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MICROBIOLOGY

Yeast as growth promoter in two breeds of growing rabbits with special reference to its economic implications

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Abstract: The present study investigated the effects of dietary supplementation of *Saccharomyces cerevisiae* (SC) on growth performance, carcass traits, blood biochemical parameters, histological changes in intestinal wall and economic indices in two breeds of weanling rabbits (V-Line and Rex). One-hundred and twenty weaned male rabbits were allotted randomly into four groups in factorial arrangement. The results could be summarized as follows: dietary supplementation of SC significantly accelerated body weight gain (BWG), reduced feed conversion ratio (FCR) and increased profit. The highest BWG and the lowest FCR were noticed in each breed when interacted with SC. There were non-significant differences in carcass traits due to the studied factors, except in loin and dressing percentages. The highest percentages of loin and dressing were obtained from V-line when fed diet supplemented with SC. The treated rabbits with yeast were characterized by an increase in Brunner`s gland and villi. Dietary Supplementation of SC decreased blood total glycerides and cholesterol and increased blood total protein, albumin and A/G ratio. The treated group showed higher profitability than the control. Conclusively, dietary supplementation of SC provided beneficial effects in growth performance and profitability of rabbits. Finally, dietary supplementation of SC is highly recommended in growing rabbits.

Key words: blood components, economic indices, growing rabbits, *Saccharomyces cerevisiae*.

INTRODUCTION

In Egypt as well as in many other countries there is a continuous increase in the demand for animal protein. One of the possible solutions to the increasing shortage of meat production problem is by using small species as rabbits (Mahsoub 2007). Rabbits have the ability in improving meat supply and food security (Ebeid et al. 2013, El-Sheikh et al. 2015). Rabbit's performance is influenced by several factors such as genetic and environment (Mahrose et al. 2010).

The ban on using antibiotic growth promoters in the EU led to investigating different natural feed additives to replace dietary antibiotics (Mahrose et al. 2019). Data for this issue on rabbits are scarce when compared to pigs or poultry (Falcão-e-Cunha et al. 2007). The seriousness of the problem is indicated by the 18-20% mortality rate (Maertens & Štruklec 2006) and 40-55% health risk (Volek et al. 2007) with antibiotic-free diets despite different natural substitutions under suboptimal conditions.

The lack of consistency in the results obtained with additives such as probiotics, prebiotics, enzymes and organic acids can be partly explained by different experimental protocols and hygienic conditions (Falcão-e-Cunha et al. 2007).

Probiotics are one of the approaches that have a potential to reduce chances of infection in poultry. There many probiotics used in poultry diets such as, lactobacillus and bifidobacteria (Ziggers 2000), Lactobacillus strains (Lan et al. 2003), protexin® (multi-strain probiotic) (Ayasan et al. 2006, Gunal et al. 2006), and *Saccharomyces cerevisiae* (Lila et al. 2004 and Ghasemi et al. 2006). The probiotics have been shown to improve feed conversion ratio and improve weight gain (Ayanwale et al. 2006), reduce mortality (Jin et al. 1997), reduce disease infection (Line et al. 1997) and stimulate the immune system (Havenaar & Spanhaak 1994).

Yeast products, such as *Saccharomyces cerevisiae* have been used as supplements in animal feed for decades. Live yeast addition to animal feed has been known to improve the nutritive quality of feed and performance of animals (Matin et al. 1989). In addition, yeast (*Saccharomyces cerevisiae*) and mannan oligosaccharides and fructo-oligosacharide derived from the cell wall of the yeast *Saccharomyces cerevisiae*, has shown promise in suppressing enteric pathogens and modulating the immunity (Mourão et al. 2006, El Abed et al. 2012).

Therefore, the objectives of the present study were to investigate the effects of *Saccharomyces cerevisiae* on the growth performance, carcass traits, some blood biochemical parameters and histological changes in intestinal wall in two breeds of weanling rabbits adapted to survive in Egypt (V-Line and Rex).

MATERIALS AND METHODS

Animals, management and the experimental design

All procedures were implemented according to the Local Experimental Animal Care Committee and approved by the ethics of the institutional committee of Damanhour University, Egypt. This experiment was carried out in a private farm in which sixty V-Line weaned male rabbits (30 control and 30 treated) and sixty Rex weaned male rabbits (30 control and 30 treated), 45 days of age and 750±70 g body weight were allotted randomly into four groups.

Rabbits were raised in a semi-closed Rabbitry of 180 m^2 (6 m width and 30 m length) with wire-netted windows in eastern and western sides for natural ventilation. Windows oriented with an elevation of 160 cm from floor. Floor of Rabbitry was concrete with moderate slope to middle to facilitate drainage of water and waste liquids towards large gutters outside Rabbitry. During cold, windy and at night day's window was closed for protection from severe atmosphere. Rabbits were housed in galvanized wire batteries with standard dimensions (60 x 35 x 35 cm). All cages were equipped with feeding hoppers made of galvanized steel and automatic drinkers (nipples). Rabbit cages were regularly cleaned and disinfected. Urine and feces dropped beneath the batteries were removed every day in the morning.

Rabbits were identified by plastic ear tags. Fresh water was offered *ad libitum* to rabbits all time. Rabbits were fed on a standard pelleted ration offered *ad libitum* twice daily at 8 am and 2 pm. The pellets were 1 cm length and 0.4 cm diameter.

a) Control groups: Rabbits were fed the basal diet (Table I) contained 2677.97 Kcal digestible energy/Kg, 17.9% crude protein and 13.75 % crude fiber.
b) Treated groups: Rabbits were fed the basal diet containing *Saccharomyces cerevisiae* at rate 0.12 g yeast/kg of ration.

Residues of feed and wasted feeds were weighed daily and then subtracted from the offered amounts to obtain the actual accumulated feed consumed per week. Rabbits were individually weighed every week before the morning meal up to 16 weeks of age.

Table I. **Ingredients and chemical composition (%) of the basal diet.**

Ingredients	%
Yellow corn	9.5
Soybean meal 44%	15.0
Wheat bran	17.0
Barley	21.7
B. Hay	34.5
Dicalcium phosphate*	1.2
Ground limestone**	0.25
DL-Methionine	0.05
Common salt	0.5
Vitamin + Mineral premix***	0.3
Total	100
Chemical composition of the basal diet	
Dry matter	87.8
Moisture	12.2
Crude protein	17.9
Crude fiber	13.75
Ether extract	3.6
Nitrogen-free extract*	42.75
Ash	9.8
DE (Kcal /kg)**	2677.97

*** Di-calcium phosphate: contain 20% Phosphorus and 25% calcium.**
**** Limestone: contain 34% calcium.**
*** NFE was calculated by difference = 100 – (moisture % + CP% + EE% + CF% + Ash %).**
**** DE was calculated according to values given in the feed composition Tables of the NRC (1977).**
*****Vit. And Min. premix per kg contains: Vit A 6000 IU; Vit D3450 IU; Vit E 40 mg; Vit K3 1 mg; Vit B1 1 mg; Vit B2 3 mg; Niacin 180 mg; Vit B6 39 mg; Vit B12 2.5 mg; Pantothenic acid 10 mg; biotin 10 mg; folic acid 2.5 mg; choline chloride 1200 mg; Manganese 15 mg; Zinc 60 mg; Iron 38 mg; Copper 5 mg; Selenium 0.1 mg; Iodine 0.2 mg; Selenium 0.05 mg.**

The experimental diet

The basal experimental diet (Table I) was formulated and pelleted to cover THE nutrient requirements of rabbits according to NRC (1977) recommendations. Ingredients needed for formulation of the experimental diets were finely ground by using hammer mill screen size 3.0 mm, then weighing of different ingredients at required amount for the experimental diets, thoroughly mixed and pelleted (3.5 mm size).

Data collection and measurements

Rabbits were individually weighed at the beginning (8 weeks) and at 16 weeks of age, then daily weight gain was calculated during the whole period. Weighing was done in the early morning before receiving any feed or water. Daily feed consumption per rabbit was recorded weekly. Residues and wasted feed were weighed daily and then subtracted from the offered amounts to obtain the actual accumulated feed consumed, and then feed conversion ratio (FCR) was calculated.

At the end of the experimental period (16 weeks of age), three representative rabbits from each group were randomly taken to estimate the carcass traits. Rabbits were fasted for approximately 6 hours before slaughtering and then individually weighed (pre-slaughter weight) and slaughtered by severing the neck with a sharp knife according to Islamic religion. Carcass was eviscerated after skinning and giblets (liver, heart, and kidneys) were separately and weighed to determine the dressed weight and the dressing percentage. The blood, viscera, lungs, skin, limbs, and tail were termed as the offal's weight. All records were expressed as percentage to the live body weight. Dressing percentage was calculated as (hot carcass weight × 100/fasted weight). Carcass was separated for the following three cuts: (1) the two fore legs (including thoracic insertion muscles), (2) Loin (including the abdominal wall and the ribs after the 7th thoracic rib) and (3) Hind legs (including the sacral bone and the lumber vertebra after the 6thlumber vertebra).

After slaughtering, blood samples were collected then tubes were left in slope position till serum samples were separated through centrifugation at 1000 *g* for 20 minutes. The sera were collected and preserved in a deep freezer at (-20°C) until the time of analysis.

Serum total protein, albumin, Alanine Aminotransferase (ALT), Aspartate Aminotransferase (AST), creatinine, cholesterol, Urea and triglycerides were measured using commercial kits (purchased from Bio-diagnostic, Cairo, Egypt, www.bio-diagnostic.com) according to the manufacturers' instructions. Serum globulin concentration was calculated by the difference between total protein and albumin, the albumin/globulin ratio was calculated.

Histopathology of intestinal villi

Samples were taken from the small intestine of apparently healthy rabbits after slaughtering. The small intestine was dissected out and fixed in 10% neutral buffered formalin or Bouin's solution for at least 2 days. The samples were then, dehydrated in ascending grade of ethyl alcohol, cleared using xylene and embedded in melted paraffin wax. Paraffin blocks were made, thin sections (3-7 µm thick) were prepared and mounted on egg albumin-glycerin coated glass slides, dried and stained with Hematoxylin and Eosin (H and E) for general inspection.

Economic parameters

The costs and returns are calculated according to the prevailing prices at the Egyptian market at the time of the experiment as follow:

Expenses: The fixed expenses were the sum of rabbit price (2.2$/rabbit), veterinary services (0.13$/rabbit), building and equipment depreciation (0.11$/rabbit), so these parameters considered as a fixed expenses for each type of rabbit. The depreciation rates were calculated for building on 30 years and for cages on 15 years according to Cartuche et al. (2014). Therefore, the total fixed costs equal (2.44$/rabbit). The variable expenses include feed and feed additive expenses where, total feed expenses equal total feed intake per rabbit multiplied by cost of 1 kg diet (0.24$/kg diet).

Feed cost/kilogram weight gain = feed conversion × cost of 1 kg diet (Tag El-Din et al. 1999). The total expenses were calculated from the summation of total fixed costs and total variable costs.

Return

The return considered was the income from selling fattening kits where, total return equal rabbit live body weight multiplied by price of one kg meat (2.3$/kg live body weight).

Net return = return-costs (Cartuche et al. 2014).

Benefit/ Cost ratio (B/C ratio) = total return/ total expenses) ×100 (Soliman 1985).

Statistical analysis

The current data were normally distributed and were subjected to statistical analysis using the general linear model (GLM) of the SAS program (SAS Institute SAS® 2009). Differences between means were tested with Duncan's multiple range test at the level of $\alpha = 0.05$ (Duncan 1955). The percentages of the studied traits were transformed to Arcsine values and then re-transformed to the original values after analysis.

RESULTS

Growth performance

Results of growth performance (BW, BWG, FC and FCR) are presented in Table II. Dietary

Table II. Growth performance of rabbits as affected by breed and *Saccharomyces cerevisiae.*

Item		Initial body weight (g)	Final body weight (g)	Body weight gain (g)	Total feed consumption (g)	Feed conversion ratio (g feed/ g gain)
Breed effect						
V-line		942.6	2048.1	1284.9	3669.3	2.8
Rex		967.1	2088.4	1310.5	3690.8	2.8
SEM		20.6	29.6	23	16	0.05
P value		0.569	0.477	0.456	0.510	0.741
Saccharomyces cerevisiae						
Treatment		950.7	2124.5[a]	1364.7[a]	3771.9[a]	2.7
Control		959.5	2005.8[b]	1223.5[b]	3578.1[b]	2.9
SEM		20.6	29.6	23	16	0.05
P value		0.839	0.048	0.009	0.001	0.156
Interactions						
V-line	Treatment	940	2116.5	1366.5[a]	3756.7[a]	2.7[b]
	Control	945.5	1972.2	1194.2[b]	3572.4[b]	2.9[a]
Rex	Treatment	961.5	2132.5	1363[a]	3787.2[a]	2.7[b]
	Control	973.4	2039.4	1252.3[ab]	3583.3[b]	2.8[a]
SEM		20.6	29.6	23	16	0.05
P value		0.9411	0.661	0.046	0.001	0.001

Means within each column for each division with no common superscript letters are significantly different (*P* ≤ .05).
SEM = standard error of means.

supplementation of *Saccharomyces cerevisiae* significantly (*P*≤0.05) accelerated BWG in rabbits and reduced FCR. There are non-significant differences in all of growth performance traits due to breed effect. The interaction effect between *Saccharomyces cerevisiae* and breed was significant on BWG, FC and FCR and the highest gain and the lowest FCR were noticed in each breed when interacted with *Saccharomyces cerevisiae* (Table II).

Carcass traits

Findings of carcass traits showed non-significant differences in all of carcass traits studied due to dietary supplementation of *Saccharomyces cerevisiae*, breed and their interaction, except in loin and dressing percentages (*P*≤0.01) due to the interaction between *Saccharomyces cerevisiae* and breed (Table III). The highest percentages of loin and dressing percentages were obtained from V-line when fed diet supplemented with *Saccharomyces cerevisiae* (28.1 and 56.4%, respectively). Figures 1-4 show small intestine of treated and non-treated rabbits, where the treated one is characterized by significant increase in Brunner`s gland and the villi.

Blood constituents

Supplementing a diet with *Saccharomyces cerevisiae* significantly (*P*≤0.01) decreased blood total glycerides and cholesterol and increased blood total protein and albumin and A/G ratio (Table IV).

Table III. Carcass traits of rabbits as affected by breed and *Saccharomyces cerevisiae* treatment (%).

Item		Forequarter	Loin	Hindquarter	Giblets	Dressing
Saccharomyces cerevisiae						
Treatment		32.6	27	40.2	10.2	54.3[a]
Control		33	26.3	40.6	11.4	52.1[b]
SEM		0.28	0.38	0.26	0.23	0.57
P value		0.507	0.332	0.510	0.439	0.058
Breed						
V-Line		32.2	27.6	40	9.6	54.6[a]
Rex		33.4	25.7	40.8	10	51.8[b]
SEM		0.28	0.38	0.26	0.23	0.57
P value		0.141	0.567	0.150	0.311	0.009
Breed × treatment interactions						
V-Line	Treatment	31.9	28.1[a]	39.8	9.9	56.4[a]
	Control	32.5	27.1[ab]	40.2	9.8	52.8[b]
Rex	Treatment	33.3	25.9[b]	40.6	10.5	52.2[b]
	Control	33.5	25.5[b]	40.9	10.2	51.4[b]
SEM		0.28	0.38	0.26	0.23	0.57
P value		0.205	0.040	0.489	0.524	0.002

Means within each column for each division with no common superscript letters are significantly different ($P \leq .05$).

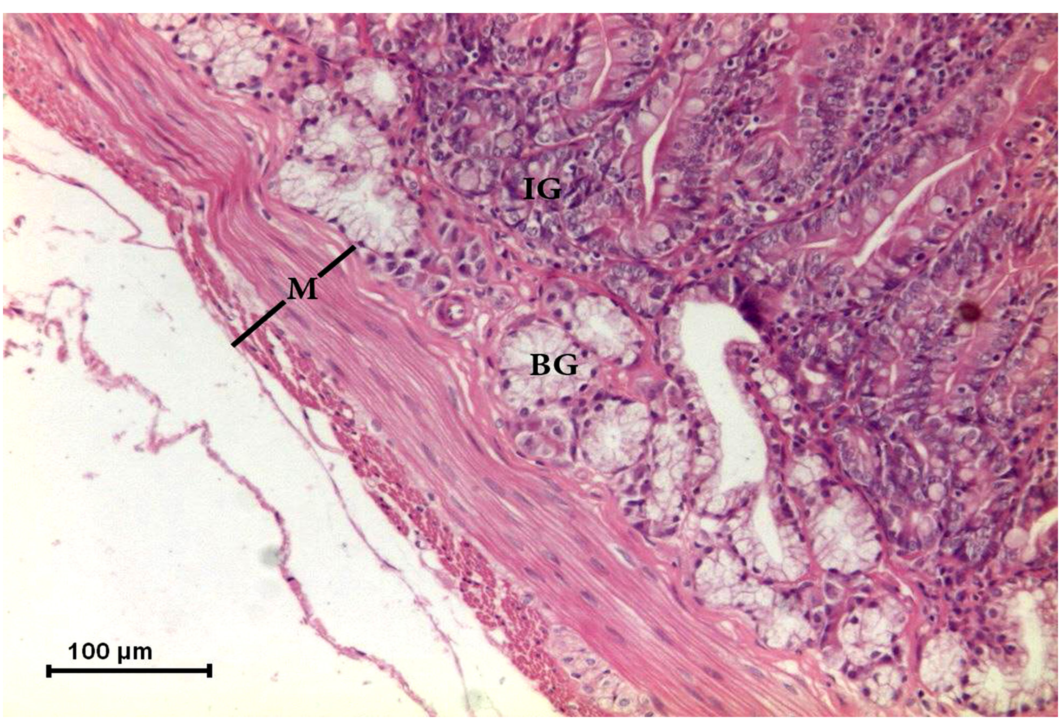

Figure 1. Light micrograph showing the rabbit small intestine in control V-Line breed rabbit consist of mucosa with submucosa with Brunner's glands (BG), IG; Intestinal gland and musculosa (M). H&E ×10.

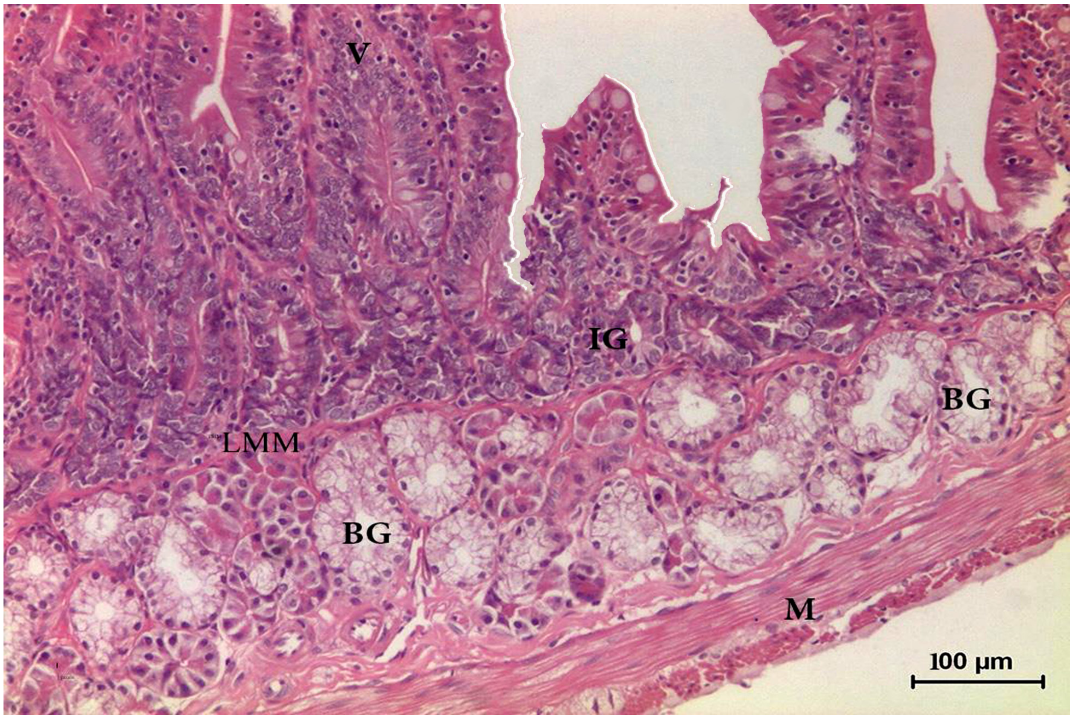

Figure 2. Light micrograph showing the V-Line rabbit small intestine treated with 0. 12% *Saccharomyces cerevisiae* for two months, The Brunner's glands increased significantly and the villi significantly increased. BG; Brunner's gland of the duodenum, IG; Intestinal gland, LMM; Lamina muscularis mucosae, M; Musculature, H&E ×10.

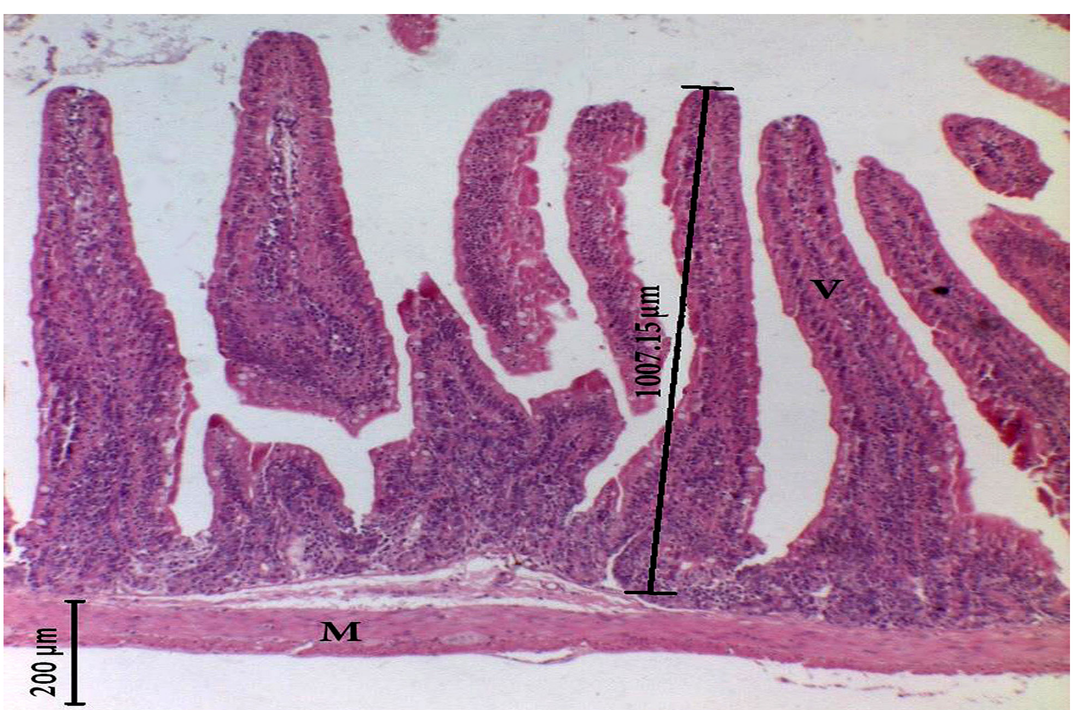

Figure 3. Light micrograph showing the control V-Line rabbit small intestine, V; Villi and the Villi length (1007.15 µm), IG; Intestinal gland, and M; Musculature. H&E ×20.

Figure 4. Light micrograph showing the V-Line rabbit small intestine treated with 0.12% *Saccharomyces cerevisiae* for two months, V; Villi and the Villi length (1083.02 µm), IG; Intestinal gland, and M; Musculature. H&E ×20.

Table IV. Chemical parameters of rabbits as affected by breed and *Saccharomyces cerevisiae* treatment

Item		ALT	AST	Urea	Creatinine	TG	Cholesterol	Albumin	Globulin	TP	AG Ratio
Saccharomyces cerevisiae											
Treatment		15.1	21.4	19.3	0.60	57.5^{b}	38.9^{b}	4.1^{a}	3.1	7.2^{a}	1.3^{a}
Control		15.6	21.7	21.1	0.65	86.4^{a}	76.2^{a}	3.4^{b}	3.1	6.5^{b}	1.0^{b}
SEM		0.31	0.34	1.01	0.01	5.4	4.4	0.09	0.05	0.10	0.03
P value		0.473	0.642	0.414	0.144	0.004	0.000	0.000	0.973	0.000	0.004
Breed											
V-Line		15.2	21.6	20.3	0.62	71.3	57.4	3.8	3.2	7.1	1.2
Rex		15.6	21.5	20.1	0.62	72.6	57.7	3.7	3.1	6.8	1.2
SEM		0.31	0.34	1.01	0.01	5.4	4.3	0.09	0.05	0.10	0.04
P value		0.514	0.947	0.907	0.880	0.910	0.967	0.598	0.394	0.328	0.994
Breed × treatment interactions											
V-Line	Treatment	14.7	21.5	18.8	0.60	57.0^{b}	38.1^{b}	4.1^{a}	3.1	7.3^{a}	1.3^{a}
	Control	15.6	21.7	21.8	0.64	85.6^{a}	76.6^{a}	3.4^{b}	3.2	6.6^{b}	1.0^{c}
Rex	Treatment	15.6	21.3	19.9	0.60	58.0^{b}	39.6^{b}	4.0^{a}	3.1	7.1^{a}	1.2^{ab}
	Control	15.6	21.8	20.3	0.64	87.2^{a}	75.9^{a}	3.3^{b}	3.0	6.4^{b}	1.1^{bc}
SEM		0.31	0.34	1.01	0.01	5.4	4.3	0.09	0.05	010	0.03
P value		0.715	0.968	0.798	0.128	0.054	0.000	0.000	0.528	0.000	0.029

Means within each column for each division with no common superscript letters are significantly different ($P \leq .05$).
SEM = standard error of the mean.

Table V. Costs and returns of rabbits as affected by breed and *Saccharomyces cerevisiae* treatment

Item		Feed expenses ($/rabbit)	Total expenses ($/rabbit)	Total return ($/rabbit)	Net return ($/rabbit)	Feed cost/ kg gain ($)	B/C ratio (%)
Saccharomyces cerevisiae							
Treatment		090[a]	3.3	4.9[a]	1.6[a]	0.65	148.4[a]
Control		0.85[b]	3.3	4.6[b]	1.3[b]	0.69	139.4[b]
SEM		0.01	0.01	0.08	0.08	0.01	2.5
P value		0.000	0.972	0.044	0. 028	0.156	0.011
Breed							
V-Line		0.88	3.3	4.7	1.4	0.68	142.4
Rex		0.88	3.3	4.8	1.5	0.68	145.5
SEM		0.01	0.01	0.08	0.08	0.01	2.5
P value		0.339	0.291	0.504	0.574	0.749	0.525
Breed × treatment interactions							
V-Line	Treatment	0.90[a]	3.3	4.8[a]	1.5[a]	0.65	145.4[a]
	Control	0.85[b]	3.3	4.5[b]	1.2[b]	0.71	136.3[b]
Rex	Treatment	0.90[a]	3.3	4.9[a]	1.6[a]	0.66	148.5[a]
	Control	0.85[b]	3.3	4.6[b]	1.3[b]	0.67	139.3[b]
SEM		0.01	0.01	0.08	0.08	0.01	2.5
P value		0.000	0.178	0.020	0.057	0.402	0.038

Feed expenses include additive cost.
SEM= standard error of the mean.
B/C ratio= Benefit cost ratio.

Economic indices

Results of economic indices are presented in Table V. The economic indices results showed that dietary supplementation of *Saccharomyces cerevisiae* improved the total return, net return and B/C ratio in each strain.

DISCUSSION

The current study aimed at investigating the beneficial effects of dietary supplementation of *Saccharomyces cerevisiae* in growing rabbit diets using two breeds (V-line and Rex). In the present work, dietary supplementation of *Saccharomyces cerevisiae* provided some positive effects on growth performance and health status. The obtained findings confirmed the previous results of the other investigators (Khanna et al. 2014, Attia et al. 2015). Ezema & Eze (2012) suggested that the inclusion level of 0.12 g yeast/kg diet may provide higher weight gain in rabbits.

The enhanced performance of growing rabbits as a result of dietary supplementation of *Saccharomyces cerevisiae* may be due to enhancing feed nutrients digestibility and absorption, resulted in positive anabolic metabolism state, improving the intestinal resistance against pathogens, reducing serum cholesterol, increasing serum protein and stimulating rabbit growth (Resta & Barrett 2003, Abdelmawla et al. 2007, Shehata et al. 2011).

It has been supposed that some of the benefits in growth performance of rabbits may be due to the benefits impacts of yeast on the intestinal health as increasing villus height. Zhang et al. (2005) suggested that this observation may explain the growth promoting effect of cell wall component of yeast on the intestinal morphology. Priya & babu (2013) indicated that feed digestion will alter by supplementing diets with *Saccharomyces cerevisiae* and then growth performance will enhance. Soliman et al. (2000) observed that rabbits fed on diet supplemented with yeast attained significantly higher marketing weight, had more weight gain and the best feed conversion ratio.

In agreement with our findings, Shehata et al. (2011), Ezema & Eze (2012), Bhatt et al. (2017) and El-Badawi et al. (2017) concluded that BWG and FCR of New Zealand White rabbits were improved with diet supplemented with *Saccharomyces cerevisiae* and probiotic. Belhassen et al. (2016) found significant differences in BWG of rabbits fed diets supplemented with *Saccharomyces cerevisiae*. On the other hand, Kimsé et al. (2008), Özsoy & Yalçin (2011), Rotolo et al. (2014) and Abouelezz & Hussein (2017) found that the *Saccharomyces cerevisiae* supplementation did not affect BW, BWG and FCR of rabbits.

The present results are partially agree with those obtained by Özsoy & Yalçin (2011), Rotolo et al. (2014) and Attia et al. (2015) who observed non-significant differences in carcass traits of growing rabbits due to dietary yeast supplementation or mannanoligosaccharides. Shehata et al. (2011) stated that Dressing percentage of growing New Zealand White rabbits were increased in rabbits fed diets containing *Saccharomyces cerevisiae*. Ahmed et al. (2015) reported non-significant differences in dressing percentage of broiler chicks as affected by different dietary levels of *Saccharomyces cerevisiae*. Our results are on contrary with those obtained by Khanna et al. (2014) who reported that the averages of weight of fore and hind parts of the rabbit carcass were found to be significantly higher in yeast treated groups of rabbits than the control one.

The impacts of probiotic on intestinal morphology and cell proliferation are tested by the morphological measures such as length of villi and depth of glands and could be consider as the indicators of intestinal functions. *Saccharomyces cerevisiae* may restore a normal gut assignment due to its protective impacts on villus and absorptive surfaces against enteric pathogens and toxins (Rodrigues et al. 2000, Pelicano et al. 2002). In this regard, Seyidoglu & Peker (2015) demonstrated that the total thickness of the mucosa, villus heights, crypt depths and gland depths were increased significantly in the rabbits fed diets supplemented with yeast. The same authors added that administration of *Saccharomyces cerevisiae* may be used for intestinal health. Zhang et al. (2005) showed that inclusion of *Saccharomyces cerevisiae* in broiler chicks diet resulted in increased villus height of ileum while the crypt depth was not changed. Similar results were also reported in broilers by (Priya & Babu 2013).

Reduction in cholesterol and triglycerides with supplemental yeast was remarkable in the current findings and are in line with the results of other researchers (Priya & Babu 2013, Ahmed et al. 2015) that the dietary supplementation of yeast to rabbit and broiler chicks reduces serum cholesterol and triglycerides. Probiotics could participate to the tuning of cholesterol concentrations by deconjunction of bile acids. Since, the excretion of deconjugated bile acids is promoted and cholesterol is its precursor, more molecules are spent for recovery of bile acids (Priya & Babu 2013). Özsoy & Yalçin (2011) and Belhassen et al. (2016) reported that dietary supplementation of *Saccharomyces cerevisiae* did not alter blood parameters of growing rabbits. Similar results were reported by Attia et al. (2015) who concluded that blood parameters of growing rabbits were not significantly changed due to dietary supplementation of mannanoligosaccharides and zinc-bacitracin.

Regarding to economics, although increasing feed expenses in treated groups compared to control ones, they showed higher total return, net profit and B/C ratio. This may be due to improving growth performance and FCR of rabbits received yeast. The present results are in agreement with Shahata et al. (2011) who showed that addition of amino-yeast (yeast +some amino acids) at 0.25, 0.50 and 0.75 percent on the diet of growing rabbit improved economic efficiency. Also, Kalma et al. (2018) who found that supplementation of probiotic (*Saccharomyces cerevisiae* Lactobacillus sporogenes) (0.5 g/kg of feed) in rabbits improved economic returns.

In conclusion, based on the present findings, it is recommended to supplement rabbit diets with *Saccharomyces cerevisiae* to enhance growth performance and profitability.

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