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IMPACT OF ANAEROBIC BACTERIA ENZYMES (ZAD) OF YEAST EFFICIENCY ON GROWTH PERFORMANCE AND BLOOD BIOCHEMICAL IN WEANED MALE RABBITS

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ABSTRACT

*This study was done to determine the effects of Saccharomyces cerevisiae (Sc) and anaerobic bacteria enzymes (ZAD) supplementation in drinking water on weaned male rabbits growth and physiological responses. Sixty-four weaned Californian male rabbits at 35 days of age with an average initial weight of 561.08 ± 7.22 g were randomly distributed into eight experimental groups (8 each). The first group was received un-supplemented drinking water and served as a control (**T1**), the 2^nd^ (**T2**), was received drinking water plus 1 ml of ZAD/l; the 3^rd^, 4^th^ and 5^th^ groups (**T3, T4 and T5**) were received drinking water plus 1, 2 and 3 g Sc/l; the 6^th^, 7^th^ and 8^th^ groups (**T6, T7 and T8**), were received drinking water plus 1 ml of ZAD/l (mix of enzymes and bacteria) and 1, 2 and 3 g Sc/l, respectively.*

***Results showed that** the incorporation of yeast in rabbit drinking water at a level of 1 g/liter resulted in improvement in final body weight, body weight gain, feed conversion ratio, and protein efficiency vs. other groups and control, respectively. Digestibility were significantly enhanced by supplemented Sc and ZAD; conversely, blend yeast and ZAD decreased CP and CF digestibility compared with yeast or ZAD alone but improved compared with control. Rabbits supplemented with yeast or ZAD alone in drinking water recorded the highest carcass percent, while groups supplemented with yeast and ZAD combined recorded the lowest percent for all carcass parameters except liver percent. Data indicated that the total protein, albumin, globulin, AST and ALT concentrations of rabbit's blood receiving yeast and anaerobic probiotic ZAD were high. While, **T3** and **T5** whose supplemented with yeast recorded high concentrations of TP, also **T3** and **T6** recorded a significant increase in Alb. Noteworthy, groups of **T6**, **T7** and **T8** (groups consumed water ~~treated~~ with combined of yeast and ZAD) recorded high concentrations of AST. A significant reduction in concentrations of TG, CH, HDL-c, V-LDL, urea, and creatinine in treated rabbits were noticed. At the same time, **T3**, **T4**, and **T5** recorded lower values of CH and LDL-c but raised concentrations of HDL-c,* *while the control group recorded the highest values for all parameters except HDL-c. The concentrations of IgG and IgM were higher in rabbits consumed water with yeast. Supplemented drinking water for weaning rabbits with Saccharomyces cerevisiae and ZAD showed improved final body weight, net profit, net revenue and relative economic efficiency in groups treated individually compared with those receiving combination of Sc and ZAD in drinking water.*

Conclusively, *Saccharomyces cerevisiae (Sc) or anaerobic bacteria (ZAD) supplementation in weaned rabbits drinking water showed the most beneficial effects, while, the combinations between them resulted in adverse effects.*

Key words: Biochemical blood, digestibility, economic, growth, rabbits, yeast, ZAD.

INTRODUCTION:

In Egypt as well as in several other countries, there has been an increase in the demand for animal protein. One of the possible solutions to the increasing meat production problem is the overabundance of small species such as rabbits (**Mahsoub, 2007**). Rabbits' production is affected by several factors, such as genetics and environment (**Mahrose *et al.,* 2019**). Non-antibiotic feed additives are currently increasingly recognized as employment in the animal feed industry as more and more reports surface on antibiotic resistance. Weaned rabbits suffer from diarrhea, which is the major cause of their mortality. Coliform bacteria (such as *Escherichia coli*) are normal inhabitants of the intestinal tract of rabbits and most animal species (**Basma El-Sawy *et al.,* 2021).**

Digestive problems caused by entero-pathogenic strains such as *Salmonellae, E. coli,* etc. are often causes of high morbidity and mortality in young rabbits after weaning and cause important economic losses in rabbit farms (**Licois, 2004**). Rabbits utilize widely used antibiotics to control enteritis infections. The use of antibiotics, however, has been viewed critically in recent times. Some were banned totally; some received no renewal of their license as a measure of preventive consumer protection. There is a pressing need for harmless antimicrobial substances suitable for rabbits nowadays.

Bioactive yeast secretes enzymes that increase digestibility and efficiency of feed intake (**Ozcan, 2001**), which improve both growth rate and resistance to diseases in animals (**Fuller, 1992**). On the other hand, probiotics have been utilized in the production of rabbits to increase the feed conversion ratio and improve nutrients digestibility (**El-Hindawy *et al.,* 1993**). Anaerobic probiotic treatments aim to enhance the nutritive value of lingocellulose materials in agricultural residues and improve animal performance. By breaking the linkage between cellulose, hemicellulose, and lignin, these treatments can improve digestibility and enhance animal performance (**Gado *et al.,* 2017**). Also, probiotics exert beneficial effects on their hosts by diverse mechanisms, *e.g.,* antimicrobial peptide, fatty acid production, stabilization of disturbed intestinal microflora competitive pathogen exclusion, modulation of host innate and adaptive immune responses (**Plaza-Diaz *et al.*, 2019**), stimulation of the host's own enzyme production, production of some vitamins competition for epithelial cell adhesion and increased resistance to colonization, and stimulation of the host's immune system (**Olsen *et al.*, 2016**).

So, this study was done to determine the effects anaerobic bacteria enzymes (zad) of dry yeast efficiency (*Saccharomyces cerevisiae*), and anaerobic bacteria enzymes (ZAD) supplementation in drinking water on the growth traits and physiological responses of weaned male rabbits.

MATERIALS AND METHODS

The experiment was carried out at Private Rabbitry Farm in Egypt's Qaluobia Province from December to February (winter season). ZAD®, a commercial culture product by BACTIZAD Company (*www.bactizad.com*). The product is a multi-mix of cellulases, xylanases, proteases and α-amylase enzymes, in addition to the related anaerobic bacteria which produce these enzymes, coated with starch and glycol (**Gado, 1997)**. Dry live yeast containing 2×10^{10} CFU g^{-1} of live *Saccharomyces cerevisiae* (Sc) (RUMI YEAST 47-Neovia- France) was used as growth promoter (Probiotic) was supplemented as 1, 2 and 3 g /liter of drinking water, while, ZAD was supplemented as 1 ml/litter of drinking water.

Animal ethics declarations:

All experimental procedures and animal use were approved by the Research Ethics Committee of the New Valley University (Approval No NVREC 03 – 03 - 01- 2024 - 08).

Animals and diets:

Sixty-four weaned Californian male rabbits aged 35 days and weighing 561.08 ± 7.22 g were equally and randomly divided into eight groups (8 each). Rabbits were housed in galvanized metal rabbit battery cages supplied with separate feeders. Diets were offered in pellets form *ad libitum*, and fresh clean water was available at all times from automatic nipple drinkers. All animals were kept under the same management and hygienic conditions. According to the **NRC (1977)** the basal experimental ration was formulated and pelleted to cover the nutrient requirements of growing rabbits as shown in Table1.The experimental period lasted for 7 weeks until 12 weeks of age. Table 1 presents the ingredient composition of the growing rabbit diets according to (**De Blas and Mateots, 1998**), the basal experimental ration was formulated and pelleted to cover the nutrient requirements of rabbits, feed was allowed to a standard pelleted diet all times.

Experimental design:

All rabbits were received basal diet while drinking water was supplemented as follows:

Table1. Composition and chemical analysis of the basal experimental diet

Ingredients	Basal diet, kg
Barley	15.00
Yellow corn	6.22
Wheat bran	23.33
Alfalfa hay	30.12
Soybean meal 44%	22.33
Premix*	0.30
Sodium chloride	0.50
Di-calcium-phosphate	1.20
Limestone	1.00
Total	**100**
Chemical analysis of diets	
Crude protein %	17.28
DE kcal/kg diet	2680
Ether extract%	2.69
Crude fiber%	13.26

* The premix provided the following (per kg of diet): Vitamin A= 6000 IU; Vitamin D_3= 900 IU; Vitamin E= 40 mg; Vitamin K_3= 2 mg; Vitamin B_1= 2 mg; Vitamin B_2= 4 mg; Vitamin B_6= 2mg;Pantothenicacid=10 mg; Vitamin B_{12}=0.01mg;Niacin=50 mg ;Folicacid=3mg;Biotin=0.05mg;Choline=250mg;Fe=50mg;Mn=85mg;Cu=5mg;Co=0.1mg;Se=1mg;I=0.2mgandZn=50mg.

T1= (Control) without water additive., **T2** = 1 ml ZAD /liter, **T3**=1 g yeast/liter, **T4**= 2 g yeast/ liter, **T5**= 3 g yeast/ liter, **T6**=1 g yeast+1 ml ZAD/liter, **T7**= 2 g yeast +1 ml ZAD /liter, **T8**= 3 g yeast +1 ml ZAD /liter.

The rabbits were weighted at 5 weeks old, with initial body weight (IBW) and final body weight (FBW) at 12 weeks of age. The body weight gain (BWG) was calculated by subtracting the initial body weight of the period from the final body weight at the end of the experimental period. Feed consumption (FC) was calculated as the difference between the weight of the feed at start and the end of the experimental period. (Feed conversion ratio (FCR) was calculated as the ratio between FC and BWG per period**.** Feed efficiency (FE) was calculated as BWG (g)/FC (g), protein intake (PI) was calculated as average FC × percentage of protein in diet, and protein efficiency ratio (PER) was calculated as BWG (g)/crude protein consumed (g) according to **Rabie *et al.* (2011).**

Digestibility trials:

During the 11th week of age, three rabbits from each group were moved and individually dwelt in metabolic crates (25×35×30 cm), which permit feces and urine segregation for 5 days as a gathering period. The feed consumed was accurately specified. Quantitative collection of feces started 24 hours after offering the daily feed. Feces were dried at 60°C for 12 hours. Pooled feces per rabbit were mixed, ground, and sampled for analysis according to **AOAC (2002).** Apparent digestibility the DM, OM, CF, CP, EE, and NFE were determined.

Slaughtering and carcass traits:

At the end of the growth experiment, three male rabbits (aged 12 weeks) were selected randomly from each group, fasted for twelve hours, weighed individually, and slaughtered immediately. Elimination of tail, pelt, and viscera after complete bleeding and then weighing the carcass and its constituents as edible parts additionally, as a percentage of pre-slaughter weight, the non-edible parts were weighed. By dividing the hot-dressed carcass weight by the pre-slaughter weight, the dressing percentage was computed and stated as a percentage.

Blood collection:

At the end of experiment, Blood samples of about 5 ml were collected from the ear- vein of each rabbit for hematological evaluation in each treatment (one from each replicate) in an aseptic condition and used for analysis. The samples were placed in sterilized glass bottles containing ethylene dopamine acetic acid (EDTA) to avoid clotting and centrifuged at 3000 rpm for 10 minutes at 4°C to obtained blood plasma and kept in refrigerator at- 20 °C.

Alanine aminotransferase (ALT) activity, aspartate aminotransferase (AST) activity, total protein (TP), and albumin (Alb) were determined by calorimetrically using commercial kits (purchased from Bio-diagnostic, Cairo, Egypt) according to the manufacturers' instructions, while globulin (Glo) was calculated by the difference between total protein and albumin, while, creatinine (CR) and urea (UR) were determined as kidney functions. Triglycerides (TG), total Cholesterol (CH), and high-density lipoprotein (HDL-c) were determined, while low-density lipoprotein (LDL-c) was calculated using the formula: LDL-c (mg/dl) = total cholesterol – {HDL-c + (TG/5)**},** which was explained by **William *et al.* (1972).**

Hematological studies:

Packed cell volume (PCV), red blood cells (RBCs), white blood cells (WBCs), and hemoglobin (Hb) were the homological parameters that were examined.

Immune response status:

Different types of immune-globulins status in blood plasma (IgG and IgM were determined by using method of (**Melgoza-González *et al.*, 2022**) .

Antioxidant and hormones, digestive enzymes:

Biochemical analyses of plasma total antioxidant capacity (TAC) and malondialdehyde (MDA) were determined using commercially available kits, methods according to **Wang *et al.(*2012)**

Economic efficiency*:*

Economic efficiency (EE) of the treatments for body weight gain, the costs of feed consumed for cost of one kg body weight gain was calculated. The cost of the experimental treatments was calculated according to the price of different sources of ingredients prevailing at local market, as well as, the price of tested materials at the time of experimentation. Economic efficiency (%) was calculated as a ratio between the return of weight gain and the cost of consumed feed.

Statistical analysis:

Data were statistically analyzed by one-way analysis to study the effect of treatment at each time using **SAS (2004).** The statistical model used was as follows:

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

Where, Y_{ij}= the dependent variable, μ= the overall mean; T_i= the effect of treatments and e_{ij}= the random error.

However, the significant differences among treatment groups were tested using Multiple Range Test according to **Duncan (1955).**

RESULTS AND DISCUSSION

Growth performance traits:

Table 2 revealed the results of the effect of supplementing different levels of live dried yeast *Saccharomyces cerevisiae* (Sc), ZAD, and their combinations on FBW, BWG, FC, FCR, PER, FE, and PI of Californian weaning rabbits. Irrespective of ZAD supplementation, the results showed that the incorporation of yeast in rabbit- water at a level of 1 g/liter drinking water improved FBW, BWG, FCR, PER, and FE (2158.75 g, 1608.12 g, 3.25, 1.81, and 0.31 vs. other groups and control, respectively. Yeast groups recorded the best values compared to other groups; at the same time, groups supplemented with combinations of ZAD and yeast recorded the lowest values in FBW, BWG, FCR, PER, FE, and PI.

The heaviest FBW and BWG achieved with yeast rabbit groups could cling to their improved health status, especially digestive health (**Falcao-e-Cunha *et al.*, 2007**), or it could prevent or ameliorate early weaning stress (**Kristas *et al.*, 2008).** They mentioned that probiotic-treated rabbits exhibited improved feed efficiency and had bio-regulatory action, including microbial antibiosis tunneling of pathogenic bacteria, increasing the animal’s immune status and capability, and diminishing pathogens (**Perez, 2007). Basma El-Sawy (2022)** found that supplementation of SC to growing rabbit diets increased FBW, BWG, relative growth rate, and PI, while feed intake and FCR were significantly decreased for all treated groups compared to the control group**.** Also, **Ayman *et al.* (2021)** found that supplementation with dry yeast for feeding rabbits significantly accelerates BWG, reduces FCR, and increases profit. The same results obtained by **Attia and Salvatore (2015)** suggested that the inclusion level of 0.12 g of yeast per kg diet may increase weight gain in rabbits.

Table 2. Effect of experimental treatments on productive performance parameters of Californian male rabbits (5-12 weeks of age)

Treatment groups	Productive performance parameters							
	IBW, g	FBW, g	BWG, g	FC, g	FCR %	PER %	FE %	PI, g
T1	574.88	1904.38^{c}	1329.50^{c}	5476.50^{a}	4.12^{ab}	1.43^{c}	0.24^{b}	931.01^{a}
T2	580.50	2033.00^{b}	1452.50^{b}	5410.35^{a}	3.72^{c}	1.58^{b}	0.27^{ab}	919.76^{a}
T3	550.63	2158.75^{a}	1608.12^{a}	5221.88^{b}	3.25^{d}	1.81^{a}	0.31^{a}	887.72^{b}
T4	556.88	2121.25^{ab}	1564.37^{ab}	5243.00^{b}	3.35^{d}	1.76^{a}	0.30^{a}	891.31^{b}
T5	552.60	2108.13^{ab}	1555.53^{ab}	5137.13^{b}	3.30^{d}	1.78^{a}	0.30^{a}	873.31^{b}
T6	556.88	1665.63^{d}	1108.75^{d}	4449.50^{e}	4.01^{b}	1.47^{c}	0.25^{b}	756.42^{d}
T7	558.75	1648.75^{d}	1090.00^{d}	4632.75^{d}	4.25^{ab}	1.38^{cd}	0.24^{b}	787.57^{d}
T8	557.50	1600.63^{d}	1043.13^{d}	4781.75^{c}	4.58^{a}	1.28^{d}	0.22^{c}	812.90^{c}
SEM	7.22	23.42	26.23	22.27	0.08	0.073	0.005	4.04
Sig. level	NS	**	**	**	**	**	**	**

a-b-c-d: Values in the same column with different superscripts differ significantly ($P \leq 0.05$),

NS = Not significant, **= ($P \leq 0.01$).

IBW= Initial body weight, FBW= Final body weight, BWG= Bodyweight gain, FC= Feed consumption, FCR = Feed conversion ratio, PI = Protein intake, FE = Feed efficiency, PER = Protein efficiency ratio.

Also, **Das and Das (2006)** recorded that in Chinchilla and Meghalaya rabbits, supplementation with probiotics had a far bigger effect on feed efficiency. Conversely, **Belhassen *et al.* (2016)** revealed that yeast treatment of rabbit feed did not affect feed intake after weaning. The same result was obtained by **Bhatt *et al.* (2017),** who documented that feed intake (FI) was not affected due to probiotic supplementation while enhancing BWG and FCR levels. Interestingly, **Mohamed *et al.* (2017)** recorded that the different results may be due to yeast dosage, strain, basal diet, environmental conditions, or growth promotion mechanisms; however, positive relationships between yeast culture and animal performance characteristics have been reported.

The present results agree with those reported by **Abdel-Azeem *et al.* (2018),** who recorded a rise in weight and best FCR in NZW rabbits due to a diet containing differing doses of probiotics (ZAD). The high total VFA concentration observed in the caecal of rabbits that had been administered ZAD® probiotics indicates there was an abundance of energy available, which had an effect on growth performance.

The same results obtained by **El-Sagheer and Hassanein (2014)** indicated that the supplemented diet with 1 or 2 g of Vetazyme/kg diet (probiotic+ enzymes) significantly increased rabbit body weight compared to those fed the basal diet. Additionally, **Gado *et al.* (2017)** found that a blend of enzymes obtained from anaerobic bacteria present in ZAD® had an improved effect on converting the polysaccharide into monomers by the enzyme catalytic enzyme in weaned rabbits. Also, **Gado and Salem (2014)** reported that a supplemented diet with ZADO® up to 5 g/kg diet has been utilized without any adverse effect on productive performance. Interestingly, the group's combinations between dry yeast and ZAD showed adverse effects on productive performance in rabbits. **Abdel-Azeem *et al.* (2018)** recorded that utilizing ZAD led to increased concentrations of pH, ammonia concentration, total volatile fatty acids (VFA), butyric acid, acetic acid, and propionic acid in the digestive tract of weaned rabbits. When consumed, ZAD combined with yeast may lead to decreased activity of yeast because dry yeast has optimal activity between pH 7.0 and 7.2 (**Pampulha and Loureiro-Dias, 1989**).

Noteworthy, **El-Badawi *et al.* (2017)** recorded a negative association between *Bacillus subtilis* and *Saccharomyces cerevisiae* in rabbits fed a mix of bacteria and yeast. The study found that the combination of microorganisms did not differ from the control, but the use of only one of both probiotics significantly increased productive performance. Additionally, it had higher digestion coefficients for most measured nutrients compared to the control.

Nutrients digestibility coefficients:

All nutrient digestibility is not significantly affected by dietary Sc, except for crude fiber (CF) and crude protein (CP)as shown in Table 3). Digestibility was significantly enhanced by supplemented Sc and ZAD; conversely, a blend of yeast and ZAD decreased CP and CF digestibility compared with yeast or ZAD alone but improved compared with the control group. The improvement in CF digestibility attributed to live yeast could increase cellulolytic digestion by bacteria. These observations are in agreement with those obtained by **Habeeb *et al.* (2006), Al Zahal *et al.* (2014),** and **Bhatt *et al.* (2017),** who recorded that live yeast addition improves crude fiber digestibility in rabbits by enhancing cellulolytic digesting bacteria, lactic acid utilization, propionic acid production, and intestine pH stability. This improvement is attributed to better gut health and the environment.

Probiotic addition has been shown to enhance crude fiber digestibility, neutral detergent fiber digestibility, and dry or organic matter digestibility; these findings may be attributed to dietary dried yeast (DY) addition, which plays a crucial role in digesting nutrients, inhibiting pathogens, and interacting with the gut-associated immune system. Also, **Ewuola *et al.* (2011)** found positive effects on protein and crude fiber digestibility with *Saccharomyces cerevisiae* administration. **Ghazanfar *et al.* (2015)** showed improved NDF and ADF digestibility in yeast-supplemented groups. Probiotic yeasts can enhance fiber-degrading rumen microorganism growth. **Elghandour *et al.* (2019)** found that adding live 3.25, 1.81, and 0.31 vs. other groups and control, respectively. Yeast groups recorded the best values compared to other groups; at the same time, groups supplemented with combinations of ZAD and yeast recorded the lowest values in FBW, BWG, FCR, PER, FE, and PI.

The heaviest FBW and BWG achieved with yeast rabbit groups could cling to their improved health status, especially digestive health (**Falcao-e-Cunha *et al*., 2007**), or it could prevent or ameliorate early weaning stress (**Kristas *et al*., 2008).** They mentioned that probiotic-treated rabbits exhibited improved feed efficiency and had bio-regulatory action, including microbial antibiosis tunneling of pathogenic bacteria, increasing the animal's immune status and capability, and diminishing pathogens (**Perez, 2007). Basma El-Sawy (2022)** found that supplementation of SC to growing rabbit diets increased FBW, BWG, relative growth rate, and PI, while feed intake and FCR were significantly decreased for all treated groups compared to the control group**.** Also, **Ayman *et al.* (2021)** found that supplementation with dry yeast for feeding rabbits significantly accelerates BWG, reduces FCR, and increases profit. The same results obtained by **Attia and Salvatore (2015)** suggested that the inclusion level of 0.12 g of yeast per kg diet may increase weight gain in rabbits.

Table 3. Effect of experimental treatments on nutrients digestibility of Californian male rabbits

Treatment groups	Nutrients digestibility %					
	DM	OM	CP	CF	EE	NFE
T1	70.2	71.30	62.6^{b}	10.40^{c}	81.40	83.40
T2	72.4	71.46	70.9^{a}	31.73^{a}	79.75	76.42
T3	74.1	74.90	70.90^{a}	29.20^{a}	84.10	84.31
T4	71.5	72.60	71.20^{a}	33.00^{a}	80.70	82.35
T5	72.7	74.10	70.80^{a}	36.10^{a}	81.90	82.22
T6	70.5	71.70	60.60^{b}	25.40^{b}	78.10	78.58
T7	71.4	70.10	61.90^{b}	28.10^{b}	76.90	79.90
T8	70.6	71.50	62.70^{b}	27.80^{b}	78.80	80.10
SEM	1.52	1.72	3.74	4.18	0.97	1.51
Sig. level	NS	NS	**	**	NS	NS

$^{a\text{-}b\text{-}c\text{-}}$ Values in the same column with different superscripts differ significantly ($P \leq 0.05$),
NS= Not significant, *= ($P \leq 0.05$), **= ($P \leq 0.01$).
DM = Dry matter, OM = Organic matter, CP = Crude protein, CF = crude fiber, EE = Ether extract,
NFE = Nitrogen free extract.

yeast to animal rations alters dietary digestion, and stable caecal pH provides an environment for microbial growth, facilitating fiber digestion. The same results were obtained by **Chaucheyras-Durand *et al.* (2016),** who demonstrated that yeasts can improve fungal colonization of plant cell walls (a stable caecal pH provides a suitable environment for microbial growth as fungi and bacteria degrade cellulose). Consequently, these microbial species help with fiber digestion. In contrast, **Tripathi and Karim (2010)** reported no impact of yeast (SC) supplementation on nutrient digestibility. Furthermore, **Noha (2019)** found that, with the exception of crud fiber digestibility, which was significantly enhanced when compared to the control group, all nutrient digestion coefficients in the rabbit diet were not significantly improved by dry yeast. The results of the present study agree with the report by **Abdel-Azeem *et al.* (2018),** who recorded that supplementing rabbits orally with ZAD® caused a significant increase in nitrogen utilization, nutritive value, and digestibility coefficients. As well, caecum activity (caecum pH, total volatile fatty acids, acetic, propionic, and butyric acids) was significantly improved by oral administration of probiotic ZAD® compared with the control group. On the other hand, **Khademi *et al.* (2022)** reported that the addition of exogenous fibrolytic enzymes (EFE) and a probiotic supplement increased neutral detergent fiber (NDF) digestibility, improved NDF digestibility, and decreased the ratio of acetate to propionate in the rumen. Also, **Gado *et al.* (2007**) recorded that the probiotic ZAD treatments increased protein content, protein digestibility, and fiber degradation and improved their chemical composition. In addition, **Bull *et al.* (1965)** reported that exogenous enzymes synergistically enhance endogenous microbial enzymes' hydrolytic potential, improving the digestion of dietary fiber.

Carcass traits:

The effect of Sc or ZAD supplementation in rabbit drinking water on carcass characteristics is summarized in Table 4. Rabbits supplemented with yeast or ZAD alone recorded the highest carcass percent, while groups supplemented with yeast and ZAD combined recorded the lowest percent for all parameters except liver percent. There was a non-significant difference in carcass percentage between the treated rabbit groups and the control group.

In our experiment, the total edible parts (%) in the ZAD groups and yeast alone were significantly higher than in the control group. These results agree with those obtained by **Abdel-Azeem *et al.* (2009),** who revealed that NZW rabbits (35 days old) receiving diets supplemented with virginiamycin and yeast (*Saccharomyces cerevisiae)* significantly increased carcass weight percentages. While our results were contrary to

Table 4. Effect of experimental treatments on carcass traits of Californian male rabbits (12 weeks of age)

Treatment groups	Carcass %	Liver %	Heart %	Kidneys %	Giblets[1] %	Dressing %
T1	57.41	3.21^{ab}	0.31^{bc}	1.30^{a}	4.82^{c}	62.23a^{b}
T2	60.57	3.20^{ab}	0.29^{bc}	0.86^{ab}	4.35^{bc}	64.92^{a}
T3	62.40	2.35^{d}	0.32^{bc}	0.66^{e}	3.33^{d}	65.73^{a}
T4	59.82	4.02^{a}	0.41^{a}	0.71^{d}	5.41^{b}	65.23^{a}
T5	56.73	3.58^{ab}	0.33^{b}	0.71^{d}	6.62^{a}	63.35^{a}
T6	52.42	2.89^{bc}	0.30^{bc}	0.76$^{?}$	3.86^{c}	56.28b
T7	54.64	3.59^{ab}	0.31^{bc}	0.98^{b}	4.88^{bc}	59.52^{b}
T8	55.62	3.92^{ab}	0.30^{bc}	0.87^{c}	5.09^{b}	60.71^{ab}
SEM -	1.322	0.144	0.180	0.031	0.321	1.452
Sig. level	NS	**	**	**	**	**

$^{a-b-c-}$ Values in the same column with different superscripts differ significantly($P \leq 0.05$)
NS= Not significant, **= ($P \leq 0.01$).

those of **El-Sagheer and Hassanein (2014),** who recorded that there was a non-significant impact of dietary Vetazyme or strain yeast treatment on rabbit carcass traits except the percentage of the liver, the same result was obtained by In the study by **Bhatt *et al*. (2017),** probiotics (107 CFU/g concentrate) were administered to weaning Chinchilla rabbits in addition to their diets**.** The percentage of liver in each ZAD group (T2) was significantly higher compared to other groups. Anaerobic probiotic ZAD had no significant impact on the percentages of heart and kidney. However, the total edible part percentage has increased. The current findings are in contrast with the results reported by **Kermauner and Struklec (1996)**, who noticed that supplementing probiotics with rabbits' diets increased both the dressing percentage and carcass weight. Furthermore, compared to other dietary treatments, probiotic administration produced a substantially greater percentage of dressing (**Fathi *et al*., 2017**).

Biochemical components of blood plasma:

Table 5 summarizes the effect of Sc and anaerobic bacteria enzymes (ZAD) in drinking water on some blood biochemical parameters of growing rabbits. The data indicated that the TP, Alb, Glo, AST, and ALT concentrations of rabbits receiving yeast and anaerobic probiotics (ZAD, a mix of enzymes and bacteria) were high. T3 and T5 supplemented with yeast recorded high concentrations of TP, while T3 and T6 recorded an insignificant increase in Alb. Noteworthy, groups T6, T7, and T8 (groups treated with a combination of yeast and ZAD) recorded high concentrations

Table 5. Effect of experimental treatments on liver function and fraction parameters of Californian male rabbits (12 weeks of age)

Treatment groups	**Liver function and fraction parameters**				
	Liver fraction			**Liver function**	
	TP, (g/dl)	**Alb, (g/dl)**	**Glo, (g/dl)**	**AST, (U/l)**	**ALT, (U/l)**
T1	5.80^{c}	3.40^{a}	2.40^{b}	22.70^{a}	16.11^{a}
T2	6.49^{ab}	3.57^{a}	2.92^{ab}	20.40^{b}	13.70^{b}
T3	6.80^{a}	3.70^{a}	3.10^{ab}	19.10^{b}	15.60^{a}
T4	6.67^{a}	3.40^{ab}	3.27^{ab}	21.40^{ab}	14.77^{b}
T5	6.97^{a}	3.47^{a}	3.50^{a}	22.33^{a}	13.83^{b}
T6	6.60^{a}	3.80^{a}	2.80^{b}	23.37^{a}	15.47^{abc}
T7	6.16^{b}	3.23^{b}	2.93^{b}	23.73^{a}	16.23^{ab}
T8	6.27^{ab}	3.27^{b}	3.00^{ab}	23.70^{a}	17.27^{a}
SEM -	0.23	0.12	0.24	0.74	0.57
Sig. level	**	**	**	**	**

[a-b-c-] Values in the same column with different super scripts differ significantly (P≤0.05),
**= (P≤0.01).

TP=Total protein, Alb=Albumin, Glo=Globulin, AST=Aspartate amino transferase, ALT=Alanine amino transferase.

of AST. All groups, except T1 recorded significantly augmented levels of Glo compared to the control group. The intriguingly increased TP and Alb of growing rabbits receiving yeast was an indication of the relatively good quality of protein and the dietary protein level and availability. Additionally, TP and Alb also belong to healthy rabbit ranges (**Ajayi and Raji, 2012**). This refers to the fact that Sc and ZAD were improved, indicating good dietary protein quality and abundance. Augmented TP and Alb values within a normal range obtained from the rabbits receiving 1 and 3 g/liter drinking water groups indicate that the high level of yeast was safe and beneficial. Total protein and globulin are the predominant components of immunity, and albumin-basic antibodies are the main protein component of blood that is synthesized in the liver tissues. They act as a reaction to humoral immunity, which can help improve immune organs. Therefore, in the current experimental study, the findings of globulin levels in plasma are supported by **Gao *et al.* (2007)**, who recommended that supplementing cockerel diets with probiotics from 7 to 21 days of age increased the response of the humeral immune system. The functions of albumin include the regulation of the destruction of extracellular fluid and the transport of many substances such as bilirubin, amino acids, fatty acids, minerals, hormones, and vitamins (**Attia and Salvatore 2015).**

Basma El-Sawy (2022) showed that total protein and globulin were increased significantly (P≤0.01) in rabbits fed diet supplemented with SC, while albumin was decreased significantly (P≤0.01) compared to the control group. **El-Shafei *et al.* (2019)** reported that supplementation of probiotics in growing NZW rabbits had no significant effect on TP. The same results were obtained by **Mohamed *et al.* (2017)** who showed partial harmony with our results, as a significant effect was reported on total protein in growing rabbits fed diets supplemented with *Lactobacillus acidophilus*. Another increase in TP, along with an increase in Glo, was observed by **Abdel-Azeem *et al.* (2018). Fathi *et al.* (2017)** in local breed-growing rabbits fed two different doses of probiotic containing *Bacillus subtilis*, reported a numerical increase in total protein level and a similar trend in globulins with the highest dose of probiotic.

Lipid profile and kidney functions:

Table 6 presents the effect of different levels of Sc and ZAD supplementation on lipid profiles and kidney functions. The results showed a significant reduction in concentrations of TG, CH, HDL-c, V-LDL, urea, and creatinine in treated rabbits. At the same time, T3, T4, and T5 recorded lower values of CH and LDL-c but raised concentrations of HDL-c, while the control group recorded the highest values for all parameters except HDL-c.

The present results are in harmony with those obtained by **Galip and Seyidoolu (2012),** who observed that serum CH values tended to be lower in rabbits when fed with *Saccharomyces cerevisiae*. Also, **Seyidoglu and Galip (2014)** recorded that there were effects on the blood TG and CH values of rabbits when their diet was supplemented with *Saccharomyces cerevisiae*. Additionally, **Awad *et al.* (2019)** recorded that feeding rabbits with diets supplemented with *Saccharomyces cerevisiae* in rabbit diets initiated an observable decrease in serum lipid profiles (CH, TG, and LDL) vs. the control group. Conversely, **Sarat Chandra *et al.* (2015)** referred to any variance in the blood CH content of rabbits when fed diets containing probiotics (*Saccharomyces cerevisiae*). **Dobicki *et al.* (2005)** found that yeast in calves' diet significantly reduced total cholesterol, possibly due to rumen fermentation changes. Rumen short-chain fatty acids reduced cholesterol synthesis in the liver, and yeast cell walls were rich in β-glucans, reducing serum cholesterol. **Basma El-Sawy (2022)** showed that plasma urea, creatinine, tri-glycerides, and total cholesterol were decreased in rabbits fed a diet supplemented with SC compared with the control group.

Abdel-Azeem *et al.* (2018) recorded that serum levels of total cholesterol (TC), lipoproteins of low density (LDL), very low-density lipoproteins, triglycerides, and total lipids were significantly decreased with ZAD®. While the LDL: lipoproteins of high density (HDL) ratio significantly decreased with increased levels of ZAD and improved in useful cholesterol (HDL), this explained that administration of an anaerobic probiotic led to a reduction in the lipid profile of serum and helped to decline total cholesterol deposition in the muscles and skin. Conversely, for our results, **Abdel-Azeem**

Table 6. Effect of experimental treatments on lipid profile and kidney function of Californian male rabbits (12 weeks of age)

Lipid profile and kidney function parameters							
Treatment groups	**Lipid profile**		**Lipid profile function**			**Kidney function**	
	TG, (mg/dl)	**CH, (mg/dl)**	**HDL-c, (mg/dl)**	**LDL-c, (mg/dl)**	**V-LDL, (mg/dl)**	**Urea (mg/dl)**	**Creatinine (mg/dl)**
T1	54.45^{a}	102.83^{a}	34.73^{b}	57.21^{a}	10.89^{a}	22.27^{a}	0.75^{a}
T2	46.47^{b}	79.87^{b}	36.70^{b}	33.87^{bc}	9.29^{b}	18.13^{b}	0.60^{b}
T3	43.63b	74.53b	39.33^{ab}	26.47^{cd}	8.73^{b}	17.63^{bc}	0.56^{b}
T4	42.93b	76.07b	42.23^{a}	25.25^{d}	8.59^{b}	18.70^{b}	0.55^{bc}
T5	42.93b	72.77b	43.80^{a}	20.38^{d}	8.89^{b}	$16.23b^{c}$	0.41^{d}
T6	47.27^{b}	80.73^{b}	36.93^{b}	34.35^{bc}	9.45^{b}	17.20^{b}	0.53^{c}
T7	41.70c	78.67b	35.47^{b}	34.35^{bc}	9.45^{b}	18.47^{b}	0.54^{c}
T8	44.93^{b}	79.33^{b}	34.70^{b}	35.65^{b}	8.99^{b}	18.20^{b}	0.47^{cd}
SEM	0.92	1.20	1.29	2.23	0.26	0.53	0.04
Sig. level	**	**	**	**	**	**	**

a-b-c- Values in the same column with different super scripts differ significantly,

**=($P \leq 0.01$).

TG=Total glyceride, CH=Total cholesterol, HDL-c= High density lipoprotein, LDL-c= Low density lipoprotein, V-LDL-c=Very low lipoprotein.

***et al.* (2018)** mentioned that kidney functions such as creatinine and urea were not significantly reduced by ZAD®.

Immunity and antioxidant status:

Regarding immunoglobulin (IgG and IgM) concentrations in the plasma of rabbits (Table 7), the concentrations of IgG and IgM were higher for rabbits supplemented with yeast, while ZAD had significant differences, while a lower concentration was recorded in the control group. On the other hand, treated groups recorded a high significant TAC concentration and decline for MDA, while the control group revealed the lowest concentration for TAC and height value of MDA.

The present results are consistent with those of **Lei *et al.* (2013),** who reported that yeast showed beneficial effects on immune function in animal production. Also, **Bu *et al.* (2019)** recorded that yeast cultures contain different immune stimulants (bioactive components), which could produce a more general immune response to regulate the nuclear factor kappa-B signal in a pathological way and improve immune status in animals. Another note is in harmony with our study and previous notes: **Gao *et al.* (2008)** showed that yeast media supplementation could improve antibody titers to the New Castle disease virus, serum lysozyme activity, and duodenal IgM and IgA contents in broiler chickens. On the other hand, the study found that adding probiotics to weaning rabbits' diet improved the immune organ index and function. This was supported by increased serum globulin levels, which are components of immunity. This finding aligns with previous research by **Gao *et al*. (2007)** and **Hongna *et al.* (2020),** which found that probiotics improved humeral immune responses. Regarding antioxidants**, Rahimnejad *et al.* (2020)** recorded that supplementing yeast products could enhance the anti-oxidative enzymes activities. The same result obtained by **Salinas-Chavira *et al.* (2018)** indicated that supplementing animals with yeast cell walls improved their antioxidant capacity.

Probiotics have a beneficial impact on improved immune-modulative abilities (**Zhang *et al.,* 2010). Eslamparast *et al.* (2014)** found that treatment with the probiotic showed that the ability to elevate immunity led to inhibition of NF-B (nuclear factor B) and diminishing production of tumor necrosis factor alpha (TNFα). Also, **Socha *et al.* (2002)** recorded that supplementing rats with probiotic products increased intestinal IgA levels. The present results are in harmony with **Hongna *et al.* (2020)** observation that adding probiotics to the diet improved the immune organ index and immune function of weaning meat rabbits' levels of immunoglobulin M (IgM).

Table 7. Effect of experimental treatments on immunity and antioxidant status of Californian male rabbits (12 weeks of age)

Treatment groups	Immunity status		Antioxidant status	
	IgG, (mg/dl)	IgM, (mg/dl)	TAC, (nmol/ml)	MDA, (nmol/ml)
T1	441.0^{c}	17.0^{d}	1.04^{b}	7.25^{a}
T2	878.0^{a}	23.0^{c}	2.85^{a}	4.97c
T3	763.0^{b}	28.0^{ab}	2.38^{a}	4.69b
T4	723.0^{b}	32.0^{a}	2.89^{aa}	4.52b
T5	727.0^{b}	29.0^{ab}	2.87^{a}	4.93b
T6	858.0^{a}	28.0^{bc}	2.79^{aa}	3.95
T7	868.73^{a}	29.49^{ab}	2.75^{aa}	5.56^{b}
T8	843.56^{a}	30.21^{ab}	2.81^{aa}	4.87c
SEM -	44.53	3.15	0.41	0.95
Sig. level	**	**	**	**

$^{a-b-c-}$ Values in the same column with different super scripts differ significantly (P≤0.05)
**= (P≤0.01).
IgG= Immunoglobulin G, IgM= Immunoglobulin M, TAC= Total antioxidant capacity, MDA= Malondialdehyde.

Interestingly, the presented study showed an increase in the concentration of total protein, albumin, and globulin. This supports the idea that this increases the immune response, where proteins and globulins are components of immunity and albumin-based antibodies are the main protein component of serum, produced in hepatic tissues that act as immune activators and support the germination of immune organs.

Hematology traits:

Regarding immunoglobulin (IgG and IgM) concentrations in the plasma of rabbits (Table 8), the concentrations of IgG and IgM were higher for rabbits supplemented with yeast, while ZAD had significant differences, while a lower concentration was recorded in the control group. On the other hand, treated groups recorded a high significant TAC concentration and decline for MDA, while the control group revealed the lowest concentration for TAC and height value of MDA.

The present results are consistent with those of **Lei *et al.* (2013),** who reported that yeast showed beneficial effects on immune function in animal production. Also, **Bu *et al.* (2019)** recorded that yeast cultures contain different immune stimulants (bioactive components), which could produce a more general immune response to regulate the nuclear factor kappa-B signal in a pathological way and improve immune status in animals.

Table 8. Effect of experimental treatments on the blood hematology of Californian male rabbits (12 weeks of age)

Treatment groups	Blood hematology parameters			
	RBCs, $\times10^6/\mu$	**WBCs, $\times10^3/\mu$**	**Hb, g/µ**	**PCV, %**
T1	4.73b	3.40^b	12.95b	27.07^c
T2	5.33a	5.50^a	13.27ab	31.07^b
T3	5.30a	5.73^a	13.67ab	34.43^a
T4	5.35a	5.63^a	14.03a	34.60^a
T5	5.37a	5.53^a	14.20a	36.23^a
T6	5.40a	5.63^a	14.07a	35.30^a
T7	5.23a	5.57^a	14.37a	34.20^a
T8	5.30a	5.34^a	14.40a	34.80^a
SEM	0.19	0.27	0.58	0.82
Sig. level	*	**	*	**

$^{a\text{-}b\text{-}c\text{-}}$ Values in the same column with different super scripts differ significantly ($P\leq0.05$)

*= ($P\leq0.05$), **= ($P\leq0.01$).

RBCs= Total red blood cells, WBCs= Total white blood cells, Hb= Blood hemoglobin, PCV= Packed cell volume.

Another note is in harmony with our study and previous notes: **Gao *et al.* (2008)** showed that yeast media supplementation could improve antibody titers to the New Castle disease virus, serum lysozyme activity, and duodenal IgM and IgA contents in broiler chickens. On the other hand, the study found that adding probiotics to weaning rabbits' diet improved the immune organ index and function. This was supported by increased serum globulin levels, which are components of immunity. This finding aligns with previous research by **Gao *et al.* (2007)** and **Hongna *et al.* (2020),** which found that probiotics improved humeral immune responses. Regarding antioxidants**, Rahimnejad *et al.* (2020)** recorded that supplementing yeast products could enhance the anti-oxidative enzymes activities. The same result obtained by **Salinas-Chavira *et al.* (2018)** indicated that supplementing animals with yeast cell walls improved their antioxidant capacity.

Probiotics have a beneficial impact on improved immune-modulative abilities (**Zhang *et al.*, 2010). Eslamparast *et al.* (2014)** found that treatment with the probiotic showed that the ability to elevate immunity led to inhibition of NF-B (nuclear factor B) and diminishing production of tumor necrosis factor alpha (TNFα). Also, **Socha *et al.* (2002)** recorded that supplementing rats with probiotic products increased intestinal IgA levels. Our results are in harmony with **Hongna *et al.* (2020)** observation that adding probiotics to the diet improved the immune organ index and immune function of weaning meat rabbits' levels of immunoglobulin M (IgM). Interestingly, our study showed an increase in the concentration of total protein, albumin, and globulin. This supports the idea that this increases the immune response, where proteins and globulins are components of immunity and albumin-based antibodies are the main protein component of serum, produced in hepatic tissues that act as immune activators and support the germination of immune organs.

Economic efficiency:

Period of fattening, total cost, and final body weight are the major factors involved in the achievement of the preferable efficiency values of a meat rabbit's production. The relative economic efficiency of the different treatments is shown in Table 9. It should be pointed out that the relative economic efficiency values were calculated according to the prevailing market selling price of 1 kg of LBW.

Results indicated that supplemented weaning rabbits, including *Saccharomyces cerevisiae* and ZAD, showed improved FBW net profit and net revenue in groups treated individually. While groups receiving combination treatment recorded the lowest final body weight, the results indicated that the addition of different doses of ZAD or *Saccharomyces cerevisiae* alone improved the REE of treatment groups by 136.99, 178.08, 150.86, and 140.73%, respectively, when compared with the rabbits fed a basal diet without supplementation, as well as that mixtures of yeast and ZAD tend to reduce the REE compared to individual treatments. This may be due to the improved growth performance and FCR of rabbits receiving yeast. Our results are in conformity with those of **Basma El-Sawy (2022),** who noted that the best economic efficacy was obtained in rabbits fed SC, comparable with rabbits in the control group. The best feed cost was shown in rabbits fed ~~a~~ diet supplemented with SC, which was comparable to rabbits in the control. **Shehata *et al.* (2011)** documented that the addition of amino-yeast (yeast plus some amino acids) to the diet of growing rabbits improved economic efficiency. The same result was obtained by **Kalma *et al.* (2018),** who found that supplementation of probiotics (*Saccharomyces cerevisiae or Lactobacillus sporogenes*) in rabbit diets improved economic returns. **El-Adawy *et al.* (2000)** recorded the highest economic efficiency value with the addition of probiotics. **Abdel-Azeem *et al.* (2009)** observed the best net return, percentage of economic efficiency, relative economic efficiency, and cost performance index due to rabbit probiotic consumption. **El-Katcha *et al.* (2011)** indicated that dietary supplementation of probiotics in the diet improves economic efficiency. Which supports our results, the **El-Badawi *et al.* (2017)** study found a negative association between *Bacillus subtilis* and *Saccharomyces cerevisiae* in rabbits fed ~~a~~ mix of bacteria and yeast, despite no significant difference in performance.

Table 9. Effect of experimental treatments on economic efficiency of Californian male rabbits (5-12 weeks of age)

Items	Treatment groups							
	T1	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**
Final body weight, kg	1.90	2.03	2.16	2.12	2.11	1.67	1.65	1.60
Price of 1 kg body weight, L.E.	95	95	95	95	95	95	95	95
Price of weaning litter (L.E.)	60	60	60	60	60	60	60	60
Net profit (L.E.)	180.5	192.9	205.2	201.4	200.5	158.7	156.8	152.0
Total cost of treatment (L.E.)	0	0.20	3.5	7.0	10.5	3.7	7.9	10.7
Total feed intake, kg	5.48^{a}	5.48^{a}	5.22^{b}	5.24^{b}	5.14^{b}	4.45^{e}	4.63^{d}	4.78^{c}
Price of 1 kg feed, (L.E)	16	16	16	16	16	16	16	16
Total feed cost/rabbit, (L.E.)	87.68	87.68	83.52	83.84	82.24	71.2	74.08	76.48
Total cost/rabbit (L.E.)	147.68	147.88	147.02	150.84	152.74	134.9	141.98	147.18
Net revenue/rabbit, (L.E.)[1]	32.82	45.02	58.18	50.56	47.76	23.8	14.82	4.82
Economic efficiency[2]	22.22^{c}	30.44^{bc}	39.57^{b}	33.52^{bc}	31.27^{a}	17.64^{c}	10.44^{d}	3.27^{f}
Relative economic efficiency	100	136.99	178.08	150.86	140.73	79.39	46.98	14.72

$^{a-b-c-d-f}$: Values in the same column with different superscripts differ significantly ($P \leq 0.05$).

Net profit = (FBW × price of 1 kg meat), L.E.

Net revenue = Net profit–Total cost, L.E.

Economic efficiency = (Net revenue / Total cost) × 100 Relative economic efficiency = (Treatment/control) ×100

Total cost = (Total feed intake × Kg feed cost, 16 L.E./kg) + Price of weaning litter (60 L.E.) + Total cost of treatment

Total cost of treatment (L.E.) = (Cost of yeast + Cost of ZAD) during experimental

In conclusion, dietary of *Saccharomyces cerevisiae* (Sc) or anaerobic bacteria (ZAD) supplementation in weaned rabbits drinking water showed most beneficial effects, while, the combinations between them resulted in adverse effects.

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تأثير إنزيمات البكتيريا اللاهوائية (زاد) على كفاءة الخميرة وأداء النمو وصفات الدم البيوكيميائية في ذكور الأرانب المفطومة

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أجريت هذه التجربة لدراسة تأثير إنزيمات البكتيريا اللاهوائية (زاد)على كفاءة الخميرة فى مياه الشرب على نمو ذكور الأرانب المفطومة وإستجابتها الفسيولوجية. تم توزيع ٦٤ ذكر أرنب مفطوم كاليفورنيا عمر ٣٥ يوما بوزن إبتدائى متوسط 561.08±7.22 g جم بشكل عشوائي على ٨ مجموعات تجريبية بعدد ٨ أرنب بكل معاملة، تلقت المجموعة الأولى مياه

شرب بدون إضافات وكانت بمثابة مجموعة ضابطة (T1)، والمجموعة الثانية (T2) تلقت مياه شرب مضافا إليها ١ مل من زاد لكل لتر؛ تم تزويد المجموعات الثالثة والرابعة والخامسة (T3 وT4 وT5) بمياه الشرب مضافا إليها ١ و٢ و٣ جم من الخميرة لكل لتر؛ كما تلقت المجموعات السادسة والسابعة والثامنة (T6 وT7 وT8) مياه الشرب بالإضافة إلى ١ مل من زاد (مزيج من الإنزيمات والبكتيريا) و١ و٢ و٣ جم من الخميرة على التوالي طوال فترة التجربة والتى إستمرت ٧ أسابيع (من عمر ٥ أسابيع حتى ١٢ أسبوع.

أظهرت النتائج أن إضافة الخميرة في مياه الشرب للأرانب المفطومة أو مخلوط الإنزيمات أدى إلى تحسن في وزن الجسم النهائي وزيادة وزن الجسم المكتسب ونسبة تحويل العلف ونسبة كفاءة البروتين مقارنة بالمجموعات الأخرى ومجموعة الكنترول على التوالي. تحسنت عملية الهضم بشكل كبير عن طريق إضافة كل من الخميرة أو زاد؛ على العكس من ذلك، أدى خلط الخميرة مع زاد إلى انخفاض هضم البروتين الخام والألياف الخام مقارنةً بالخميرة أو زاد منفردا ولكنه تحسن مقارنةً بالكنترول. سجلت الأرانب المضاف لها الخميرة أو زاد منفرده أعلى نسبة للذبيحة، في حين سجلت المجموعات المضاف إليها الخميرة و زاد مجتمعة أقل نسبة لجميع صفات الذبيحة بإستثناء الكبد. وقد أشارت البيانات المتحصل عليها إلى أن تركيزات البروتين الكلي والألبيومين والجلوبيولين وAST وALT للأرانب التي تلقت الخميرة والبروبيوتيك اللاهوائي زاد كانت عالية، في حين سجلت المجموعات التجريبية T3 وT5 المضاف إليها الخميرة تركيزات عالية من البروتين الكلى، كما سجلت T3 وT6 زيادة معنوية في الألبيومين. ومن الجدير بالذكر أن المجموعات T6 وT7 وT8 (المجموعات المضاف لها الخميرة مع زاد) سجلت تركيزات عالية من AST. كما لوحظ انخفاض كبير في تركيزات الدهون الثلاثية، والكوليسترول الكلى، والكوليسترول عالى الكثافة، والكوليسترول منخفض الكثافة، واليوريا، والكرياتينين في بلازما دم الأرانب المعاملة مقارنة بالكنترول. في الوقت نفسه، سجلت T3 وT4 وT5 قيمًا أقل لـلكوليسترول الكلى والكوليسترول منخفض الكثافة ولكن زادت تركيزات الكوليسترول عالى الكثافة، بينما سجلت مجموعة الكنترول أعلى القيم لجميع المعاملات باستثناء الكوليسترول عالى الكثافة. وكانت تركيزات IgG وIgM أعلى في الأرانب المضاف لها الخميرة. وأظهرت أرانب الفطام المعاملة سواء بالخميرة أو زاد تحسنًا في وزن الجسم النهائى وصافي الربح وصافي الإيرادات والكفاءة الاقتصادية النسبية في المجموعات التي عوملت بشكل فردي مقارنة مع تلك التى تلقت مزيجًا من الخميرة مع زاد.

التوصية: إضافة كل من الخميرة أو البكتيريا اللاهوائية (زاد) في مياه شرب الأرانب المفطومة أدت لتأثيرات أكثر فائدة، في حين أن التوليفات بينهما أدت إلى آثار سلبية.