Determine the Proper Level of Yeast with Different Levels of Roughages to Improve the Nutritive Value of Lamb's Ration

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Abstract: The aim of this study was to evaluate the effects of supplemented two levels of yeast culture (YC) to two rations of different roughage levels on animal performance, nutrient digestibility, nitrogen balance, nutritive value and rumen fermentation of growing lambs. Sixty Ossimi male lambs of an average being 37.5Kg body weight and 9 months age were randomly assigned to six nutritional groups. Animals were fed two basal rations differ in roughage ratios (Control 1 or 2) without supplementation or supplemented with 0.1 or 0.2% dry yeast containing 10^8 cells of *Saccharomyces cerevisiae* per gram (Yea- Sacc^{1026}). The growth experiment lasted 120 days. A digestion trail was carried on and samples of rumen liquor were collected at the end of the growth experiment. The results showed that addition of YC to the basal ration increased DMI, TDNI, DCPI, feed conversion ratio and did significantly ($P<0.05$) improve lambs average daily gain (ADG). On the other hand, YC supplementation improved digestion coefficients of DM, OM, CP and CF. Nitrogen balance, TDN and DCP also significantly ($P<0.05$) increased by the addition of YC. Ruminal pH value increased ($P<0.05$) and ammonia concentration decreased ($P<0.05$) for in animals fed YC supplemented rations compared to the control rations. However, total VFA's concentration not significantly affected by YC supplementation. Supplementation of YC to control 2 of higher roughage content significantly ($P<0.05$) increased acetate concentration and decreased of propionate concentration in rations 5 and 6 compared with other rations. While, the butyrate concentration were significantly ($P<0.05$) decreased with supplement control ration 1 and 2 by both two levels of YC (rations 3, 4, 5, and 6). It could be concluded that addition of YC to sheep rations containing different levels of roughages improved growth performance, crude protein and crude fiber digestibility, nitrogen balance and some rumen parameters.

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1. Introduction:

The goal of any feeding program is to provide the correct amount and balance of nutrients to animals at the proper time to achieve optimum productive and reproductive efficiency and profitability (Gaafar, 2010).

The use of probiotics for farm animals has increased considerably over the last 15 years. Probiotics are defined as live microorganisms which can confer a health benefit for the host animals. It also used in a wide range of nutritional techniques in order to support the host organism to reduce stress (Chaucheyars-Durand and Durand, 2010).

Yeast culture, mainly *Saccharomyces cerevisiae* may also improve ruminal fermentation (Newbold *et al.*, 1990) and therefore provide another enhancer for microbial growth. It can help in the stability of rumen fermentation by consuming oxygen in the rumen. Also, live yeast supplement can release essential enzymes, vitamins and amino acids during digestion which are thought to have a positive influence on the rumen media.

Rationary factors such as forage- to- concentrate ratio and forage type are important in determining the response to yeast culture supplementation (Piva *et al.*,1993).This may explain the contradiction found in the results of the previous studies.

Several researches (Mathieu *et al.*, 1996; Jouany *et al.*, 1998, Robinson and Grrett, 1999; Arcos Gascia *et al.*, 2000; Abd El- Ghani, 2004; Kamel *et al.*, 2004 and Mohrrery and Asad, 2009) reported that supplementation of YC to ruminant rations may improve feed intake, milk production, weight gain, digestion, numbers of anaerobic and celluletic bacteria, ruminal pH value and alter the patterns of volatile fatty acids.

Also, Ahlam (2011) concluded that supplementation of dried yeast to rations of growing goat kid's improved daily gain, feed efficiency, digestibility coefficients, rumen fermentation and utilization and absorption of minerals consequently improving animal performance under desert condition of southern Sinai.

The present study aimed to investigate the effect of yeast culture supplementation level in fattening

lambs rations contained two levels of roughage on growth performance, nutrient digestibility, nitrogen balance, nutritive value and rumen parameters.

2. Material and Methods

This study was carried out at Animal Production Farm, Faculty of Agriculture, Al-Azhar University. Chemical analyses were carried out at Laboratories of Animals Production Department, National Research center, Egypt.

Sixty Ossimi male lambs aged about nine months with an average live body weight being 37.5 Kg were randomly divided into six experimental groups (10 lambs each) in a feeding trial lasted for 120 days. Formulation and chemical composition of mixed experimental rations are presented in Tables 1 and 2, in which the basal rations (control 1 or 2) were differ in roughage ratio. The two basal rations were supplemented with either 0.1 or 0.2 % dry yeast contains 10^8 cells of *Saccharomyces cerevisiae* per gram (Yea-Sacc^{1026}).

Ingredients were mechanically mixed in 10 mm pelleted form and offered to lambs for *ad libitum* consumption with free access to water. At the end of the experiment a conventional digestion trial was conducted using four animals per each group in order to justify rations digestibility, nutritive value and nitrogen balance. Digestion trial consisted of 14 days primarily period for adaptation followed by 5 days as collection period using digestion cages.

During the collection period, feces and urine were quantitatively collected from each animal once a day at 8.0 am before feeding. Actual quantity of feed intake was recorded and water consumption was also recorded. Representative samples of the experimental feed and feces were analyzed for dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE), ash and urinary nitrogen were determined according to A.O.A.C (1995). Nitrogen free extract (NFE) was obtained by difference.

At the end of the digestion trials, rumen samples were collected from animals using stomach tube 4 hrs post feeding and filtered through four layers of cheese cloth for determining different rumen parameters. The pH value was immediately recorded using digital pH Metter, while samples were stored at -20 ^{o}C until chemical analysis. Ruminal ammonia nitrogen (NH_3-N) concentrations were determined applying NH3 diffusion technique using kjeldahle distillation method as described by A.O.A.C. (1995). Ruminal total volatile fatty acids (TVFA's) concentrations were determined by steam distillation procedure according to Warner (1964).

Volatile fatty acid fractions were determined according to Erwin *et al.* (1961) using gas liquid chromatography.

Data were statistically analyzed for analysis of variance (One-way) using the General Liner Model (SAS, 1990)**.** Differences among means were compared ($P< 0.05$) using Duncan's new multiple rang test (Duncan, 1955).

3. Results and Discussion

The basal rations (Rations 1 and 2) differed only in percentage of roughages (30 or 45% bean straw, respectively). These basal rations were supplemented with either 0.1 or 0.2% dried yeast (YC). Formulation of the experimental rations and its chemical composition are shown in Tables 1 and 2. Crude fiber content of rations 2, 5 and 6 were higher than that in rations 1, 3 and 4. This was mainly due to increasing level of bean straw on these rations (45%) compared to rations 1, 3 and 4 which contained 30% bean straw. The values of other nutrients were nearly similar in all the experimental rations.

Lambs Performance:-

Data of average daily gain (ADG), dry matter intake (DMI), TDNI, DCPI and feed conversion are presented in Table 3. Lambs fed YC supplemented rations (3, 4 and 6) showed higher ADG ($P<0.05$) compared with those fed on control rations 1 or 2 and 5. The ADG showed the least value for R2 contained higher CF content. Addition of YC improved ($P<0.05$) ADG. The pronounced effect of YC supplementation was observed for ration low CF content supplemented with 0.1% YC (R3) followed by R4 and R6 which supplemented with 0.2% YC. The highest values of ADG was recorded for ration 3 (192g/day) and the lowest values was recorded for ration 2 (150g/day). Addition of YC showed slight ($P>0.05$) improvement in daily DMI. However, animals fed ration of high CF content without YC supplementation (R2) recorded the lowest daily DMI among the other groups. The same trend was obtained for TDN and DCP intake. Also minor enhancement ($P>0.05$) was obtained in values of feed conversion ratio determined as Kg DMI or TDNI/ Kg gain.

The obtained results on performance agreed with those of Abou Ward (2001) who found that animals fed YC supplemented rations had higher DMI, TDNI and DCPI and lower feed conversion ratio compared with those fed the un-supplemented rations. Similar results were reviewed by many authors (Williamas *et al.*, 1991; Philips and Von Tungeln, 1985 and Cole *et al.*, 1992) who noticed an improvement in performance of heat stressed lambs, when YC was added to their rations. Also, Abou ward (2001) reported that lambs fed rations supplemented with 0.1% YC recorded significant increase in ADG than lambs fed un-supplemented ration. The resulted increase in the dry matter intake with added YC to the

ration may be due providing stimulating factors to rumen celluloytic bacteria (Williams, 1989; Wholt *et al.*, 1988; Williams *et al.*, 1991; Erasmus *et al.*, 1992; Piva *et al.*, 1993; Putnam *et al.*, 1997 and Wholt *et al.*, 1998).

Fallon and Hart (1987) attributed the improvement occurred in animal performance of lambs raised on rations supplemented with YC to the increased palatability of supplemented feeds which lead to an increase in animals feed intake. Chademana and Offer (1990) explained the variable DM intake responses of YC to differences in the nature of rations used, particularly their different contents of readily fermentable carbohydrates. Results of Haddad and Goussous (2005) demonstrated that 3g/d of YC supplementation to finishing Awassi lambs fed high energy rations improves weight gain, ADG and feed: gain ratio.

Digestibility and Nutritive Values:

Results concerning nutrients digestibility, nutritive values and nitrogen utilization are presented in Table 4. Digestion coefficient values for DM, OM, EE, NFE were nearly similar and were not influenced by supplementing the control 1 or 2 with YC at both the two tested levels (rations 3, 4, 5 and 6).

On the other hand, CP and CF digestibility values improved ($P<0.05$) when YC was supplemented to both control1 and 2. Rations 3, 4, 5 and 6 showed higher CP and CF digestibility values compared to the un-supplemented rations. Theses results are in agreement with the previous findings of Gado *et al.* (1998), Harris *et al.* (1992), Abou Ward (2001), Allam *et al.* (2001) and El-Ashry *et al.* (2001). Improving crude fiber digestibility may be attributed to increasing the number of rumen cellulolytic bacteria as a result of yeast supplementation (Williams, 1989 and Gomez-Alarcon *et al.*, 1990). Wiedneier *et al.* (1987) and Newbold *et al.* (1990) who reported that addition of *Saccharomyces cerevisiae* culture to sheep rations did improve the digestibility of dry matter, crude protein and hemicellulose which in turn lead to increase degradability of protein and flow of microbial nitrogen to post ruminal.

On the other hand, Chademana and Offer (1990) found that supplementation of yea- sacc^{1026} did not affect the apparent digestibility of DM, OM, NDE, and CP of hay plus concentrate of different rations. Previous studies (Dowson *et al.*, 1990 and Williams *et al.*, 1991) have reported that the stimulation of cellulose degradation by yeast culture is associated with a decreased log time which results in increased initial rates of digestion, but not in increased extent of digestion by ruminal microorganisms. Williams *et al.* (1991) reported that yeast culture stimulated DM digestion in the rumen of hay fed steers when barley was absent. They attributed this difference to stabilization of ruminal pH by yeast culture in animals receiving barley.

In a subsequent study, Newbold *et al.* (1995) reported that some yeast culture increased the number of total and cellulolytic bacteria in the rumen and in some cases increased cellulose degradation. They also suggested that *Saccharomyces cerevisiae* culture stimulated the rate rather than the extent of fiber digestion by ruminal microorganisms.

El-Waziry *et al.* (2002) observed that N degradability was slightly increased by the addition of yeast. The improvement of digestion coefficients may be attributed to increase in the number of rumen cellulolytic bacteria (Williams, 1989, Gomez-Alarcon *et al.*, 1990).

The results of the present study was also in agreement with those of Erasmus *et al.* (1992) who reported that CP digestibility was significantly increased with yeast culture supplementation. Wholt *et al.* (1998) found that CP digestibility improved by cows fed a ration supplemented with YC. They suggested that such improvement may be due to the greater DM intake by the experimental cows. Wiedmeier *et al.* (1987) reported significant higher CP digestibility values in dairy cattle fed YC supplemented rations. This supplementation could probably provide stimulatory factors toward proteolytic bacteria that significantly higher CP digestibility.

However, Aramble and kent (1990), Williams *et al.* (1991), Mir and Mir (1994) found little or no effect on ration digestibility. Williams and Newbold (1990) suggested that YC may alter the site of digestion and total tract digestibility studies do not give an accurate representation of effects of YC in the rumen.

The nutritive value of the tested rations expressed as TDN and DCP showed insignificant improvement due to supplementing the control rations 1 or 2 with YC at the two tested levels. Theses results may reflected the improvement occurred in nutrients digestibility and the slightly higher feed intake of lambs fed rations supplemented with YC.

Addition of 0.1 or 0.2 % YC significantly ($P<0.05$) increased the resulted values of N-balance for rations contained the low CF content (rations 3 and 4). Addition of 0.1 % YC to the high dietary CF level did not enhance N-balance value (ration 5). However, when such high CF content ration was supplemented with 0.2 % YC, N-balance significantly ($P<0.05$) increased. This means that lambs fed rations 3 and 6 supplemented with 0.1 and 0.2% YC, respectively, retained significant ($P<0.05$) more N than lambs received the control 1 and 2. This might

be attributed to the improvement of crude protein digestibility. This finding agreed with that of Cole *et al.* (1992) who reported that lambs raised on rations supplemented with YC had greater N-balance than the control. Similar trend was reported by Abou Ward (2001), Allam *et al.* (2001) and El-Ashry *et al.* (2001).

The increase in N-balance may be due to the possible increased production of microbial protein synthesis or increased presence of fermentable energy (Tagari *et al.*, 1976), the variability in nitrogen that might escape ruminal fermentation or an increased utilization of ammonia in the rumen (Holzer *et al.*, 1986).

Rumen liquor Parameters:-

Table 5 summarized values of ruminal pH, TVFA's concentration, the molar proportion of individual VFA's and also NH_3-N concentration 4 hrs post feeding. Data showed that pH values significantly increased ($P<0.05$) when the ration was supplemented with YC at 0.1 or 0.2%. This elevation was probably related to the reduction occurred in ruminal lactic acid concentration. These result agreed with those obtained by Newbold *et al.* (1990) and Williams *et al.* (1991) who pointed out a significant reduction in ruminal lactate concentrations accompanied with small elevation in ruminal pH value when YC was added to sheep ration.

Abou Ward (2001) showed that inclusion of YC with the basal ration resulted in a non-significant increase in either pH or TVFA's values. The results of this study agreed with those of Abd El-Ghani (2004) who found that bucks fed YC had higher pH values ($P< 0.05$) at 3 h post feeding compared to the control group. Also, Kamra *et al.* (2002) showed that pH value increased ($P< 0.05$) in rumen liquor of the YC supplemented group.

In contrary, Harrison *et al.* (1988) showed that pH value decreased in the rumen of animals received yeast supplements, while others reported little or no effect of yeast on ruminal pH (Adams *et al.*, 1981; Wiedmeier *et al.*, 1987, Gado *et al.*, 1998 and Zelenak *et al.*, 1994).

Ammonia N concentration significantly ($P<0.05$) decreased due to YC supplementation. These results are in agreement with those of Dawson (1993), Harris *et al.* (1992), El-Waziry *et al.* (2000), Abou Ward (2001) and Kamra *et al.* (2002) who found that addition of YC increased number of anaerobic and cellulitic bacteria.

Yeast culture supplementation tended to reduce ruminal NH_3-N (Harrison *et al.*, 1988 and Newbold, 1990). Lower ammonia concentrations in the rumen of animal fed yeast may increase transformation of ammonia into microbial protein (Harrison *et al.* 1988). According to Wiedmeier *et al.* (1987) the greater concentrations of total anaerobic bacteria in the rumen, might explain why ruminal ammonia concentration are lowered since ammonia is the preferred source of N for large proportion of the ruminal microbial population (Bryant and Robinson 1963). As a conclusion, the lower ammonia concentration in rumen liquor of lamb fed rations supplemented with YC may reflect an accelerate synthesis of microbial protein from ammonia, which in turn would be reflected on fiber digestibility and lamb performance.

Data of rumen TVFA's concentration showed no significant decrease due to supplementing the control rations with YC at both the yeasted levels at 4 hrs post feeding.

Similar results were obtained by Wiedmeier *et al.* (1987) who stated that although YC had to change patterns of VFA's produced by ruminal bacteria, no difference in ruminal TVFA's concentration was detected.

The results of the present study showed significant differences ($P<0.05$) on TVFA's concentrations among treatments.

The reported effect of yeast supplementation on TVFA's concentrations in rumen was inconsistent. In this study, yeast stimulated the production of acetate at the expense of propionate. Similar results were reported by Chademana and Offer (1990), Mutsvangwa *et al.*, (1992), Kumar *et al.* (1994), Zelenok *et al.*, (1994), Newbold *et al.* (1995) and El-Waziry *et al.* (2000). Results of molar proportion of acetate significantly increased ($P<0.05$) while propionate and butyrate molar decreased ($P<0.05$) when the control rations (1 and 2) were supplemented with both levels of YC.

Similar results were obtained by Mir and Mir (1994) when the VFA data were analyzed, yeast supplementation resulted a decreased production of propionic acid when the steers were fed either the corn silage ration or the high grain ration.

However, other authors had found either an increase of propionate of expense of acetate (Adams *et al.*, 1981; Harrison *et al.*, 1988; Newbold *et al.*, 1990; Eramuset *et al.*, 1992; Plata *et al.*, 1994; El-Hassan *et al.*, 1996, El-Badway *et al.*, 1998 and Abou Ward, 2001), or no effect of yeast on VFA concentration (Dawson *et al.*, 1990; Callaway and Martin, 1996 and Kung *et al.*, 1997).

Table 1: Formulation of the experimental rations.

Ingredients	**Control$_1$ (1)**	**Control$_2$ (2)**	**Control$_1$ +%0.1yeast (3)**	**Control$_1$ +%0.2yeast (4)**	**Control$_2$ +%0.1yeast (5)**	**Control$_2$ +%0.2yeast (6)**
Yellow corn	30	30	30	30	30	30
Un-decorticated cottonseed meal	10	10	10	10	10	10
Soya bean meal	15	6.0	14.9	14.8	5.9	5.8
Wheat bran	7.5	-	7.5	7.5	-	-
Urea	-	1.5	-	-	1.5	1.5
Molasses	5.0	5.0	5.0	5.0	5.0	5.0
Bean Straw	30	45.0	30	30	45.0	45.0
Lime stone	1	1	1	1	1	1
Salt	1	1	1	1	1	1
Vit & Min Mix	0.5	0.5	0.5	0.5	0.5	0.5
Yeast culture (yea-sacc) (YC)	-	-	0.1	0.2	0.1	0.2

Table 2: Chemical composition of the experimental rations

Rations Item	**Control$_1$ (1)**	**Control$_2$ (2)**	**Control$_1$ +%0.1yeast (3)**	**Control$_1$ +%0.2yeast (4)**	**Control$_2$ +%0.1yeast (5)**	**Control$_2$ +%0.2yeast (6)**
Dry matter	89.79	90.10	89.81	89.85	90.26	89.88
Ash	10.10	11.42	10.51	10.60	11.35	11.17
Organic matter	89.90	88.58	89.49	89.40	88.65	88.83
Crude protein	13.95	14.00	14.10	14.22	13.99	14.19
Ether extract	3.52	3.00	3.38	3.53	3.11	2.97
Crude fiber	17.21	20.79	17.66	17.74	20.91	20.65
N- Free extract	55.22	50.79	54.35	53.91	50.64	51.02

Table 3: Performance of male lambs fed finishing rations with different levels of roughage supplemented by different levels of YC.

Items	**Control$_1$ (1)**	**Control$_2$ (2)**	**Control$_1$ +%0.1yeast (3)**	**Control$_1$ +%0.2yeast (4)**	**Control$_2$ +%0.1yeast (5)**	**Control$_2$ +%0.2yeast (6)**
Body weight (Kg)						
Initial	37.8±2.9	37.5±2.5	37.7±3.0	38.0±3.2	37.3±3.1	38.0±2.6
Final	57.8±2.1	55.5±2.5	60.7±1.8	60.0±2.2	57.1±1.9	60.0±1.7
Total gain	20	18	23	22	20	22
ADG (gm./h/day)	167^{b}±4.9	150^{c}±4.2	192^{a}±6.0	183^{a}±5.1	167^{b}±5.3	183^{a}±4.8
DM Intake:						
gm/animal/day	1800	1730	1860	1890	1810	1856
TDN Intake:						
gm/animal/day	1118	1017	1190	1204	1104	1165
DCP Intake:						
gm/animal/day	148	131	173	178	156	176
Feed conversion:						
Kg.DMI/Kg. gain	10.8	11.5	9.7	10.3	10.8	10.1
Kg.TDN/Kg. gain	6.7	6.8	6.2	6.7	6.6	6.4

a, b and c Means in the same raw with different superscripts differ (P<0.05)

Table 4: Effect of YC level on nutrients digestibility, nutritive values and rationary nitrogen utilization for rations contained different levels of roughage

Digestibility%	**Control$_1$ (1)**	**Control$_2$ (2)**	**Control$_1$ +%0.1yeast (3)**	**Control$_1$ +%0.2yeast (4)**	**Control$_2$ +%0.1yeast (5)**	**Control$_2$ +%0.2yeast (6)**
Dry matter	66.7±3.1	64.5±3.3	67.3±3.2	66.8±2.8	65.6±3.2	67.9±3.1
Organic matter	68.8±2.8	66.2±2.1	69.4±3.6	68.9±3.9	68.9±3.3	69.9±3.4
Crude protein	58.9^b±2.1	54.4^c±2.9	66.1^a±2.2	66.2^a±2.6	61.3^a±2.4	67.1^a±2.1
Ether extract	83.8±3.4	80.4±3.6	82.4±3.6	82.2±4.0	80.0±4.1	82.3±4.1
Crude fiber	48.3^c±2.4	47.6^c±2.5	57.8^a±2.3	58.1^a±2.7	53.8^b±2.8	58.4^a±2.8
N-free extract	72.1±4.0	70.7±4.6	71.2±4.4	70.5±4.4	70.7±4.5	69.9±5.1
Nutritive values						
TDN	62.1	58.8	64.0	63.7	61.0	62.8
DCP	8.2	7.6	9.3	9.4	8.6	9.5
N-Utilization (gm/h/day)						
Intake	40	39	42	43	41	44
Faecal	16	18	14	15	16	14
Digestable	24	21	28	28	25	30
Urinary - N	21.4	18.6	24.6	24.8	22.3	26.7
Nitrogen balance (gm/h/day)	2.6^b	2.4^b	3.4^a	3.2^a	2.7^b	3.3^a

a, b and c means in the same raw with different superscripts differ (P<0.05)

Table 5: Effect of YC level on rumen liquor parameters of lambs fed different levels of roughage (4 hrs post feeding).

Items	**Control (1)**	**Control (2)**	**Control$_1$ +0.1% yeast (3)**	**Control$_1$ +0.2% yeast (4)**	**Control$_2$ +0.1% yeast (5)**	**Control$_2$ +0.2% yeast (6)**
pH Value	6.1^b ±0.1	6.2^b ±0.2	6.7^a±0.1	6.7±0.1	7.0^a±0.2	7.1^a±0.2
NH3- N mg/dL	35.9^a ±2.0	40.1^a±3.1	25.4^b±2.8	26.6^b±2.3	25.6^b±3.7	25.2^b±2.3
Total VFA's mcq/dL	12.4^a±0.7	10.1^b±0.8	11.9^a±0.5	12.1^a±0.4	9.4^b±0.3	9.1^b±0.9
Acetate, molar%	53.1^b±1.3	55.6^b±2.5	56.3^b±1.4	55.4^b±2.3	60.9^a±1.2	62.4^b±2.5
Propionate, molar%	25.9^a±0.8	22.3^a±1.0	23.0^a±0.7	23.8^a±0.8	18.4^b±0.6	17.1^b±0.7
Butyrate, molar%	17.5^a±0.6	16.4^a±0.4	14.9^b±0.2	15.1^b±0.4	15.2^b±0.3	15.0^b±0.3

a,b Means in the same raw with different superscripts differ (p<0.05)

Conclusion

From the obtained results and the forgoing discussion, it could be concluded that addition of YC to sheep rations containing different levels of roughages improved growth performance determined as daily gain, feed intake and feed conversion ratio. Such supplementation increased crude protein, crude fiber digestibility, nitrogen balance and some rumen parameters. The higher level of inclusion (0.2%) was recommended for higher dietary roughage content.

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