

Chapter

Current View of the Significance of Yeast for Ruminants. A Review: Importance of Yeast in Ruminants Feeding on Production and Reproduction

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Abstract

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. Feeding on feed mixture contained Active dry yeast (ADY) improved the appetite of animals which lead to increase the feed intake and consequently increased the daily weight gain of the treated animals. From the physiological point of view, adding ADY caused a significant increase the levels of both T_4 and T_3 hormones which lead to increase the protein and fat biosyntheses. Moreover, benefits of yeast supplements for ruminants are increased milk production and improvements in milk quality, improves milk selenium content, reduced mastitis and somatic cell count, less stillbirths, weak neonates, improves fertility, reduced incidence of retained placenta, improved immune response, increases immune resistance, high content in B-vitamins and trace elements, enhances weight gain and feed utilization.

Introduction

Yeast is a live microbial feed supplement which beneficially affects the host animal by improving its intestinal microbial balance [1]. In USA, nutrient yeast is used where producing animal feed, as well as an additive to the feed ration of farmed animals, farmed poultry and fur-bearing animals. According to the Association of American Feed Control Officials and American Pet Diner Products recommendations, active dried yeast (Sc must be supply daily to pellet ration of rabbits which contains crude fiber, not less than 20.0% and not more than 30.0%) for best results. Therefore, adding Yeast to the diet of rabbits may be increase in cellulolytic fiber digestion and consequently enhance utilization of feed and improve feed efficiency.

Some of the benefits associated with *Sc* include increased DM and NDF digestion [2] and milk production [2-4]. *Sc* also increased the number of ruminal total bacteria and cellulolytic bacteria [5,6] and stimulated the growth of the cellulolytic bacteria, fibrobacter succinogenes and ruminococcus albus [7]. Feeding a yeast following weaning has been found to increase feed intake, daily gain and feed efficiency in beef cattle while in lactating dairy cows, feeding a yeast and yeast cultures products significantly increased milk production, milk composition and dry matter intake [3,8-11].

Breul [12] reported that S.C. has demonstrated positive effects in different species such as broilers, calves, beef cattle, dairy cow and rabbit. The effects generally observed with probiotics in animal nutrition are increased productive parameters and better sanitary conditions. The purpose of this study was to review critically all relevant research specific to only a single manufactured yeast culture product and to estimate the effect of the yeast culture product on milk yield and DMI of dairy cattle. Piata et al. [13] reported that providing proper nutrition is one of the best ways to ensure the health of the rabbit and adult rabbit's diet should be made up of a limited quantity of high fiber/low protein pellets. Because rabbits required higher fiber diets i.e. higher calorie diets for young, growing or lactating rabbits for enhanced health vitality. Piata et al. [13] mentioned that live yeast and beneficial bacterial (probiotics) supplemented to pellet ration for help controlling digestive problems in rabbits and to stabilize the micro flora in the gut, consequently improving the fiber digestion, which means better overall feed utilization and a healthier gut.

Yeast products are widely utilized as feed additives for ruminant animals in many parts of the world, and there is a widespread belief among dairy and beef producers and ruminant nutritionists, that yeast products are beneficial by enhancing DM intake and overall animal performance. However, the mechanisms have been proposed to explain why yeast products could stimulate DM intake and productivity in growing and lactating cattle are presented by Robinson [14]. The oldest hypothesis is that the yeasts are able to grow, at least for a

short period of time, in the rumen thereby directly enhancing fiber digestion and/or producing nutrients that stimulate growth of rumen bacteria, which do the bulk of the fiber digestion. It has also been suggested that yeasts utilize nutrients, such as lactic acid which, if allowed to accumulate in the rumen, could suppress bacterial growth and/or suppress DM intake by driving rumen pH down.

A more recently suggested possibility is that growth of yeast in the rumen utilizes the trace amounts of dissolved oxygen, particularly at the interface of the cellulolytic bacteria and fiber, thereby stimulating growth of rumen bacteria, to which oxygen is toxic. It seems clear that for these mechanisms to be operative, yeasts in the product have to be viable, in the sense of being able to grow for at least a short period of time in the rumen. Hence the origins of the debate between 'live' and 'dead' yeast products. The alternate mechanism is that it is the yeast culture itself, which is created in the yeast fermentation process, which provides a mixture of micro-nutrients to stimulate bacterial growth in the rumen thereby facilitating increased fermentation of fiber and/or utilization of end products of fiber fermentation to prevent their accumulation in the rumen. Supporters of this theory point to a limited research base showing that when cultures of live brewers or fermentation yeasts are fed to ruminants, there are few, if any, changes to rumen fermentation and/or animal performance.

The objective of this article is to summarize studies that have been published in the scientific literature that have examined the impact of yeast on rumen fermentation, fiber digestion and/or animal performance.

Ruminant Responses to Yeast Supplementation

Effect of Yeast on Digestibility and Nutritive Values

The concentrations of total, total viable and cellulolytic bacteria increased significantly by 41.0, 33.5 and 57.4%, respectively, with yeast culture supplements to the diet of buffalo calves [1]. Miranda

et al. [15] found that Sc increased in situ Lucerne NDF digestion and propionate concentration at both 25 and 27% levels of NDF. Plata et al. [13] found also NDF digestibility increased with Sc addition (48.6 vs. 60.45). In addition, the yeast (Sc) increases NDF digestibility and the number of protozoa present in the rumen and increased the microbial protein flow from the rumen [16]. El Ashry et al. [17] found that adding live dried yeast to the buffaloes calve diet improved the digestibility coefficient of OM, CP, CF, EE and NFE. The same trend was recorded for digestible crude protein (DCP). Addition of Sc to the ration of large animals improved in-vitro DM and OM disappearance and increased in-vivo digestibility of DM, CP and CF [18]. Panda et al. [19] found also that digestibility of CP increased from 63.9 to 68.7% with supplements of yeast culture to the diet of crossbred male calves. Habeeb et al. [20] found that the CP digestibility improved significantly from 70.6 to 79.5 when ADY was added and attributed this increase in CP digestibility to the stimulation of proteolytic bacteria. Habeeb et al. [20] found that improvement in nutritive value of ration with ADY supplements. TDN significantly increased from 70.4 for control to 73.7 for ADY treatment. The same trend was recorded for DCP (12.7 vs 14.3). Habeeb et al. [20] reported that adding ADY significantly increased apparent digestibility of DM, OM, CP, CF and Ash. It is of interest to observe that CF digestibility increased by 26.9 % with yeast supplementation to the diet of the rabbits compared with the group fed basal diet without ADY. The improvement in CF digestibility may be due to that yeast stimulates the cellulolytic bacteria. Habeeb et al. [20] concluded from digestibility trial that yeast supplement to the diet of male rabbits improved the apparent digestibility of nutrients and the nutritive values of diet due to an increase in the bacteria number or stimulate some of the bacteria species like proteolytic or cellulolytic bacteria or both in intestine of rabbits. Saleh et al. [21] found that CF digestibility in Barki male lambs was increased by 12.3% with yeast supplementation compared with the basal diet. Saleh et al. [21] showed slight improvement in nutritive value of ration with ADY supplements, so, the total TDN was increased from 75.43 for control treatment to 76.31 for ADY treatment. The same trend was

recorded for DCP. Saleh et al. [21] concluded trial that yeast supplement to the diet of male lambs improved the apparent digestibility of nutrients and the nutritive values of diet and this may be due to an increase in the rumen bacteria number or stimulate some of the rumen bacteria sp. like proteolytic or cellulolytic bacteria or both.

Table 1: Mean values of apparent digestibility and nutritive values in the ration supplemented with ADY fed to rabbits.

*Apparent digestibility	Control	ADY
Dry matter (%)	76.5	79.5*
Organic matter (%)	78.0	81.0*
Crude protein (%)	70.6	79.5**
Crude fiber (%)	63.3	80.3**
Ether extract (%)	77.7	76.3 ^{NS}
Nitrogen-free extract (%)	84.3	83.6 ^{NS}
Ash %	52.7	58.7
Nutritive values:		
Total digestible nutrients (%)	70.4	73.7*
Digestible crude protein (%)	12.7	14.3**

*Habeeb et al. (2006) NS = Not significant, * = $P < 0.05$ and ** = $P < 0.01$.

Table 2: Mean values of apparent digestibility and nutritive values for ration fed to lambs with or without ADY supplements

*Apparent digestibility,%	Control	ADY
Dry matter	76.51	77.53
Organic matter	78.99	79.86
Crude protein	70.68	73.48
Crude fiber	59.00	66.26
Ether extract	77.84	80.26
Nitrogen-free extract	84.33	83.58
Ash	53.67	56.10
Nutritive values		
Total digestible nutrients (%)	75.43	76.31
Digestible crude protein(%)	10.42	10.81

*Saleh et al. (2004)

Habeeb et al. [20] concluded from digestibility trial that yeast supplement to the diet of male rabbits improved the apparent digest-

ibility of nutrients and the nutritive values of diet due to an increase in the bacteria number or stimulate some of the bacteria species like proteolytic or cellulolytic bacteria or both in intestine of rabbits. More improvement in nutritive values were reported by Allam et al. [22] who found that TDN and DCP values increased from 73.73 to 81.88 and from 13.19 to 15.32, respectively, when yeast 2.5 g/h/day was added. EI-Ayek et al [23] found that CP content of CFM markedly increased by about 7.8% as a result of YC supplementation compared to the control one. Digestibility of CP was significantly higher for diet than the control diet. Most researchers agree that yeast supplementation strategies have measurable effects on rumen fermentation and rumen metabolism [24]. Initial rate of digestion is markedly improved by live yeast culture addition. Feed intake can be considered to be a function of initial rates of fiber digestion and therefore, it may be assumed that increased initial fiber digestion rates may increase dry matter intake. Chaucheyras et al. [25] found that bacterial growth and fermentation end product concentrations were increased in the presence of SC and some amino acids and vitamins stimulated the bacterial specific activity of L-lactate uptake. The authors concluded that SC very useful tool to reduce lactate accumulation in vitro during fermentation of soluble sugars. However, Fiems et al. [26] reported that digestibility and nitrogen balance in wethers were not affected by yeast treatment but supplementation of yeast increased acetate: propionate ratio, butyrate, isoacids, pH and ammonia and concluded that the effect of yeast culture on rumen fermentation may depend on the nature of the diet.

Table 3: Effect of live dried yeast and yeast culture in the diets of growing buffalo calves on nutrients digestibility and feeding values.

*Apparent digestibility %	Control	Live DY	YC
OM	67.89 ^b ±0.58	70.88 ^a ±0.58	71.90 ^a ±0.49
CP	70.43 ^a ±0.39	75.08 ^b ±0.77	77.93 ^a ±0.70
CF	49.30 ^b ±0.39	54.92 ^a ±0.70	56.70 ^a ±0.63
EE	73.70±0.59	72.90±0.55	73.98±0.68
NFE	70.18 ^b ±0.72	73.69 ^a ±0.70	73.10 ^a ±0.49
Feeding values, %			
TDN	52.83 ^b ±0.54	55.90 ^a ±0.55	56.23 ^a ±0.45
DCP	8.00 ^b ±0.11	8.13 ^a ±0.09	8.73 ^a ±0.09

Means in the same row with differ superscripts differ (P<0.05). *Al-Ashry et al. [27]

Blezinger [28] showed that yeast inclusion increased total mineral supplemental intake. Both mineral consumption and absorption have been positively affected by the addition of yeast culture to free-choice mineral mixes Total supplemental mineral intake was 0.23 and 0.40 lb per day for the control and yeast-mineral, respectively. The yeast-mineral intake was 4.8 ounces per day, and the total yeast consumption per day was 1.2 ounces per day. The difference in total supplement intake between treatments was 0.19 ± 0.072 lb per day. From a different perspective, use of yeast has been shown to have a positive influence on intake in newly received stocker and feedlot cattle. Yeast appears to be useful in reducing stress effects in these cattle and has been shown to be of benefit in getting fresh cattle started on feed somewhat faster. Blezinger [28] reported that Yeast cultures (S C) have a positively affect animal performance and improved feed intake, production and reduced rectal temperatures during summer heat stress in dairy.

Effect of Yeast on Milk Yield, Composition and Dry Matter Intake

Studies in several laboratories have demonstrated that YC supplementation can influence digestive process in the rumen and feed intake. DMI is often considered to be a function of the initial rate of

fiber 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 [29]. Dawson and Tricarico [30] analyzed the results gained from 22 studies with Yea-Sacc®1026 involving more than 9039 lactating dairy animals. The authors found an average increase in milk production of 7.3% in yeast-supplemented animals. Responses to supplementation were variable and ranged from 2 to 30% increase in milk production. The improvement of milk production was 1.8 L in the controlled experiments which are probably significant. It became 1.4 L in the field studies. According to Gunter [31], the effects of yeast were highest within the first 100 days of lactation. YC can also action the persistence of lactation after the production peak of dairy cows [32]. Growth responses to YC in meat producing ruminants was also variable and ranged from no significant increase in average daily gain to an increase of more than 20%, with an average daily gain of 8.7%. In general, YC preparations are least effective when animals are fed well balanced diets that promote the stability of the gastrointestinal microbial population and are more likely to have dramatic effects under conditions of dietary and environmental stress. However, data from a wide range of both controlled studies and field trials suggest that YC supplements can have a significant role in strategies for economically enhancing the performance of ruminant animals [30].

The positive effect on animal production, when observed, is better explained by an increase of feed intake rather than a better feed digestibility. The YC 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 [33]. This physical regulation could be involved to explain the higher feed intake in treatment animals. Another factor that can influence the physical regulation of intake is the outflow rate of digesta from the rumen, but the effect of yeast on this parameter is really inconsistent [34].

Feeding YC has increased dry matter intake [30]. Milk production has been increased in some studies [35]. Yeast cultures have also been fed to pre-partum cows improving DMI [36]. During the post-partum period, dry matter intake, milk yield, and milk protein content were higher in cows receiving direct-fed microbial supplementation compared with the control group. Effects of different doses and rations of roughage and concentrates on the milk performance and efficiency of rumen digestion were discussed also by Strzetelski et al. [37]. The effect of different doses of LYC (*S. cerevisiae*, strain SC-47) (0, 3, 6 and 12 g of yeast/day respectively) on the lactating performance of Holstein dairy cows was described by Nikkhah et al. [38] and concluded that the LYC had a beneficial effect on the rumen health. Other available data indicated that in the rumen fluid of animals receiving supplements of LYC, the total content of volatile fatty acids, and the percentage of propionic acid, and acetic acid increased, the content of ammonia decreased and the total numbers of ruminal bacteria significantly increased [39]. Ando et al. [39] stated that dietary supplementation of Yea-sacc®1026 a significant increase in degradability of roughage in 6 h ($P < 0.05$) after live yeast addition. Strohle [40] also reported that the addition of LYC (*S. cerevisiae*) into the feeding ration of dairy cows improved their milk performance significantly. Jouany [34] decided that a positive effect of yeasts on the performance of dairy cows and on the content of milk components resulted from increased daily feed intake and improved digestibility of nutrients).

From another point of view, Nikkhah et al. [38] did not find the dry matter intake and milk yield in cows to be affected ($P > 0.05$) by experimental diets but milk composition including fat and percent total solids were improved by the addition of LYC ($P < 0.05$). Formigoni et al. [41] reported that Yea-Sacc®1026 improved significantly the DMI and milk yield of dairy cows, on the overall period, but also, during heat stress period. Yea-Sacc®1026 improved significantly the composition of cow's milk, including fat ($P < 0.01$) and protein ($P < 0.05$) content. Bertin and Andrieu [42] demonstrated the beneficial effect of Yea-Sacc®1026 on the performance of high producing dairy cows.

Yea-Sacc®1026 significantly improved milk production among high-producing dairy cows. Dairy cows fed Yea-Sacc®1026 were better able to rebuild body stores better than control cows. Kravale et al. [43] also reported that Yea-Sacc®1026 significantly improved milk yield of dairy cows, fat and protein content in cow's milk especially during the hot season. Economic results of the dairy herd were improved in the Yea-Sacc®1026 group in comparison with untreated control.

Many other investigations demonstrated a significantly positive effect of Yea-Sacc®1026 on DMI [44-46]; Milk production of dairy cows [46,47], lactating buffalo [48,49], dairy sheep and goats and meat production of lambs [50], calves [44] and finishing bulls [44]. Yea-Sacc®1026 helps of ruminant animals achieve their full potential-cost effectively-through better utilization of feed. Yea-Sacc®1026 reduces digestive disorders, drives dry matter intake, improves feed efficiency, increases milk yield, improves milk composition, and improves meat production. Yea-Sacc®1026 is the first LYC to gain EU approval as performance enhancing product for dairy cows, fattening cattle and calves [51,52].

In lactating dairy cows, feeding a yeast and yeast cultures products significantly increased milk production, milk composition and dry matter intake [8]. Addition of Sc to the ration of large animals improved in-vitro DM and OM disappearance and increased in-vivo digestibility of DM, CP and CF [18,20,21]. In addition, the yeast (Sc) increases neutral detergent fiber digestibility and the number of protozoa present in the rumen and increased the microbial protein flow from the rumen [16]. To evaluate the effects of pre-and post-partum yeast feeding on early lactation milk in Jersey and Holstein cows, Britt et al. [9] found that the research group received 2 oz. of Yeast daily during in the pre-partum or post-partum periods had an 8.25 lb per day milk yield, a 0.395 lb per day fat yield, and a 9.92 Lb per day fat corrected milk biological advantage over the control group and concluded that there was a \$1.00 economical advantage per day to the research group. Housewright et al. [11] found that cows supplemented with Western Yeast Live Cell Culture had numerically higher

milk production than the cows receiving the dead cell yeast culture. On average an increase of 14 lbs per cow per day was observed when cows were supplemented with 56.75 g/head/day of yeast live cell culture. Piva et al., [3] reported that production of milk, 4% fat-corrected milk and milk fat values were increased significantly by dietary yeast culture. In addition, Schingothe et al. [53] found that feed efficiency defined as kilogram of energy corrected milk/kilogram of DM intake was improved by 7% for cows fed the yeast and concluded that the yeast can improve feed efficiency of heat stressed dairy cows in mid-lactation. Shaver and Garrett [54] reported that the addition of yeast culture to TMR for mid lactation dairy cows in high producing commercial herds increased milk and protein yield and its use was profitable. However, Britt et al., [10] found that Milk yield, butterfat %, butterfat yield, protein yield, fat corrected and energy corrected milk were not statistically but were biologically higher in the yeast group than the control group and there was a \$0.54 economical advantage daily to the yeast group. The yeast group did have an advantage over the control group in faster recovery from a drop in milk production following an increase in ambient temperature since both groups were subject to the same heat stress conditions.

In dairy cows an improvement by around 4% of the milk yield, often associated with increased feed intake was generally reported, and response was greater in early as opposed to mid or late lactation [55]. Lehloenya et al. [56] found that daily uncorrected milk, solids-corrected milk, and 4% fat-corrected milk production for multiparous Holstein cows fed propionibacteria plus yeast during mid lactation (9–30 weeks) was 9–16% greater than control cows. The authors concluded that combined feed supplement may hold potential as a natural feed alternative to enhance lactational performance. Allam et al. [22] reported that DMI tended to increase significantly by the addition of yeast with level of 2.5 and 5 g/h/day. El Ashry et al. [57] found that DMI from concentrates was increased from 18.26 to 19.86 g/kg LBW when Sc was added to the diet of male barking lambs. However, Saleh et al. [21] found that adding ADY to male lambs tended to increase insignificantly DMI from CFM and rice straw.

Ashour et al. [58] found that daily milk, 4% FCM, fat and total solids yields and milk energy output in Egyptian (baladi) cattle were improved significantly with yeast supplementation (Sc^{1026}) while the dry matter intake and gross efficiency of milk energy production were insignificantly increased due to this supplementation. Regarding the effects of direct-fed microbials on ruminant feedstuff utilization and performance, Martin and Nisbet [59] found from in vivo research that increased weight gains, milk production, total tract digestibility of feed components, increased cellulolytic bacterial numbers in the rumen and stimulated the production of some fermentation end products and may be providing growth factors for the ruminal microbes, increased the production of acetate, propionate, succinate, total VFA, and cell yield (grams of cells per mole of lactate) that stimulate lactate utilization. Lehloenyia et al. [56] found that milk lactose% in multiparous Holstein cows fed propionibacteria plus yeast during mid lactation (9–30 weeks) was 3–5% greater than in control while milk fat% was 8–18% greater in control than treated cows.

Table 4: Effect of yeast culture on milk production in early-lactation dairy cows^a.

Items	Control	Yeast Culture
Milk Yield, lb/d	68.4	69.5
4% Fat Corrected Milk, lb/d	61.7	64.8 *
Butterfat, %	3.36	3.57 *
Protein, %	3.05	2.97 *

^a Harris and Lobo [60]. * Means within a row are different (P<0.05).

Table 5: Effect of yeast culture on milk production in early-lactation dairy cows^a.

Items	Control	Yeast Culture
Milk Yield, lb/d	68.1	69.8
3.5% Fat Corrected Milk, lb/d	65.7	69.1 *
Butterfat, %	3.27	3.41 *
Protein, %	3.10	3.15 *

^a Harris and Webb [61]. * Means within a row are different (P<0.05).

Table 6: Effect of yeast culture on milk production in mid-lactation dairy cows from eleven high producing (22,000-28,000 lb) dairy herds^a.

Items	Control	Yeast Culture
Milk Yield, lb/d	80.7	82.6 **
150d Adjusted Milk Yield, lb/d ^b	77.1	79.0 **
4% FCM, lb/d	75.8	76.5
Butterfat, %	3.65	3.55 **
Butterfat, lb/d	2.91	2.90
Protein, %	3.15	3.13 **
Protein, lb/d	2.52	2.56 *

^aShaver and Garrett [54]. ^bManagement Level Milk ^cMeans within a row are different (P<0.01), ** Means within a row are different (P<0.001)

Table 7: Effect of yeast culture on milk production and component yields in early-lactation dairy cows^a.

Items	Control	Yeast Culture
Milk, lb/day	92.2	93.5 *
Butterfat, lb/day	2.95	3.22 *
Protein, lb/day	2.98	3.15 *
3.5%FCM, lb/day	87.1	92.2 *

^a Sanchez et al. [62]. * Mean significantly different from control (P<0.05).

Table 8: Effect of yeast culture on milk production in early-lactation primiparous and multiparous dairy cows^a.

Items	Primiparous		Multiparous	
	Control	Yeast Culture	Control	Yeast Culture
Milk, lb/day	55.9	61.3 †	85.1	89.0
Butterfat, %	3.88	3.59	3.88	3.82
Protein, %	3.16	3.00 †	3.05	3.05
Lactose, %	4.63	4.66	4.49	4.50
Butterfat, lb/day	2.12	2.18	3.26	3.37
Protein, lb/day	1.74	1.83	2.56	2.69
Lactose, lb/day	2.60	2.87 ††	3.81	4.01

^a **Robinson and Garrett [63].**

† Means within a row are different ($P < 0.10$). †† Means within a row are different ($P = 0.12$).

Table 9: Effect of yeast culture on milk production and composition the first 42 days of lactation in early-lactation Jersey dairy cows^a.

Items	Control	Yeast Culture	<i>P</i> -value
Dry Matter Intake, lb/day	26.2	30.2	0.05
Milk, lb/day	47.0	50.5	0.31
Butterfat, %	4.27	4.44	0.28
Protein, %	3.64	3.78	0.15
Lactose, %	4.93	4.99	0.18
Total Solids, %	13.60	13.90	0.10

^a **Dann et al. [36].**

Table 10: Effect of Active Dry Yeast (YEA-SACC® 1026) at the rate 10 g/ head/ day in the diet of lactating baladi cows on daily milk yield, daily FCM 4% and milk energy#.

Items	Control (without treatment)	Treatment with yeast with YEA-SACC® 1026 ^a
Daily milk yield (kg)	5.74 ± 0.92	6.19 ± 0.92 [*]
Daily FCM 4% (kg)	4.91 ± 0.76	5.30 ± 0.77 [*]
Milk dry matter (%)	10.90 ± 0.17	10.86 ± 0.18
GE (M cal / Kg DM)	5.60 ± 0.02	5.61 ± 0.02
DE (M cal / Kg DM)	5.43 ± 0.02	5.44 ± 0.02
ME (M cal / kg f DM)	5.22 ± 0.02	5.22 ± 0.02
NEM (M cal / Kg DM)	4.49 ± 0.01	4.49 ± 0.01
NEG (M cal / Kg DM)	3.60 ± 0.01	3.61 ± 0.01

* Significant at P< 0.05 #Abo-Amer [64].

Giger-Reverdin et al. [65] found that supplying yeast (*Saccharomyces cerevisiae* I-1077) to dairy goats decreased energy and nitrogen balances during the first 6 weeks after parturition. The authors concluded that Yeast seemed to facilitate increased mobilization of body reserves and to increase milk fatty acid production. Thus, fat-corrected milk yield increased during the period when animals are very susceptible to nutritional stress. Blezinger [28] found that milk production for heifers consuming the yeast-mineral mix appeared to be greater as well as weaning weights and weight per day of age appeared to be improved by availability of a yeast-mineral mix. Sretenović et al. [66] reported that preparation Yeasture influenced quantity and composition of the milk by 2.57 kg 4%FCM or 8.70% (P<0.01) and 7.16% milk fat (P<0.05). Wang et al. [67] found that feeding a ration with 21% forage neutral detergent fiber and yeast culture positively affected dry matter intake, actual milk yield, 3.5% fat corrected milk. Wu Zilin [68] demonstrated that inclusion of yeast culture in the daily ration of Chinese Holstein lactating cows increased DMI 3.94%, milk yield 4.04, 3.5%FCM 7.07%, milk fat percent 5.77% and significantly increased the amount of milk produced, but had minor effect on percent of milk protein and lactose content.

Table 11: Milk production of spring-calving and weaning weight of calving heifers supplemented yeast while grazing fescue heifers.

Items	Control	yeast
*Milk, lb/day	9.6	12.9
**Weaning weight, lb	382.1	408.9

Blezinger [28] *Based on weight- suckle-weight measurements, **Adjusted for birth weight

Schingoethe et al. [53] used the yeast culture to evaluate its effect on production efficiency during the summer weather. Weekly day-time high temperatures during the 12 wk period averaged 33°C (28 to 39°C). Yeast culture has improved mean daily 4% fat-corrected milk (31.2 and 32.0 kg/d), but percentages of milk fat (3.34 and 3.41) and true protein (2.85 and 2.87) were similar for both diets.

Table 12: Quantity and composition of milk Holstein-Friesian cows influenced by preparation Yeasture*.

Parameter	Control	Treated
Average 4%FCM	29.55A	32.12B
4%FCM (1st control)	24.33A	29.16B
4%FCM (2nd control)	30.81a	33.71b
4%FCM (3rd control)	30.00a	32.81b
Milk fat,%	3.91a	4.19b
Milk protein,%	3.05	3.11
Lactose,%	4.91	5.16
Fat free dry matter,%	11.65	11.72

A,B significant at the level $P < 0.01$ a,b significant at the level $P < 0.05$ *Sretenović et al. [66].

Table 13: Influence of Alltech Yea-Sacc¹⁰²⁶, Diamond V Mills ‘XP’ and Chr. Hansen (CH) Biomate Plus on dry matter intake, milk production, milk components and estimated diet energy density (net energy for lactation (NEL)).

DMI and Milk Production	Source		Diet		Benefit.	
	Papers	Exper.	Cont. diet	Diet + Yea-sacc ¹⁰²⁶	Overall %	% expts
Dry matter intake (kg/d)						
Alltech ¹⁰²⁶	3	5	19.1	19.5	+2.1	60
Diamond V XP	11	12	20.8	21.1	+1.7	63
CH Biomate Plus	4	5	22.0	22.1	+0.5	60
Milk Production (kg/d)						
Alltech ¹⁰²⁶	3	5	22.7	23.5	+3.5	80
Diamond V XP	11	12	35.6	36.6	+2.6	83
CH Biomate Plus	4	5	36.0	37.2	+3.4	100
Milk protein (%)						
Alltech ¹⁰²⁶	3	5	3.17	3.13	-1.3	60
Diamond V XP	11	12	3.12	3.10	-0.6	63
CH Biomate Plus	4	5	3.10	3.04	-2.1	100
Milk fat (%)						
Alltech ¹⁰²⁶	3	5	3.34	3.33	-0.3	40
Diamond V XP	11	12	3.64	3.72	+2.2	75
CH Biomate Plus	4	5	3.61	3.63	+0.6	40
Diet Energy Density (Mcal/kg DM)						
Alltech ¹⁰²⁶	3	5	1.30	1.32	+1.5	-
Diamond V XP	10	10	1.65	1.68	+1.8	-
CH Biomate Plus	4	5	1.60	1.63	+1.9	-

*Schingoethe et al. [43].

Poppy et al. [69] reported that treatment with yeast culture increased MY 1.18 kg/d, and stated that yeast culture treatment effect of 1.34 kg/d. Yeast culture supplementation increased 3.5% FCM by 1.61 kg/d and ECM by 1.65 kg/d. Milk fat yield and PY results showed significant treatment effects with 0.06 kg/d and 0.03 kg/d, respectively. Poppy et al. [69] reported that during early lactation DMI increased by 0.62 kg/d and during the late lactation studies, average DMI declined significantly. The change in DMI in early lactation may be an opportunity for nutritionists and farm consultants to modify DMI of cows during the critical period of transition to increase intakes and possibly aid in transition health while decreased DMI in later lactation, along with increasing milk production, will increase efficiency

of milk production. Similar finding was reported by Desnoyers et al. [70] Yeast products are commonly used around the world for inclusion in diets of production animals. It is thought that yeast products affect the rumen microbial population, causing changes in ruminal VFA production that result in increased milk production as well as an increase in milk fat and milk protein yields from lactating dairy cows [71-73].

Effect of Yeast on Production and Reproduction

Panda et al. [19] found that mean daily gain for male calves which were given a daily dose of yeast cell suspension (Sc) was greater than that of control (478 ± 40 g vs. 339 ± 28 g). Yadav et al. [8] found that daily body gain for female buffalo heifers received yeast culture (5g daily) was 645 g vs 553g for control heifers. Saleh et al. [21] found that adding ADY increased significantly total gain and ADG by 12.1% and that ADG was significantly increased until 85 days of experiment or until LBW of lambs reached 42.2 kg, thereafter the differences between control and treatment groups in ADG were not significant ($p>0.05$). These results mean that ADY was efficient with lambs from weaning to approximately 42.2 kg LBW i.e. during first growing stage. Saleh et al. [21] found that mean body weight of yeast treatment was higher than control treatment all over experimental period which extended for 105 days and the gape between two treatments was approximately constant until 99 day of experiment. In male Barki lambs, EL Ashry et al. [57] found that adding yeast culture to the diet increased ADG from 139.3 to 148.3 g, but the difference was not significant. In growing Buffalo calves, EL Ashry et al. [27] found that adding live dried yeast to the ration increased ADG from 678.4 to 744.6 g for experiment which extended for 9 months and the differences between both was not significant.

In beef cattle the addition of SC leads to an increase of live weight by 7.5% depending on the type of diet tested. Improvement can reach 13% in feedlot conditions, with diets rich in starch and sugars [74]. Wallace and Newbold [75] reported that responses recorded in trials in beef cattle tended to be higher with corn silage rather than with

grass silage. In dairy ruminants, ADYs have been shown to improve performance, the most consistent effects being an increase in dry matter (DM) intake and milk production [76-79]. In addition, in beef cattle or young ruminants, growth parameters (average daily gain, final weight, DM intake, feed to gain ratio) have been reported to be improved by daily ADY supplementation in several studies [80,81]. Studies in dairy cows indicated that supplementation with yeast culture (YC) may increase Dry matter intake (DMI) and milk production and improve milk composition [3677,82]. Several factors affect the response of dairy cows to YC supplementation, such as stage of lactation, type of forage given, feeding strategy (total mixed ration (TMR) or forage and concentrate given separately), and forage: concentrate ratio [71,72]. Schingothe et al. [53] found that feed efficiency defined as kilogram of energy corrected milk / kilogram of DM intake was improved by 7% for cows fed the yeast and concluded that the yeast can improved feed efficiency of heat stressed dairy cows in mid-lactation. Kholif and Kholif [83] found that selenized yeast supplementation in the diets of Egyptian lactating buffaloes improved significantly the nutrients digestibility coefficient and increased milk yield, 4% FCM yield, milk protein and solids not fat contents as well as fed efficiency (milk yield/DMI and FCM/DMI) compared with control.

In rabbits, Habeeb et al. [20] found that average daily gain and feed intake improved by 12,6 and 21.2 %, respectively, when ADY was added and concluded that ADY supplement is efficiently for improving growth traits of new weaned growing male rabbits without any side effects on nutritional and physiological performance. Habeeb et al. [20] found that adding ADY increased significantly total gain by 12.6%. and body weight of yeast treatment group was higher than control group all over the experimental period which extended for 70 days and the gape between two groups was approximately constant until the end of the experiment. The same authors found that the accumulative ADG for male rabbits fed ration supplemented with either 0.0 or 10.0 g ADY/ kg CFM showed that ADG was significantly increased until LBW of rabbits reached 2.5 kg at the end of the experiment. These results mean that ADY was efficient with rabbits from

weaning to approximately 2.5 kg LEW i.e. during growing stage until market age.

An increase in body weight gain and feed efficiency in calves has been seen when YC is added to the diet [84]. Lesmeister et al. [80] fed *S. cerevisiae* in calf starter to Holstein calves from 2 to 42 days of age and found that average daily gain and DMI was higher for the treatment group. Laborde [85] found that calves receiving starter containing yeast culture consume water more than calves not fed YC and calves consuming yeast culture showed significant increased body weight when compared to other calves at week 6 and 8 and concluded that yeast cultures have been shown to improve growth performance and health of calves when supplemented in the diet. Many nutritionists and researchers agree that dry matter intake is the primary factor in determining milk production in dairy cattle. Increased milk production in these studies ranged from 3% to 30%, when a live yeast culture was fed [86,87]. Piva et al. [3] reported that production of milk, 4% fat-corrected milk and milk fat values were increased significantly by dietary yeast culture.

Table 14: Growth and feed performance of male rabbits fed ration with or without ADY supplement*.

Growth and feed performance	Control	ADY	Change%
Initial live body weight, g	670 ±10	660±11	-1.5 ^{NS}
Final live body weight, g	2450 ^b ±20	2660 ^a ±25	+8.6*
Total weight gain, kg/70 days	1.78 ^b ±0.02	2.00 ^a ±: 0.01	+12.6**
Daily body weight gain, g	25.4 ^b ±0.4	28.6 ^a ±0.3	+12.6**
Daily feed intake (g feed /head)	76.2 ^b ±7	92.3 ^a ±9	+21.2**
Daily feed intake (g DM /head)	68.3 ^b ±5	82.8 ^a ± 8	+32.2**
Feed conversion (g feed /g gain)	3.00 ^b	3.20 ^a	+6.7*
Feed conversion (g DMI/g gain)	2.69 ^b	2.90 ^a	-7.8*

*Habeeb et al. [17].

*Significant at P< 0.05,

**Significant at P< 0.01 and NS=not significant, Change% = (Treatment meant- control overall mean) x 100 / control overall mean

Table 15: Effect of Active Dry Yeast (YEA-SACC® 1026) at the rate 10 g/ head/ day in the diet of lactating baladi cows on growth performance of their calves during suckling period#.

Growth performance	Control (without treatment)	Treatment with YEA-SACC® 1026#
Daily body weight gain (g)	422.62 ± 14.34	523.81 ± 17.39
Change %		23.94**
Relative growth rate	4.72 ± 0.23	5.86 ± 0.39
Change %		24.19**

Change % = (Treatment meant- control overall mean) x 100 / control overall mean
 ** Significant at P< 0.01 #Abo-Amer [64]

To evaluate the effects of pre-and post-partum yeast feeding on early lactation milk in' Jersey and Holstein cows, Britt et al. [9] found that the research group received 2 oz. Yeast daily during the pre-partum or post-partum periods had an 8.25 Ib per day milk yield, a 0.395 Ib per day fat yield and a 9.92 Ib per day fat corrected milk over the control group and concluded that there was a \$1.00 economical advantage per day to the research group. Housewright et al. [11] added that cows supplemented with Yeast live cell culture had numerically higher milk production than the cows received the dead cell yeast culture. On average an increase of 14 Ib per cow per day was observed when cows were supplemented with 56.75 g/head/day of yeast live cell culture. However, Britt et al. [10] found that milk yield, butterfat %, butterfat yield, protein yield, fat corrected and energy corrected milk were not statistically significant but were biologically higher in the yeast group than the control group and there was a \$0.54 economical advantage daily to the yeast group. EI-Ayek et al [23] found that significant increase in monthly milk yield as actual or fat connected milk by a 45 and 41.6% for buffaloes fed YC respectively compared with control one. Milk feed efficiency was significantly higher in buffalo cows fed YC than of the control group and concluded that the efficiency of yeast supplementation diet of lactating buffaloes lead to increase their milk yield and its composition.

Concerning effect of ADY on reproductive performance, Abdel-Khalek et al. [88] revealed that mean period elapsed from parturition until drop of the fetal membranes was lower significantly in buffaloes treated with yeast culture than that of the control animals (5.07 vs 8.14 hours). The interval required for pregnant uterus to return intrapelvic, time of postpartum cervical closure and postpartum uterine horns symmetry was earlier significantly in buffaloes treated with yeast culture (16.7, 24.0 and 25.7 days, respectively) than control group (29.5, 37.7 and 38.0 days, respectively). Dietary treatments resulted in changes in intensity of oestrous behavior of buffalo cows as compared to the control. Average service period length was 0 in treated animals and 12.3 days in control animals; number of cervixes/conception was 1.0 in treated buffaloes and 1.33 and number of days open was 42.7 in treated and 54.2 in control. Buffaloes in treated showed the shortest calving interval 358 days vs 373.2 days in control. Within the first 50 days postpartum postpartum buffalo cows in treated with yeasts showed the highest conception rate (83.3%) while control buffalo cows showed the lowest (50%) values.

Table 16: Effect of live dried yeast and yeast culture on performance of growing buffalo calves and economic efficiency.

Items*	Control	Live DY	YC
Initial weight, kg	112.0±7.1	113.5±11.4	112.0±6.1
Final weight, kg	295.2 ^b ±11.2	317.8 ^{ab} ±7.2	322.6 ^a ±2.2
Total weight gain, kg	182.2 ^b ±9.3	204.3 ^{ab} ±7.5	210.6 ^a ±6.4
DG, g/d	678.4 ^b ±34	744.6 ^{ab} ±26	780.3 ^a ±23
DMI, kg/d	7.29±0.46	7.30±0.40	7.16±0.26
F.C. kg DM/kg gain	10.73 ^a ±0.34	9.64 ^b ±0.31	9.18 ^b ±0.31
F.C. kg TDN/kg gain	6.49 ^a ±0.21	6.17 ^{ab} ±0.20	5.90 ^b ±0.20
F.C. kg DCP/kg gain	0.93±0.03	0.94±0.03	0.92±0.03
Return, LE	2.69	3.18	3.29
Economic efficiency	100	118.20	118.96

Means in the same row with differ superscripts differ (P<0.05). *Al-Ashry et al. [27]

Bruno et al. [89] studied treatment Multiparous Holstein cows with diet containing 30 g/d of a culture of *Saccharomyces cerevisiae*

(YC; n = 358) from 20 to 140 d postpartum and found that feeding a yeast culture of *S. cerevisiae* had no impact on reproduction of cows under heat stress. Changes in rumen fermentations or rumen parameters attributed to yeast feeding are: increase in cellulolytic digesting bacteria; increased fiber digestion; enhanced utilization of lactic acid by rumen bacteria; increased propionic acid production in the rumen and more stable rumen pH [90]. It remains to be seen whether these products actually do alter rumen fermentations, have a metabolic effect on the animal or improve feed intake. Belknap [91] reported that average daily gain was improved from 2.92 to 3.10 lb/hd/day due to feeding yeast culture and feed efficiency was also improved from 6.45 to 5.95 lb feed/lb gain. Blezinger [28] showed improved weight gains in yeast culture fed cattle grazing fescue pasture and found that Yeast products such as S C may assist in digestion of forages. The same author found also that pregnant heifers appeared to gain slightly more weight if they had access to a free-choice mineral supplement containing yeast when compared to a control mineral. In this particular study, however, the control heifers lost less weight during the interval of calving and peak lactation although this may have some relation to milk production differences. Cow-calf pairs consuming yeast-mineral mixes resulted in increased weaning weights. The gestating heifers appeared to gain slightly more weight if they had access to a free-choice mineral supplement containing yeast than a control mineral. There also appeared to be slightly more body-weight gain for the yeast-supplemented heifers compared to controls during early-spring grass growth. Blezinger [28] concluded that the use of yeast and yeast derivative products have been shown to have merit in a number of animal feeding situations, especially calves and growing cattle. Macedo et al. [92] found that differences were not observed ($p > 0.05$) between YC and C sheep on body weight (36.00 vs 36.75 kg), dry matter intake (68.10 vs 69.50 kg), average daily gain (290 vs 300 g/d) and feed conversion (4.22 vs 4.15 g DM/g gain) and concluded that adding yeast culture did not improve production performance of intensively fattened Pelibuey sheep.

Diamond V Yeast Culture increases the population of total rumen bacteria by up to 59% [5] and this increase in turn helps increase feed intake as well as feed stuff digestibility [93]. Therefore, as more nutrients go into the animal via greater intake, and more nutrients are provided to the animal via greater digestibility, the animal is put on a generally higher plane of nutrition. Midwest Feed Manufacturer [94] revealed that calves on the yeast culture treatment consumed numerically greater dry matter and had a higher average daily gain than the control cattle. Although the control group gained an exceptional 3.69 lb/hd/day, the yeast culture group still out performed by gaining 3.98 lb/hd/day ($P < 0.01$). Moreover, feed efficiency was numerically better for the yeast culture group as well. Once again, when economics are applied to this trial, the net benefit of feeding yeast culture was over 20 cents/hd/day.

Table 17: Analysis of animal body weight gain during different periods of the year and stages of production.

Body weight gain, lb/mo		
Periods	Control	yeast
July-February Gestation period,	35.8	40.7
February-April Calving-Peak lactation	-63.3	-76.1
April-June Spring Grass Growth	21.8	30.9

Blezinger [28]

Table 18: Influence of Yea-Sacc1026 on DMI, BW gain and FCE.

DMI, BW gain and FCE.	Source		Diet		Benefit.	
	Papers	Exper.	Control diet	Diet + Yea-sacc ¹⁰²⁶	Over-all %	% expts
DMI (kg/d)	4	8	7.39	7.54	+2.0	75
BWG (kg/d)	4	8	1.25	1.30	+3.7	100
F. E.(kg BW gain/kg DM intake)	4	5	0.175	0.179	+1.8	60

*Robinson [14].

Table 19: Effect of Diamond V Yeast Culture on 28-day performance of low-stress re-ceiving cattle*.

Items	Control	Yeast culture	P-value
Initial LBW	596	596	
Final LBW	703	712	0.01
ADG, lbs	3.69	3.98	0.01
DMI, lbs/hd/day	14.78	15.58	0.19
Feed: Gain	4.00	3.91	NS

*Midwest Feed Manufacturer [94].

Effect of Yeast on Blood Component

El-Ashry et al [17] found 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 10^9 CFU *Sc* per gram) for lactating buffalo. The same authors found also that GOT and GPT activities were not significantly affected due to treatment. El-Ashry et al. [57] reported that serum total proteins, albumin and globulin for Barky male lambs increased significantly from 7.93 to 8.26, 4.31 to 4.45 and 3.61 to 3.98 g/dl, respectively. The same authors reported also that urea concentration was not significantly affected with yeast supplements.

Habeeb et al. [20] reported that the levels of TS and T4 hormones as well as liver immunity function (i.e. total proteins, albumin and globulin), serum total lipids and triglycerides concentrations increased significantly with adding ADY to the diet of growing rabbits. No significant differences were detected in urea-N, creatinine and cholesterol concentrations as well as serum SCOT and SGPT activities due to adding ADY to diets. Habeeb et al. [20] showed also that total proteins, albumin and globulin concentrations as well as total lipids and triglycerides concentrations increased significantly by adding yeast to the ration of the growing rabbits. The same trend was observed in T3 and T4 levels. On the other hand, GOT and GPT activities (liver function) as well as creatinine and urea concentrations (kidney function) and total cholesterol concentration (heart function) were not significantly affected by the yeast supplementation.

Habeeb et al. [20] reported that feeding rabbits on CFM with 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. El-Ashry et al. [57] reported that serum total proteins, albumin and globulin for Barky male lambs increased significantly from 7.93 to 8.26, 4.31 to 4.45 and 3.61 to 3.98 g/dl, respectively, while serum urea concentration was not significantly affected with yeast supplements. El-Ashry et al. [17] found 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 10^9 CPU Sc per gram) for lactating buffalo. The same authors found also that GOT and GPT activities were not significantly affected due to treatment. Piva et al. [3] found that feeding yeast culture for Holstein-Friesian cows in mid-lactation period was not affected significantly on blood plasma metabolites(total protein, albumin, globulin, billirubin, cholesterol and urea) and blood plasma minerals(Ca, Pj , Mg, Na and K) concentrations while blood plasma glucose and Zn tended to be improved by supplementation with yeast culture. Stella et al. [79] reported that supplementation of live Sc for lactating dairy goats during early lactation period was not affected significantly on plasma NEFA, GOT, GGT and glucose concentrations while treated animals had somewhat higher plasma BHBA.

Habeeb et al. [20] concluded that feeding on CFM contained ADY improved the appetite of rabbits which lead to increase the feed intake and consequently increased the daily weight gain of the treated animals. From the physiological point of view, adding ADY caused a significant increase the levels of both T4 and TB hormones which lead to increase the protein and fat biosyntheses. From the nutritional point of view, feeding rabbits CFM supplemented with ADY may be support the intestinal microflora to increase the digestion of fiber ^especially, cellulose in the CFM and consequently improved the utilization of the diet [13,19]. The increase in cellulose digestion may

be responsible in the increase of the volatile fatty acids production which are the building blocks for the protein, fat and vitamins synthesis necessary to allow the increase in weight gain and feed efficiency [95]. In addition, Habeeb et al. [20] consider yeast is the source of B-complex vitamins which represent the digestion and appetite stimulating vitamins. These vitamins make as important co-enzymes like Nicotine-amide Adenine Dinucleotides (NAD) and Flavin Adenine Dinucleotides (FAD) which responsible on biological oxidation to produce the necessary ATP for protein, fat and carbohydrate biosynthesis. Moreover, yeast offers several important nutritional benefits such as naturally high levels of protein (45% minimum), a wide array of amino acids (16 total amino acids), a high concentration of the B vitamins and several minerals necessary for maintaining healthy animals (10 essential and trace minerals) [96,97].

Finally, Habeeb et al. [20] mentioned that yeast produces enzymes which assist animal digestion *as well as* nutrients which feed and stimulate digestive bacteria found in the gut.. Yeast improved digestion by providing the digestive enzymes amylase for starch digestion, protease for protein digestion, lipase for fat digestion and cellulase for butterfat synthesis. In addition, Yeast stimulates the appetite of rabbits and helps maintain maximum dry matter intake by stimulating intestine fermentation and improving fiber digestion. Yeast helps incoming rabbits on to full feed quicker with an improvement in rate of gain and/or feed conversion as shown from the results of this research with ending to overall feed cost per kilogram gain reductions.

Table 20: Blood components in male rabbits fed ration with or without ADY supplement.

#Blood components	Control	ADY	Difference %
Liver function:			
Total proteins (g/dl)	7.01 ^b ±0.3	7.91 ^a ±0.2	+12.8**
Albumin (g/dl)	3.45 ^b ±0.1	3.94 ^a ±0.1	+14.2**
Globulin (g/dl)	3.56 ^b ±0.1	3.97 ^a ±0.1	+11.5*
GOT (U/l)	23.50±3	24.40±5	+3.8 ^{NS}
GPT (U/l)	22.10±3	23.40±2	+1.4 ^{NS}
Kidney function:			
Urea-N(mg/dl)	32.64±5	33.78±4	+5.9 ^{NS}
Creatinine(mg/dl)	1.00±0.01	1.02±0.01	+2.0 ^{NS}
Thyroid function:			
T ₃ (ng/dl)	83 ^b ±4	100 ^a ±5	+20.5**
T ₄ (ng/ml)	45 ^b ±4	55 ^a ±6	+22.2**
Lipid fractions:			
Total Lipids(mg/dl)	360 ^b ±12	396 ^a ±16	+10.00**
Total cholesterol (mg/dl)	126±6	120 ±7	4.80 ^{NS}
Triglycerides (mg/dl)	140 ^b ±6	160 ^a ±5	14.29**

#Habeeb et al. [20]

Table 21: Effect of feeding ration with or without ADY supplement (5g/h/d) on some serum parameters in male lambs

Item	#Control	ADY
Total protein (g/dl)	9.31	10.61
Albumin ,A (g/dl)	3.85	4.14
Globulin ,G(g/dl)	4.46	6.47
Urea (mg/dl)	32.64	34.78
GOT (U/l)	33.5	34.4
GPT (U/l)	21.3	22.4

#Saleh et al. [21]

Table 22: Effect of live dried yeast and yeast culture in the diets of growing buffalo calves on blood components

Items*	Control	Live DY	YC
Total protein	5.26 ^b ±0.27	5.36 ^a ±0.19	5.89 ^a ±0.16
Albumin	3.27 ^a ±0.07	2.98 ^b ±0.11	3.08 ^{ab} ±0.06
Globulin	1.99 ^b ±0.24	2.23 ^b ±0.17	2.78 ^a ±0.16
Urea	46.25±2.64	51.25±4.01	51.92±4.19
Creatinine	1.33±0.07	1.42±0.09	1.38±0.09
Cholesterol	64.25 ^a ±2.27	58.08 ^{ab} ±4.10	54.50 ^b ±3.98
GPT	144.44±15.7	127.97±11.97	141.22±9.59
GOT	56.15 ^a ±2.42	50.56 ^{ab} ±2.31	49.33 ^b ±3.36

A,b Means in the same row with differ superscripts differ (P<0.05).*Al-Ashry et al. (2001b).

Table 23: Blood biochemical parameters of Holstein-Friesian cows.

Parameter	Time of sampling			
	Trial beginning		Trial end	
	C	T	C	T
Glucose	3.43	3.42	3.27	3.53
Total bilirubin	2.62	2.23	3.80	2.73
AST, U/L	67.40	58.35	107.32	105.58
ALT, U/L	23.57	21.50	32.20	33.50
Calcium	2.60	2.62	2.35	2.32
Phosphorus	2.07	2.25	2.07	2.08

Sretenoviic et al. [66]

Feeding on total feed mixture contained ADY improved the appetite of animals which lead to increase the feed intake and consequently increased the daily weight gain of the treated animals. From the physiological point of view, adding ADY caused a significant increase the levels of both T₄ and T₃ hormones which lead to increase the protein and fat biosyntheses. Habeeb et al. [20] recommended to apply nutrition yeast for feeding rabbits as a protein-rich additive, which contains biological pure active substances of microbiological origin, protein, all indispensable amino acids, vitamins, fertnents facilitating digestion and assimilation of fodder, as well as micro and macro elements. It is concluded that addition of commercial ADY to

the basal diet of rabbits tended to improve nutrient digestibility and significantly improve the live body weight and daily body gain without any adverse effects on rabbits healthy or any pollution in the rabbitry building. Lehloenya et al. [56] 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. Saleh et al. [21] found that total proteins, albumin, globulin, A/G ratio and urea concentrations increased insignificantly by yeast supplements. GOT and GPT activities also were not significantly affected by the yeast supplementation. These results are in agreement with those reported by El-Ashry et al. [17] who found 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 10^9 CFU *Sc* per gram) for lactating buffalo. The same authors found also that GOT and GPT activities were not significantly affected due to treatment. El-Ashry et al. [57] reported that serum total proteins, albumin and globulin for Barki male lambs 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 non-significantly affected with yeast supplements. In Egyptian (baladi) cattle, Ashour et al. [58] found that treatment with yeast supplementation (*Sc*¹⁰²⁶) 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 (T3 and T4).

Overall Effects of Yeast on Performance of Animals

In ruminants the beneficial effects of yeast as microbial feed additive on the performance of animals were summarized by Kamra and Pathak [98] as:

1. Increases the palatability of feed (Glutamic acid produced by yeast is responsible for improvement in the taste of feed stuffs and a pleasant odour).
2. Stimulation of rumen microbes and enhanced microbial protein synthesis in the rumen.
3. pH stabilization in the rumen, viable yeast acts as a modulator of rumen pH.
4. Oxygen scavenging from the rumen.
5. Supply of vitamins and minerals to fiber degrading microbes.
6. Reduced ammonia nitrogen in rumen liquor. This can be either due to a reduced degradation of dietary protein, or due to an enhanced use of ammonia by bacteria resulting in an enhanced production of microbial protein or both.
7. Increase rate of fiber digestion and the rate of digesta flow.
8. Improves bacterial count and VFA in rumen liquor, decreases the ratio of acetic to propionic acid, mainly due to higher production of propionic acid.
9. Higher production of carboxymethyl cellulase activity in rumen liquor.
10. Better ruminal digestion, metabolism and improved nutrient utilization.

11. An increase in feed conversion efficiency and LBWG in growing animals.
12. Improved milk production in dairy animals.
13. Protection of young animals against enteropathic disorders such as diarrhoea by inhibiting the colonization of coliform bacteria in the gut.

Conclusion

The ban on antibiotic growth promoters in feed for production of animal foods has increased interest in evaluating the effect of YC on the GI ecosystem, rumen microbial populations and function. The effects of YC on animal productivity are strain-dependant. So, all YC preparations are not equivalent in efficiency. This aspect opened a new field of research for new strains, each being more specialized in its use. The goal of many of these research activities has been to define the application and production strategies that can optimize animal responses to YC supplements.

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