonia concentration has been used as an indicator of microbe protein degradation and of non-protein nitrogen utilization as noted by [94]. Also, Dawson *et al*. [95] recorded that the addition of *Saccharomyces cerevisiae (*Sc) to hay based diet fed to steers had no effect on $NH_3$-N concentrations. Meanwhile, Newbold *et al*. [26] revealed that $NH_3$ concentrations increased when sheep fed ration containing Sc. Also, Biricik and Yavuz [96] showed that ruminal $NH_3$-N concentration was increased at 4 hrs post feeding with adding Sc in the ration. Also, [97] reported that the inclusion of Sc at 0.5 % increased $NH_3$-N concentration. Furthermore, Erasmus *et al.* [98] noted that *Saccharomyces cerevisiae* supplementation was associated with an increased flow of microbial protein leaving the rumen and enhanced supply of amino acids entering the small intestine. However, [78] observed no effect with yeast on the passage of nitrogen fraction and amino acids to the small intestine. But, [99] found no alteration in ruminal $NH_3$-N concentration due to the addition of yeast. Stewart and Smith [88] reported that the inclusion of Sc at one g/day had no effect on $NH_3$-N concentration. Also, [85] noted that addition commercial live yeast culture to the lamb rations at 4 g/day did not affect $NH_3$-N concentration. On the other hand, Dole_ali *et al*. [90] revealed that value $NH_3$-N concentration was decreased with adding Sc. In addition to, $NH_3$-N was not affected by live yeast culture supplementation at 4 g/day as obtained by [97, 100, 101]. Meanwhile, Kholif and Khorshed [70] noticed that no alteration in ruminal $NH_3$-N concentration due to the addition of yeast. The development of the rumen is primarily chemical being influenced by volatile fatty acids (VFA's) metabolism and absorption in the rumen. These (VFA's) are produced by naturally occurring microbes as noted by [65]. On the other hand, Adams *et al*. [102] observed a little effect of yeast supplementation on ruminal (VFA's) concentrations. Furthermore, [90] noted that the YC showed a positive effect on production of TVFA's (127.6 vs. 84.0 m mol/l) and the utilization of ammonia was higher in experimental groups (8.40) than the control (9.06 m mol/l). Also, Galip

[103] stated that adding *Saccharomyces cerevisiae* (Sc) to the forage-enriched ration ruminal VFA's concentrations tended to increase. In addition to, Kholif and Khorshed [70] found no differences in the concentrations of acetate, propionate and butyrate after 24 and 48 hrs when baker's yeast was include. Morover, [60] reported that forage: concentrate ratio of the ration at 3 hrs post feeding, the ruminal TVFA's were increased from 91.26 to 103.34 m mol/l in control vs. animals that fed 2.5 g Sc containing ration. Also, Dole_ali *et al.* [90] showed that concentration of TVFA's was increased with adding *Saccharomyces cerevisiae*. In addition to, Longuski *et al*. [104] observed that adding yeast at (56 g/cow/d) had no effect on total ruminal VFA's or acetate concentration. Furthermore, [93] recorded that total VFA's concentration was not affected by either the yeast supplementation or dietary concentrate level, (averaging 102.3 mml). Neither acetate nor propionate concentrations were affected with the yeast supplementation in both 50 and 70% concentrates. However, ruminal acetate and propionate concentrations were decreased and increased respectively. TVFA concentration was significantly higher ($P<0.01$) in live YC fed kids at 2 and 4 months as described by Özsoy *et al.* [105]. Moreover, Cunha *et al.* [81] investigate the effect of live and inactive sugarcane yeast on beef cattle, they noted that feed additives did not influence ($P>0.05$) on values of total and individual VFA's concentrations as well as acetate to propionate ratio.

The effects of yeast culture (YC) on volatile fatty acids (VFA's) and ammonia nitrogen-N concentrations in rumen fluid were summarized previously by [16, 106-108]. The effects are always small and often insignificant and it is our view that even where the differences reach statistical significance the biological significance is low. Possibly of much greater significance are findings that YC stimulated the rate of VFA production from different substrates *in vitro* in rumen fluid taken from sheep receiving YC [109, 110]. Several modes of action have been proposed on the function of yeast in the rumen [111, 112]; live yeast scavenges oxygen within the rumen, thus stimulating the growth of anaerobic bacteria, which increases fiber digestion in the rumen; yeast reduces lactic acid producers, stimulates lactic acid utilizes, promotes growth of ruminal protozoa and thus, alleviates incidence of rumen acidosis. However, some aspects of these proposed modes of action of yeast in the rumen may have been of limited importance in the current experiment: the high-grain diet would have resulted in less oxygen in rumen fluid than a roughage-based diet, fibrolytic activity was not predominant compared high-grain with amylolytic activity because of low ruminal pH and lactic acid is not a major issue in cattle adapted to high-grain diets [113]. Modes of action have been suggested to explain the effects that yeast culture, based on *Saccharomyces cerevisiae,* can have on rumen fermentation and ruminant production [16, 107, 114, 115]. An increasing in bacterial numbers recovered from the rumen is the most reproducible effect of dietary yeast supplementation and it has been suggested that the increased bacterial population is central to the action of the yeast in improving ruminant productivity [107]. What causes the increased bacterial count is not clear, however. Removal of oxygen ($O_2$), which would inhibit the growth of the strictly anaerobic bacteria of the rumen, as noted by [116], but no experimental evidence has appeared in support of this hypothesis. On the other hand, yeast has been shown to provide nutrients which stimulate the growth of certain rumen micro-organisms. Aqueous extracts prepared from *Saccharomyces. cerevisiae* stimulated the growth and activity of the lactic acid-utilizing rumen bacterium *Selenomonas ruminantium,* in pure culture [117, 118]. Yeast has been shown also to provide vitamins to support the growth of rumen fungi [25]. Moreover, Newbold *et al*. [26] suggested two modes of action of yeast in stimulating rumen fermentation. The first, that yeast respiratory activity protects anaerobic rumen bacteria from damage by $O_2$. They added yeast to rumen fluid *in vitro* and found that the rate of $O_2$ disappearance increased by 46-89% and also stimulated the total and cellulolytic bacterial population numbers. The second hypothesis, that yeast provides malic and other dicarboxylic acids which stimulate the growth of some rumen bacteria. The authors were examined by comparing between the effects of yeast and malic acid on rumen fermentation in sheep. The authors found that yeast increased significantly the total viable count of bacteria whereas malic acid did not and concluded that the stimulation of rumen bacteria yeast is at least partly dependent on its respiratory activity and is not mediated by malic acid. The mode of action of yeast in ruminant involves modification of rumen fermentation, related to increased bacterial numbers and concluded that yeast effect in ruminants is strongly dependent on the diet and also that particle yeast size (5x10ìm) is also significantly higher than bacteria size (0.5x5ìm). Among yeast, *Saccharomyces serevisiae* is industrially important due to its ability to convert sugars (i.e. glucose, maltose) into ethanol and carbon dioxide [119].

Table 6: Blood parameters of the experimental groups

| | Experimental rations | | | |
|---|---|---|---|---|
| Item | 0 % RY $R_1$ | 0.10 % RY $R_2$ | 0.20 % RY $R_3$ | SEM |
| Glucose (mg/dl) | 72.31 | 72.69 | 72.88 | 0.121 |
| Hemoglobin (g/dl) | 12.24[b] | 12.40[ab] | 12.61[a] | 0.059 |
| Red blood cell (RBC) count (n x$10^6$/µl) | 3.91 | 3.95 | 3.98 | 0.019 |
| White blood cell (WBC) count (n x$10^3$/µl) | 4.09[b] | 4.13[ab] | 4.18[a] | 0.017 |
| Total protein (g/ dl) | 6.51[b] | 6.56[ab] | 6.62[a] | 0.020 |
| Albumin (g/ dl) | 3.28 | 3.29 | 3.33 | 0.019 |
| Globulin (g/ dl) | 3.23 | 3.27 | 3.29 | 0.019 |
| Albumin: globulin ratio | 1.02 | 1.01 | 1.01 | 0.008 |
| Lipids parameters | | | | |
| Total cholesterol (mg/dl) | 118 | 115 | 117 | 0.907 |
| Total lipids (mg/dl) | 340 | 336 | 330 | 2.874 |
| Triglycerides (mg/dl) | 12.15[a] | 12.07[ab] | 12.01[b] | 0.024 |
| Liver functions | | | | |
| GPT (U/I) | 36.11 | 36.04 | 35.98 | 0.042 |
| GOT (U/I) | 20.23 | 20.15 | 20.11 | 0.079 |
| Kidney functions | | | | |
| Urea (mg/dl) | 17.98[a] | 17.75[b] | 17.63[b] | 0.053 |
| Createnin (mg/dl) | 1.15[a] | 1.08[b] | 0.98[c] | 0.022 |
| Alkaline phosphatase (U/I) | 61.36 | 61.03 | 60.92 | 0.095 |

a, b and c: Means in the same row having different superscripts differ significantly (P<0.05).

SEM: Standard error of mean. RY: Rymi yeast (RY)

Glutamic oxaloacetic transaminase. GPT: Glutamic pyruvic transaminase..

$R_1$: 1st experimental ration assigned as control and it contained 0% RY.

$R_2$: 2nd experimental contained 0.10% RY (1 g / kg CFM).

$R_3$: 3rd experimental ration replace ration contained 0.20% RY (2 g / kg CFM)

**Blood Parameters of the Experimental Groups:** Data of blood parameters that illustrated in (Table 6) cleared that dietary treatments had no significant (P>0.05) on values of glucose, Red blood cell (RBC) count, albumin, globulin, albumin: globulin ratio, total cholesterol, total lipids, GPT, GOT and Alkaline phosphatase. Meanwhile adding Rymi yeast at 0.20% ($R_3$) significantly (P<0.05) increased value of hemoglobin, White blood cell (WBC) count, total protein, but it significantly (P<0.05) decreased value of triglycerides, Urea and creatinin in comparison with the control ($R_1$). Generally, adding RY occurred decreasing in total cholesterol, total lipids, triglycerides, GPT, GOT, urea, Createnin and alkaline phosphatase. So, it can be mentioned that incorporation RY in sheep rations useful because it occurred an improvements in sheep health throughout decreasing their lipids contents, liver and kidneys functions. These results in agreement with those obtained by Habeeb [6] who reported that when active dry yeast (YEA-SACC® 1026) incorporated at the rate 10 g/ head/ day in the lactating Baladi cows rations caused a significantly (P<0.05) increasing in their contents of total lipids, albumin, globulin, $T_3$, $T_4$, total lipids and triglycerides, meanwhile insignificantly decreasing (P.0.05) was observed for total cholesterol, but insignificantly increasing (P>0.05) was recorded for values of GOT, GP, urea -nitrogen and cratenine comparing to control. Moreover, El-Ashry *et al* [120] with lactating buffalo, they showed that total proteins, albumin and globulin concentrations increased insignificantly from 6.64 to 7.09, 3.30 to 3.50 and 3.34 to 3.37g/dl, respectively, when added 10 g/h/day Baker's yeast (containing 109 CFUSc per gram) while GOT and GPT activities were not significantly affected due to treatment.

On the other hand, with male lambs, Saleh *et al.* [56] noted that total proteins, albumin, globulin and urea concentrations increased insignificantly while GOT and GPT activities were not significantly affected by the yeast supplementation.

In Barky male lambs, El-Ashry *et al.* [121] reported that serum total proteins, albumin and globulin increased significantly from 7.93 to 8.26, 4.31 to 4.45 and 3.61 to 3.98 g/dl, respectively while urea concentration

was not significantly affected with yeast supplements. Furthermore, Stella *et al.* [122] reported that supplementation of live *Saccharomyces cerevisia* for lactating dairy goats during early lactation period was not affected significantly on plasma GOT, GPT and glucose concentrations. In rabbits, Habeeb *et al.* [123] revealed that the levels of T3and T4 hormones as well as liver immunity function (i.e. total proteins, albumin and globulin), serum total lipids and triglycerides concentrations increased significantly while urea-N and creatinin (liver function) and cholesterol (heart function) concentrations as well as serum SCOT and SGPT activities (liver function) were not significantly affected with adding active dry yeast (ADY) to the diet of growing rabbits. Adding ADY caused a significant increase the levels of both T4 and T3hormones which lead to increase the protein and fat biosyntheses. At the same time, ADY improved the appetite of rabbits and increase the digestion of food and consequently improved the utilization of the diet which leads to increase the feed intake which leads to increase the blood metabolites. Consequently, ADY have a positive effect on protein and fat metabolism as well as thyroid hormonal secretions and in the same time had no adverse effect on liver, kidney and heart functions. Lehloenya *et al.* [124] found that plasma insulin levels in multiparous Holstein cows fed propionibacteria plus yeast during mid lactation (9–30 weeks) were 30–34% greater than control. The authors concluded that combined feed supplement may hold potential as a natural feed alternative to hormones and antibiotics to enhance lactational performance. In Egyptian native cattle, Ashour *et al.* [125] noticed that treatment with yeast supplementation (Sc1026) produced highly significant decrease in the activity of ALT enzyme and significant increase in the activity of AST enzyme while yeast treatment did not affect concentrations of blood plasma thyroid hormones ($T_3$ and $T_4$).

## CONCLUSION

Under condition as that available through out of carrying this work, adding Rumi yeast (commercial product) as feed additive in sheep ration occurred an improvement in their growth, also it not recorded any adverse effect on their digestion coefficients, nutritive values, nitrogen utilization, ruminal fermentation, ruminal nitrogen fraction and blood constituents. In addition to, adding RY in sheep rations considered safety and important source of supplementation because it improves sheep health throughout decreasing their lipids contents, liver and kidneys functions.

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## REFERENCES

1. Mohammed Sundus, F., A. Mahmood Firas and R. Abas Enas, 2018. A review on effects of yeast (*Saccharomyces cerevisiae*) as feed additives in ruminants performance. Journal of Entomology and Zoology Studies, 6(2): 629-635.
2. Desnoyers, M., S. Giger-Reverdin, G. Bertin, C. Duvaux-Ponter and D. Sauvant, 2009. Meta analysis of the influence of *Saccharomyces cerevisiae* supplementation on ruminal parameters and milk production of ruminants. J. Dairy Sci. (92): 1620-1632. https://doi.org/10.3168/jds.2008-1414.
3. Gaggìa, F., P. Mattarelli and B. Biavati, 2010. Probiotics and prebiotics in animal feeding for safe food production. Int. J. Food Microbiol., 141: 15-28. https://doi.org/10.1016/j. ijfoodmicro.2010.02.031.
4. Shurson, G.C., 2018. Yeast and yeast derivatives in feed additives and ingredients: sources, characteristics, animal responses and quantification methods. Animal Feed Science and Technology, 235: 60-76. https://doi.org/10.1016/j. anifeedsci.2017.11.010.
5. Pancinia, S., R.F. Cooke, AP. Brandão, N.W. Diasa, C.L. Timlin, P.L.P. Fontes, A.F.F. Sales, J.C. Wicks, A. Murray, R.S. Marques, K.G. Pohler and V.R.G Mercadante, 2020. Supplementing a yeast-derived product to feedlot cattle consuming monensin: Impacts on performance, physiological responses and carcass characteristics. Livestock Science, 232: 103907 www.elsevier.com/locate/livsci.
6. Habeeb, A.A., 2017. Importance of yeast in ruminants feeding on production and reproduction. Ecology and Evolutionary Biology, 2(4): 49-58 http://www.sciencepublishinggroup.com/j/eeb doi: 10.11648/j.eeb.20170204.11.
7. Habeeb, A.A.M., H.M. Saleh, A.A. EL-Tarabany, 2017. Effect of yeast on ruminal function of farm animals a Review. Merit Research Journal of Agricultural Science and Soil Sciences, 5(5): 80-88.

8. Denev, S.A., T.Z. Peeva, P. Radulova, P. Stancheva, G. Staykova, G. Beev, *et al.,* 2007. Yeast cultures in ruminant nutrition. Bulgarian Journal of Agricultural Science, 13: 357-374.
9. Fuller, R., 1989. A review: Probiotics in man and animals. Journal of Application Bacteriology, 66: 365-378.
10. Abdel-Ghani, A.A., 2004. Influence of diet supplementation with yeast (*Saccharomyces cerevisiae*) on performance of Zaraibi goats. Small Ruminant Research, 52(3): 223-229.
11. Krehbiel, C.R., S.R. Rust, G. Zhang and S.E. Gilliland, 2003. Bacterial direct-fed Microbials in ruminant diets: Performance response and mode of action. J. Anim. Sci., 81: E120-E132.
12. Dawson, K.A. and T.P. Lyons, 1993. The effects of culture in a production Current and future role of yeast: A review of research Biotechnology in the Feed Industry, pp: 269-291.
13. Greenquist, M.A., J.S. Droillard, B. Dicke, G.E. Erickson and T.J. Klopfenstein, 2004. Effects of Lactobacillus acidophilus and Propionibacterium freudenreich on growth performance and carcass characteristics of finishing beef cattle. Kansas State University Cattlemen's Day, Report of Progress 923 and KSU Agriculture. Exp. St .and Coop. Ext. Service, 2004; pp: 71-74.
14. Petersonet, R.E., T.J. Klopfenstein, D.R. Smith, J.D. Folmer, G.E.S. Erickson, R. Hinkley, *et al*., 2005. Direct-fed microbial product for *Escherichia coli* 0157: H/ in market ready feedlot cattle. Animal Science Department University of Nebraska, pp: 64-65.
15. Mirzaei, F. and K.R. Hari, 2012. Introduction of five well-known ayurvedic medicinal plants as feed additives on livestock's performance: A review. Global Journal of Research of Medical. Plants and Indigene Medical., 1(8): 328-339.
16. Martin, S.A. and D.J. Nisbet, 1992. Effect of direct-fed microbials on rumen microbial fermentation. Journal of Dairy Science, 75: 1736-1744.
17. Tripathi, M.K., H. Chaturvedi, S.A. Karim, V.K. Singh and S.L. Sisodiya, 2007. Effect of different levels of concentrate allowances on rumen fluid pH, nutrient digestion, nitrogen retention and growth performance of weaner lambs. Small Ruminant Research, 72(2): 178-186.
18. Salim, H.J.H., 2009. The effect different levels of feeding on Karadi lambs response to local Iraqi probiotics. Sulaimani University. MSc. Thesis.
19. Seo, J.K.K., M.H. Seon-Woo, D. Kim, D.K. Santi, K. Kam and H. Jong, 2010. Direct-fed Microbials for ruminant animals. Asian-Aust. Journal of Animal. Science, 12: 1657-1667.
20. Luebbe, M.K., K.H. Jenkins, S.A. Furman and K. Kreikemeier, 2013. Effects of feeding microbial feed additives on growth performance and carcass traits of steers fed steam-flaked corn-based diets with wet distillers grains plus soluble, Nebraska Beef Cattle Report, 2013, pp: 66.
21. Galina, M., L.J. Pineda and R. Morales, 2010. Supplementation in dairy goats grazing with a slow release source of nitrogen (SLNN) with or without the addition of a probiotic lactic acid bacteria. III Congress of tropical animal production and symposium focal, Havana, Cuba, 2010.
22. Elías, A. and F.R. Herrera, 2008. Feed production through processes use of beneficial microorganism's evaluation active biotechnological activated (MEBA), 2008, pp: 8-13.
23. Elías, A., P. Chilibroste, J.B. Michelena, J. Iriñiz and D. Rodríguez, 2010. Evaluation actively MEBA and silage sorghum and sugar cane topping: nutritional value, fermentability *in vivo* and *in vitro* and animal testing and growing dairy cows. Project Report. Republic of Uruguay, 2010.
24. Jouany, J.P., 2001. 20 years of research and now more relevant than ever - the coming of age of yeast cultures in ruminant diets. In: Responding to a Changing Agricultural Landscape. Alltech's European, Middle Eastern and African Lecture Tour., pp: 44-69.
25. Chaucheyras, F., G. Fonty, G. Bertin and P. Gouet, 1995a. Effects of live *Saccharomyces cerevisiae* cells on zoospore germination, growth and cellulolytic activity of the rumen anaerobic fungus, *Neocallimastix frontalis* $MCH_3$. Current Microbiology, 31: 201-205.
26. Newbold, C.J., R.J. Wallace and F.M. McIntosh, 1996. Mechanisms of action of the yeast Saccharomyces cerevisiae as a feed additive for ruminants. British Journal of Nutrition, 76(2): 249-261.
27. Cömert M, Y. Şayan, H. Özelçam and G.Y. Baykal, 2015. Effects of *Saccharomyces cerevisiae* Supplementation and Anhydrous Ammonia Treatment of Wheat Straw on In-situ Degradability and, Rumen Fermentation and Growth Performance of Yearling Lambs Asian-Australasian Journal of Animal Science, 28(5): 639-46.

28. Xiao, J.X., G.M. Alugongo, R. Chung, S.Z. Dong, L. Li, S. Wu, Z.H. Yoon and J.Z. Cao, 2016. Effects of Saccharomyces cerevisiae fermentation products on dairy calves: Ruminal fermentation, gastrointestinal morphology and microbial community. Journal of Dairy Science, 99(7): 5401-5412.
29. Patra, A.K., 2012. The Use of live yeast products as microbial feed additives in ruminant nutrition. Asian Journal of Animal and Veterinary Advances, 7: 366-375. DOI: 10.3923/ajava.2012.366.375.
30. Abou-Raya, A.K., 1967. Animal and poultry nutrition, 1st ed Pub. Dar El-Maarif, Cairo (Arabic text book)
31. AOAC, 2005. Official Methods of Analysis, 18th ed. Association of Official Analytical Chemists, Washington, DC, USA.
32. Warner, A.C., 1964. Production of volatile fatty acids in the rumen, methods of measurements. Nutr. Abstr. Rev., 34: 339.
33. Erwin, E.S., C.J. Marco and E.M. Emery, 1961. Volatile fatty acid analysis of blood and rumen fluid by gas chromatography. J. Dairy Sci., 44: 1768.
34. Weiss, D.J. and K.J. Wardrop, 2010. Schalm's veterinary hematology, 6th ed. Blackwell Publishing Ltd, Ames, Iowa, USA.
35. Bunn, H.F., 2011. Approach to the anemias. In: Goldman L, Schafer AI (ed) Goldman's Cecil Medicine, 24th ed. Elsevier Saunders, Philadelphia, Pa, pp: 2011 Chap 161
36. Elghetany, M.T. and K. Banki, 2011. Erythrocytic disorders. In: McPherson RA, Pincus MR, eds. Henry's Clinical Diagnosis and Management by Laboratory Methods. 22nd ed. Philadelphia, Pa: Elsevier Saunders 2011: Chap 32.
37. Armstrong, W.D. and C.W. Carr, 1964. Physiological Chemistry: Laboratory directions 3: 75. Buger Puplishing Co, Minneapolis.
38. Witt, I. and C. Trendelenburg, 1982. A method for the rapid determination of total protein plasma. J. Clin Biochem., 20: 235.
39. Doumas, B.L., T. Watson and W.A. Biggs, 1971. Albumin standards and measurement of serum with bromocresol green. Clin. Chem. Acta., 31: 87-96.
40. Tietz, N.W., 1986. A method for the rapid determination of albumin of blood plasma. P.589 in textbook of clinical chemistry. W.B Saunders Company, Philadelphia.
41. Fossati, P. and L. Prencipe, 1982. Serum triglycerides determined colorimetrically with an enzyme that produces hydrogen peroxide. Clinical Chemistry, 28(10): 2077-2080.
42. Postma, T. and J.A. Stroes, 1968. Lipids screening in clinical chemistry. Clin. Chim. Acta., 22: 569.
43. Allain, C.C., L.S. Poon, C.S. Chan, W. Richmond and P.C. Fu, 1974. Enzymatic determination of total serum cholesterol. Clin. Chem., 20: 470-475.
44. Pisani, T., G.P. Gebski and E.T. Leary, 1995. Accurate direct determination of low- density lipoprotein, cholesterol assay. Arch. Pathol. Lab. Med., 119: 1127.
45. Beliefield, A. and D.M. Goldberg, 1971. Estimation of serum alkaline phosphates. Enzyme, 12: 561.
46. Patton, C.J. and S.R. Crouch, 1977. Spectrophotomattic and kinetics investigation of the Berthelot reaction for the determination of ammonia. Anal. Chem., 49: 464.
47. Husdan, H., 1968. Chemical determination of creatinine with deproteinization. Clin. Chem., 14: 222.
48. Reitman, S.M.D. and S. Frankel, 1957. A colorimeter method for determination of serum glutamic oxaloacetic acid and glutamic pyruvic acid transferases. Am. J. Clin. Pathol., 28: 56-63.
49. Harold, V., 1975. Colorimetric determination of glutamate pyruvate and oxaloacetic transaminase, practical Clin Biochem, 4th ed, pp: 294.
50. Goering, H.K. and P.J. Van Soest, 1970. Forge fiber analysis (apparatus, reagents, procedure and some applications). Agriculture. Hand book 379, USDA, Washington and DC., USA.
51. Van Soest P.J., J.B. Robertson and B.A. Lewis, 1991. Methods for dietary fiber, neutral detergent fiber and non starch polysaccharides in relation to animal performance. J. Dairy Sci., 74: 3583-3597.
52. SPSS, 2008. Statistical package for Social Sciences, Statistics for Windows, Version 17.0. Released 2008. Chicago, U.S.A.: SPSS Inc.
53. Duncan, D.B., 1955. Multiple Rang and Multiple F-Test Biometrics, 11: 1- 42.
54. McPeake, C.A., C.S. Abney, K. Kizilkaya, M.L. Galyean, A.H. Trenkle *et al*., 2002. Effects of direct-fed microbial products on feedlot performance and carcass characteristics of feedlot steers. Proceedings of the Plains Nutrition Council Spring Conference, April 25-26, 2002, San Antonio, Texas, pp: 133.
55. Swinney-Floyd, D., B.A. Gardner, F.N. Owens, T. Rehberger and T. Parrot, 1999. Effects of inoculation with either Propionibacterium strain P-63 alone or combined with Lactobacillus acidophilus strain LA53545 on performance of feedlot cattle. J. Anim. Sci., 77: 77-77.

56. Saleh, H.M., M.A. El-Ashry, M.M. Khorshed and A. Saleh Safaa, 2004. Performance of male lambs fed rations supplemented with active dried yeast. Egyptian J. Applied Sciences, 19: 1-12.
56. Umesh Sontakke, 2012. *Saccharomyces cerevisiae* in ruminants nutrition: Benefits of *Saccharomyces cerevisiae* as a feed additive in ruminants. Taba Medical Pharma (Report of National Dairy Research Institute, Karnal), 10/1/2012.
57. Pedro, A.H.G., A. Lara-Bueno, G.D. Mendoza-Martínez, J.R. Bárcena-Gama, F.X. Plata-Pérez, R. López-Ordaz and J.A. Martínez-García, 2015. Effects of feeding yeast (*Saccharomyces cerevisiae*), organic selenium and chromium mixed on growth performance and carcass traits of hair lambs. Journal of Integrative Agriculture, 14(3): 575-582.
58. Fadel El-seed A.N.M.A., J. Sekine, H.E.M. Kamel and M. Hishinuma, 2004. Changes with time after feeding in ruminal pool sizes of cellular contents, crude protein, cellulose, hemicellulose and lignin. Indian J. Anim. Sci., 74: 205-210.
59. El-Waziry, A.M. and H.R. Ibrahim, 2007. Effect of *Saccharomyces cerevisiae* of yeast on fiber digestion in sheep fed berseem (*Trifolium alexandrinum*) hay and cellulase activity. Aust. J. Basic Applied Sci., 1: 379-385.
60. Ahmed, B.M. and M.S. Salah, 2002. Effect of yeast cultures an additive to sheep feed on performance, digestibility, nitrogen balance and rumen fermentation. Journal of King Saudi University. Journal of Agriculture Science, 14(1): 1-3.
61. Wohlt, J.E., T.T. Corcione and P.K. Zajac, 1998. Effect of yeast on feed intake and performance of cows fed diets based on corn silage during early lactation. J. Dairy Sci., 81: 1345-1352.
62. Tang, S.X., G.O. Tayo, Z.L. Tan, Z.H. Sun, L.X. Shen, *et al*., 2008. Effects of yeast culture and fibrolytic enzyme supplementation on *in vitro* fermentation characteristics of low-quality cereal straws. J. Anim. Sci., 86: 1164-1172.
63. 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., 72: 537-545.
64. Jouany, J.P., F. Mathieu, J. Senaud, J. Bohatier, G. Bertin and M. Mercier, 1998. The effect of *Saccharomyces cerevisiae* and *Aspergillus oryzae* on the digestion of the cell wall fraction of a mixed diet in defaunated and refaunated sheep rumen. Reprod. Nutr. Dev., 38: 401-416.
65. Newbold, C.J., R.J. Wallace, X.B. Chen and F.M. McIntosh, 1995. Different strains of *Saccharomyces cerevisiae* differ in their effects on ruminal bacterial numbers *in vitro* and in sheep. J. Anim. Sci., 73: 1811-1818.
66. Miller-Webster, T., W.H. Hoover, M. Holt and J.E. Nocek, 2002. Influence of yeast culture on ruminal microbial metabolism in continuous culture. J. Dairy Sci., 85: 2009-2014.
67. Kawas, J.R., R. Garcia-Castillo, H. Fimbres-Durazo, F. Garza-Cazares, J.F.G. Hernandez-Vidal, *et al*., 2007. Effects of sodium bicarbonate and yeast on nutrient intake, digestibility and ruminal fermentation of light-weight lambs fed finishing diets. Small Rumin. Res., 67: 149-156.
68. Yoon, I.K. and M.D. Stern, 1996. Effects of *Saccharomyces cerevisiae* and *Aspergillus oryzae* cultures on ruminal fermentation in dairy cows. J. Dairy Sci., 79: 411-417.
69. Harris, B., D.E. Dorminey, W.A. Smith, H.H. Van Horn and C.J. Wilcox, 1992. Effects of feather meal at two protein concentrations and yeast culture on production parameters in lactating dairy cows. J. Dairy Sci., 75: 3524-3530.
70. 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.
71. Wiedmeier, R.D., M.J. Arambel and J.L. Walters, 1987. Effect of yeast culture and *Aspergillus oryzae* fermentation extract on ruminal characteristics and nutrient digestibility. J. Dairy Sci., 70: 2063-2068.
72. Harrison, G.A., R.W. Hemken, K.A. Dawson, R.J. Harmon and K.B. Barker, 1988. Influence of addition of yeast culture supplement to diets of lactating cows on ruminal fermentation and microbial populations. J. Dairy Sci., 71: 2967-2975.
73. Chaucheyras-Durand, F., N.D. Walker and A. Bach, 2008. Effects of active dry yeasts on the rumen microbial ecosystem: Past, present and future. Animal Feed Science and Technology, 145: 5-26.
74. Roger, V., G. Fonty, S. Komisarczuk-Bony and P. Gouet, 1990. Effects of physicochemical factors on the adhesion to cellulose avicel of the ruminal bacteria *Ruminococcus flavefaciens* and *Fibrobacter succinogenes* subsp. *succinogenes*. Applied Environ. Microbiol., 56: 3081-3087.
75. Chaucheyras, F., G. Fonty, G. Bertin and P. Gouet, 1995b. *In vitro* $H_2$ utilization by a ruminal acetogenic bacterium cultivated alone or in association with an archaea methanogen is stimulated by a probiotic strain of *Saccharomyces cerevisiae*. Applied Environ. Microbiol., 61: 3466-3467.

76. Koul, V., U. Kumar, V.K. Sareen and S. Singh, 1998. Mode of action of yeast culture (*Yea-Sacc* 1026) for stimulation of rumen fermentation in buffalo calves. J. Sci. Food Agric., 77: 407-413.
77. Enjalbert, F., J.E. Garrett, R. Moncoulon, C. Bayourthe and P. Chicoteau, 1999. Effects of yeast culture (*Saccharomyces cerevisiae*) on ruminal digestion in non-lactating dairy cows. Animal. Feed Science and Technology, 76: 195-206.
78. Putnam, D.E., C.G. Schwab, M.T. Socha, N.I. Whitehouse, N.A. Kierstead and B.D. Garthwaite, 1997. Effect of yeast culture in the diets of early lactation dairy cows on ruminal fermentation and passage of nitrogen fractions and amino acids to the small intestine. J. Dairy Sci., 80: 374-384.
79. Arambel, M.J. and B.A. Kent, 1990. Effect of yeast culture on nutrient digestibility and milk yield response in early to mid lactation dairy cows. J. Dairy Sci., 73: 1560-1563.
80. Sauvant, D., S. Giger-Reverdin and P. Schmidely, 2004. Rumen acidosis: Modeling ruminant. Proceedings of the Alltech's 20th Annual Symposium: Re-Imagining the Feed Industry, May 23-26, 2004, Nottingham University Press, pp: 221-229.
81. Cunha, C.S., M.I. Marcondes, A.L. Silva, T.R.S. Gionbelli, M.A.S. Novaes, L.S. Knupp, G.F. Virginio Júnior and C.M. Veloso, 2019. Do live or inactive yeasts improve cattle ruminal environment? Revista Brasileira de Zootecnia 48:e20180259. https://doi.org/10.1590/rbz4820180259.
82. Santos, T.G., FL.B. Cavalieri and E.C. Modesto, 2001. Recentes avanços em nitrogênio não proteico na nutrição de vacas leiteiras, pp: 199-228. In: Anais do 2° Simpósio Internacional em Bovinocultura de Leite: Novos conceitos em nutrição. Universidade Federal de Lavras, Lavras.
83. González, F.H.D. and S.C. Silva, 2006. Introdução à bioquímica clínica veterinária. 2nd Ed. Editora da UFRGS, Porto Alegre
84. Kowalik Barbara, Skomial Jacek, Miltok Renata and Majewska Małgorzata, 2016. The effect of live *Saccharomyces cerevisiae* yeast in the diet of rams on the digestibility of nutrients, nitrogen and mineral retention and blood serum biochemical parameters. Turk J. Vet. Anim. Sci., 40: 534-539 ©TÜBÝTAKdoi:10.3906/vet-1511-37.
85. 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. Journal of Dairy Science and Nutrition, 92: 631-639.
86. Mwenya, B., B. Santoso, C. Sar, B. Pen, R. Morikawa, K. Takaura, K. Umetsu, K. Kimura and J. Takahashi, 2005. Effects of yeast culture and galacto-oligosaccharides on ruminal fermentation in Holstein cows. J. Dairy Sci., 88: 1404-1412.
87. Paryad, A. and M. Rashidi, 2009. Effect of yeast (*Saccharomyces cerevisiae*) on apparent digestibility and nitrogen retention of tomato pomace in sheep. Pak. J. Nutr., 8: 273-278.
88. Stewart, G.S. and C.P. Smith, 2005. Urea nitrogen salvages mechanisms and their relevance to ruminants, non-ruminants and man. Journal of Nutrition Research. Review., 18: 49-62.
89. Fadel, A.M. and A. Abusamra, 2007. Effect of supplemental yeast (*Saccharomyces cerevisiae*) culture on NDF digestibility and rumen fermentation of forage sorghum hay in Nubian goat's kids. Journal of Agriculture and Biological Science, 3: 133-137.
90. Doležali, P., J. Doležali and J. Třinácty, 2005. The effect of *Saccharomyces cerevisiae* on ruminal fermentation in dairy cows. Czechs. Journal of Animal Science, 50(11): 503-510.
91. Guedes, C.M., DE. Goncalves, M.A.M. Rodrigues and A. Dias, 2008. Effects of a Saccharomyces cerevisiae yeast on ruminal fermentation and fiber degradation of maize silages in cows. Journal of Animal and Feed Science Technology, 145: 27-40.
92. Ghasemi, E., M. Khorvash and A. Nikkhah, 2012. Effect of forage sources and Saccharomyces cerevisiae (Sc47) on ruminal fermentation parameters. African. Journal of Animal Science, 42(2): 0375-1589.
93. Bal, A.M. and S. Gokus, 2013. Effects of live yeast supplementation on ruminal parameters and lactation performance of dairy cows fed medium or high levels of dietary concentrate. Kafkas Univercity of Veternal Fak Derg., 191: 57-62.
94. Broderick, G.A., M.J. Stevenson and R.A. Patton, 2008. Effect of dietary protein concentration and degradability on response to rumen-protected methionine in lactating dairy cows Journal of Dairy Science, 92: 2719-2728.
95. Dawson, K.A., K.E. Neuman and J.A. Boling, 1990. Effects of microbial supplements containing yeast and lactobacilli on roughage-fed ruminal microbial activities. Yeast Cultures in Ruminant Nutrition. Journal of Animal Science, 68(10): 3392-3398.
96. Biricik, H. and H.M. Yavuz, 2001. Effects of *Saccharomyces cerevisiae* yeast culture on milk production, milk composition Saccharomyces cerevisiae live cells on mixed ruminal microorganism fermentation *in vitro*. Journal of Animal Science, 82: 1847-1854.

97. Fatma, I., G. Emel, C. Behic, S.A. Mustafa, B.C. Ozcan, P. Esadsam, *et al*., 2010. The effects of live yeast culture (*Saccharomyces cerevisiae*) on rum 71. en fermentation and nutrient degradability in yearling lambs. Kafkas University of Veterinary Fafkas Dergisi, 16(5): 799-804.
98. 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. Journal of Dairy Science, 75: 3056-3065.
99. Hong, P.H. and J.R. Gallaghe, 1994. The effects of yeast supplement on digestibility of low quality roughage fed to sheep. Protocol Australia Soc. Animal Production, 20: 398.
100. Saeed, A.A., 2011. Effect of level and degradability of dietary protein fed without baker, s yeast (*saccharomyces cerevisiae*) on Turkish Awassi lamb's performance. College of Agriculture, Baghdad University. PhD. Thesis.
101. Hassan, S.A. and S.F. Mohammed, 2016. Effect of *saccharomyces cerevisiae* supplementation on rumen characteristics in Awassi lambs fed diets with different roughage to concentrate ratios. Iraqi Journal of Agricultural Science, 47: 1-11.
102. Adams, D.C., M.L. Galyean, H.E. Kiesling, J.D. Wallace and M.D. Finker, 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. Journal of Animal Science, 53: 780-789.
103. Galip, N., 2006. Effect of supplemental yeast culture and sodiubicarbonate on ruminal fermentation and blood variables in rams. Journal of Animal Physiological and Animal Nutrition, 90: 446-452.
104. Longuski, R.A., Y. Ying and M.S. Allen, 2009. Yeast culture supplementation prevented milk fat depression by a short-term dietary challenge with fermentable starch. Journal of Dairy Science, 92(1): 60-167.
105. Özsoy, B., S. Yalcin, Z. Erodogan, Z. Cantekin and T. Aksui, 2013. Effects of dietary live yeast culture on fattening performance on some blood and rumen fluid parameters in goats. Revue Veterinary Medicine, 164(5): 263-271.
106. Dawson, K.A., 1990. Designing the yeast culture of tomorrow: mode of action of yeast culture for ruminants and non-ruminants. In: Biotechnology in the Feed Industry (Ed.: Lyons, T.P.). Alltech Technical Publications, Nicholasville, Kentucky, pp: 59-78.
107. Wallace, R.J. and C.J. Newbold, 1992. Probiotics for ruminants. In: Probiotics, the scientific basis (Ed.: Fuller, R.). Chapman and Hall, London, pp: 317-353.
108. Wallace, R.J. and C.J. Newbold, 1993. Rumen fermentation and its manipulation: the development of yeast cultures as feed additives. In: Biotechnology in the Feed Industry (Ed.: Lyons, T.P.). Alltech Technical Publications, Nicholasville, Kentucky, pp: 173-192.
109. Gray, W. and J.P. Ryan, 1989. Effect of yeast culture on volatile fatty acid levels in ovine rumen fluid incubated with oats, barley and hay. Biochem. Soc. Trans., 17: 390-392.
110. Ryan, J.P. and W.R. Gray, 1989. Effect of high strength yeast culture *ab initio* utilizes a residual source of volatile fatty acids in strained ruminal fluid from hay fed sheep. Biochem. Soc. Trans., 18: 392-393.
111. Vohra, A., P. Syal and A. Madan, 2016. Probiotic yeasts in livestock sector. Animal Feed Science and Technology, 219: 31-47.
112. Jiao, P.X., L.Y. Wei, N. Walker, F.Z. Liu, L.Y. Chen, K.A. Beauchemin and W.Z. Yangb, 2017. Comparison of non-encapsulated and encapsulated active dried yeast on ruminal pH and fermentation and site and extent of feed digestion in beef heifers fed high-grain diets.
113. Beauchemin, K.A., W.Z. Yang, D.P. Morgavi, G.R. Ghorbani and B. Kautz, 2003. Effects of bacterial direct-fed microbials and yeast on site and extent of digestion, blood chemistry and sub clinical ruminal acidosis in feedlot cattle. J. Anim. Sci., 81: 1628-1640.
114. Dawson, K.A., 1993. Current and future role of yeast culture in animal production: a review of research over the last six years. In Biotechnology in the Feed Industry, pp: 269-291 [T. P. Lyons, editor]. Nicholasville, Kentucky: Alltech Technical Publications.
115. Jewbold, C.J., R.J. Wallace and F.M. McIntosh, 1996. Mode of action of the yeast *Sacchavomyces cerevisiae* as a feed additive for ruminants. British Journal of Nutrition, 76: 249-261.
116. Rose, A.H., 1987. Yeast culture, a micro-organism for all species: a theoretical look at its mode of action. In Biotechnology in The Feed Industry, pp: 113-1 18 [T. P. Lyons, editor]. Nicholasville, Kentucky: Alltech Technical Publications.

117. Nisbet, D.J. and S.A. Martin, 1990. Effect of dicarboxylic acids and *Aspergillus oryzae* fermentation extract on lactate uptake by the ruminal bacterium *Selenomonas ruminantium*. Applied and Environmental Microbiology, 56: 3515-3518.
118. Nisbet, D.J. and S.A. Martin, 1991. The effect of *Saccharomyces cerevisiae* culture on lactate utilization by the ruminal bacterium *Selenomonas ruminantium*. Journal of Animal Science, 69: 4628-4633.
119. Auclair, E., 2001. Yeast as an example of the mode of action of probiotics in monogastric and ruminant species. In: Brufau J. (ed.). Feed manufacturing in the Mediterranean region. Improving safety: From feed to food. Zaragoza: CIHEAM, Cahiers Options Mediterranéennes, 54: 45-53.
120. 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 lactation buffaloes. Egyptian J. Nutrition and Feeds, 4: 21-33.
121. El-Ashry, M.A., M. Fayed Afaf, K.M. Youssef, F.A. Salem and A. Aziz Hend, 2003. Effect of feeding flavomycin or yeast as feed supplement on lamb performance in Sinai. Egyptian J. Nutrition and Feeds, 6(special issue): 1009-1022.
122. Stella, A.V., R. Paratte, L. Valnegri, G. Cigalino, G. Soncini, E. Chevaux, V. Dell'Orto and G. Savoini, 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.
123. Habeeb, A.A.M., SA.M. Attia and N. Sharoud Mona, 2006. Performance of growing rabbits fed rations supplemented with active dried yeast (*Saccharomyces cerevisiae*). Egyptian J. Applied Sciences, 21(4A): 1-18.
124. Lehloenya, K.V., D.R. Stein, D.T. Allen, G.E. Selk, D.A. Jones, M.M. Aleman, T.G. Rehberger, K.J. Mertz and L.J. Spicer, 2008. Effects of feeding yeast and propioni bacteria to dairy cows on milk yield and components and reproduction. Journal of Animal Physiology and Animal Nutrition, 92(2): 190-202.
125. Ashour, G., A.A. Habeeb, H.M. Mourad, A.A. Abo-Amer, 2009. Effect of yeast (*Saccharomyces cerevisiae* 1026) ration supplementation on milk production and blood parameters of lactating Baladi cows. Egypt. J. Basic Appl. Physio., 8(1): 237-254.