RABBIT GROWTH, CARCASS CHARACTERISTIC, DIGESTION, CAECAL
FERMENTATION, MICROFLORA, AND SOME BLOOD BIOCHEMICAL
COMPONENTS AFFECTED BY ORAL ADMINISTRATION OF ANAEROBIC
PROBIOTIC (ZAD®)

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SUMMARY

The present research designed to study the influences of diverse doses of oral administration of
anaerobic probiotic (ZAD®) on growth performance, carcass characteristic, digestibility coefficient,
caecal activity, microflora and some blood biochemical components of growing rabbits. At 6 weeks
(average body weight 539.87±13.35 g), one hundred and eighty weaned male rabbits from New Zealand White
(NZW) were randomly distributed to four groups. The control group received orally 0.0 ZAD®; the
experimental groups administrated orally with 0.25, 0.5 and 1.0 ml ZAD®/rabbit/day, respectively. The
experimental period lasted for 8 weeks. Groups 0.25 ZAD® and 0.5 ZAD® had improved feed conversion ratio
and body weight gain and the lowest mortality rate. In comparison with the control and 1.0 ZAD® groups, the
groups 0.25 ZAD® and 0.5 caused a significant increase (P≤0.05) in nitrogen utilization, nutritive value
and digestibility coefficients. The different doses of ZAD® had improved dressing percentage and percentage of
edible parts, although parts of total non-edible were decreased (P≤0.001) compared to the group of control. As
well as, cecum activity (cecum pH, total volatile fatty acids, acetic, propionic and butyric acid) were improved
significantly by administrated orally different doses of probiotic ZAD® 0.25, 0.5 and 1.0 ml/rabbit/day
compared with the control group. The opposite trend was observed in ammonia concentration which had been
reduced significantly by administrated all doses of ZAD®. In addition, a total number of anaerobic bacteria
were less than those of total microbial count and coliform group but, they have the same trend of decreasing the
number as the amount of anaerobic probiotic ZAD® increased. Also, fermentation of lactobacilli take the
opposite trend as the amount of probiotic ZAD® increased the lactobacilli number increased. As streptococci
isolated was lower than lactobacilli group. As the concentration of probiotic ZAD® increased isolates numbers
decreased, also lactobacilli enumeration increased. The serum total protein, albumin, globulin, and albumin:
globulin concentration of rabbits received probiotic ZAD® groups were significantly augmented
compared with the group of control. On the contrary, levels of creatinine and urea in rabbit serum were not
significantly affected by probiotic oral administration ZAD®. Alanine aminotransferase and aspartate
aminotransferase enzymes of serum were significantly decreased with augmenting levels of ZAD®. Serum
levels of total cholesterol (TC), lipoproteins of low density (LDL), very low-density lipoproteins, triglycerides,
total lipids, and LDL: HDL ratio were significantly decreased with augmenting levels of ZAD®. But, the HDL: TC and HDL: LDL ratio augmented significantly with probiotic oral
administration ZAD® levels.

Keywords: ZAD®, growth performance, digestible coefficient, caecum activity, nitrogen balance, rabbit.

INTRODUCTION

Because of the pollution of feed with pathogenic bacteria and their associated impacts on the animal,
such as increased mortality or reduce weight gains, both the food production and the feed industry sectors
are still suffering enormous losses. Pathogenic bacteria are constantly existing in the alimentary canal, but it is determined by the balance between pathogenic and beneficial bacteria that a disease will occur or not. Preserving a healthy equilibrium within the intestine between all microflora is known as symbiosis (Jensen, 1980) and may be affected by microflora endemic bacteria. Bacteria considered useful to the intestine, comprising bacteria creating lactic acid like Lactobacillus spp., avoid the propagation of pathogens such Salmonella spp. by competitively excluded of receptor and nutrient sites on the intestinal wall (Thomke and Elwinger, 1998). It has been observed in recent decades that the development of rabbit production is the result of the contributions in genetics, management, nutrition, health, environment and other fields of certain technologies and innovations. Other alternative feed additives are currently being adopted to fill the antibiotic gap. Due to the common problem of reducing consumer agreement of antibacterial growth promoters and increasing bacterial resistance, various substances called natural growth promoters (NGPs) have been recognized as active and benign alternatives to antibacterial growth promoters.

A large number of NGPs, including immune-boosters, probiotics, and prebiotics are currently available on the market. Under this point of view, the anaerobic probiotic technology (ZAD®) may be a substitute for antibiotic growth promoters in the feeding idea (Gado et al., 2017). The ZAD® is a patented product manufactured by the Academy of Scientific Research and Technology, Egypt and an enzyme biotechnology product from natural sources to raise the anaerobic bacteria cellulase enzymes levels that can transform polysaccharide by the enzyme catalytic process to monosaccharide. The product is designed in form liquid to provide tools to improve the nutritional value of fibrous materials and to improve the overall digestion of animals. It includes the subsequent activity of enzymes such as 6.2 U/g hemicellulase and 8.2 U/g cellulose, as well as 12.3 U/g protease and 64.4 U/mg amylase (Gado et al., 2011, Gado and Salem, 2013 and Gado et al., 2017), besides the anaerobic bacteria that create these enzymes (Abdel-Aziz et al., 2014, 2015), additionally, the patent number is 22155 (Gado, 1997).

Anaerobic probiotic (ZAD®) is a dietary 1.5 liter for rabbits that helps the animals to overcome the stress of heat. It augmented production of milk for rabbits, raised the daily average gain, enhanced throughout the physiological aspects and lowered the rabbit mortality rate.

It is relatively new to know the effects of synergistically acting anaerobic probiotic blends to the rabbit with mixture enzymes. The main aims of this report are hence to study the effect of anaerobic probiotic ZAD oral intake on growth performance, mortality, digestible nutrient coefficient, carcass characteristics, caecum activity and some blood biochemical components of New Zealand White (NZW) growing rabbits.

MATERIALS AND METHODS

Experimental design:

This study took place at Al - Noubaria Research Station, Research Institute for Animal Production, Research Center for Agriculture, Egypt, to investigating the effect of oral administration anaerobic probiotic (ZAD®) on growth performance, nutrient digestibility coefficient, nitrogen balance, caecum activity, caecum microflora, and some blood biochemical components of NZW rabbits for 56 days. In a simple randomized design experiment, one hundred and eighty weaned male rabbits at 6 weeks old (average body weight 539.87±13.35 g) from NZW were distributed randomly to four dietary groups (45 in each group; three replicates 15 for each replicate). The control group was administered 1.0 ml distilled water (0.0 ZAD®) orally once daily, the trial groups were administered anaerobic probiotic (ZAD®) at levels 0.25, 0.5 and 1.0 ml/ rabbit/ day (groups 0.25, 0.5, and 1.0 ZAD®, respectively) were oral gavage administration/each rabbit. Doses were given once daily via gavage for 56 consecutive days. This method could be improved eliminates risks of variability in intake between individual animals which may arise when substances are administered through delivery in water.

Diets and housing of the experiment:

The rabbits were kept in cages from galvanized wire individually (50x40x35 cm) under a 16:8 h light–dark cycle until marketing at 14 weeks of age. Pelleted feed ad libitum was fed to all rabbits. According to Lebas (2004), the experimental diets were prepared to fulfill the nutrient needs of growing rabbits. All rabbits were reared under the same conditions of hygiene, management, and the environment. Rabbits were kept in a building was well-ventilated; through nipples from stainless-steel fastened in every cage, fresh
water was automatically obtainable the whole time. Body weight was determined every week throughout the experimental period and an average gain of body weight was computed. Feed intake (FI) was accurately measured by grams throughout the experimental period for each rabbit per week. During the computation of FI and feed conversion ratio (FCR), feed residuals collected daily from each cage, weighed and taken into account. The composition and calculated analyses of the experimental diets and feed ingredients are presented in Table (1). According to AOAC (2000), chemical analyses of rations in the experiment were performed.

### Table (1). Composition and calculated analyses (%) of the experimental diets on dry matter basis.

| Feed ingredients      | Control diet | Calculated analyses (according to NRC, 1977) |
|-----------------------|--------------|----------------------------------------------|
|                       | %            | Item %                                       |
| Dried Egyptian clover | 35.00        | dry matter 89.67                            |
| Yellow corn           | 10.0         | Crude protein 17.18                         |
| Soybean meal          | 17.5         | Crude fiber 13.05                           |
| Barley                | 18.0         | Neutral detergent fiber 37.49                |
| Wheat bran            | 15.00        | Ether extract 3.41                          |
| Molasses              | 3.00         | Nitrogen-free extract 56.03                 |
| Di-Ca-phosphate       | 0.8          | Ash 10.33                                    |
| DL-Methionine         | 0.10         | Calcium 0.83                                 |
| NaCl                  | 0.30         | Phosphors 0.31                              |
| Vit.-Min. premix      | 0.30         | Methionine 0.36                             |
| Total                 | 100          | Total sulphur amino acid (%) 0.68            |
|                       |              | Digestible energy (Kcal/Kg) 2519.87          |

Provided per kilogram diet: vitamin D₃, 450 IU; vitamin A, 6000 IU; vitamin K₃, 1 mg; vitamin E, 40 mg; vitamin B₁₂, 1 mg; niacin, 180 mg; vitamin B₃, 3 mg; vitamin B₆, 39 mg; pantothenic acid, 10 mg; folic acid, 2.5 mg; vitamin B₁₂, 2.5 mg; biotin, 10 mg; manganese, 15 mg; 1200 mg; zinc, 35 mg; iron, 38 mg; choline chloride, copper, 5 mg; selenium, 0.05 mg; iodine, 0.2 mg.

**Digestibility trials:**

At the end of the growth experiment (14 weeks of age) digestibility studies were conducted to define the digestibility of nutrients, values of feeding, and experimental diet nitrogen balance. A total number of 20 male rabbits were taken randomly (5 within each treatment) and allotted in different treatment. Animals were stayed in cages separating feces and urine individually. Twice daily at 9 AM and 15 PM experimental diets were obtainable, and additional water was ad libitum supplied. Daily feed consumption survey has been documented. All probable contamination of feed has been eliminated from the feces. Samples of every rabbit's daily feces were taken and oven dried for 48 h at 60⁰C, then grounded and stocked for proximate chemical analysis. By the AOAC (2000) methods samples of feces were evaluated for dry matter (DM), ash, ether extract (EE), crude protein (CP), and crude fiber (CF). According to Cheeke (1987), the nutritive values of the experimental diets were computed as total digestible nutrients (TDN). Digestible energy (DE) was calculated according to Schneider and Flatt (1975) using the following equation: Digestible energy (DE, Kcal/Kg diet) was calculated as follow: TDN × 44.3. Each animal's urine was collected in a glass container, comprising 10 ml of a 1:1 H₂O: HCl sol, to avert potential losses through volatilization and bacterial production. The nitrogen intake (NI) values, excreted feces nitrogen (FN) and urine nitrogen (UN) were acquired by the quantities of feed consumed and excreted nitrogen in feces and urine respectively retained nitrogen was computed as NR = NI – (FN+UN).
**Slaughtering and carcass traits:**

At the end of period of growth experiment, ten rabbits male (aged 14 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 weighed the carcass and its constituents as edible parts. Additionally weighed as a percentage of pre-slaughter weight performed the non-edible parts comprise large intestine, lung, stomach, spleen, and small intestine. By dividing the hot dressed carcass weight by pre-slaughter weight, the dressing percentage was computed and stated as a percentage.

Gastrointestinal tracts were individually removed from three slaughtered rabbits from each group, weighted cecum and measured the pH of the caecal content by a digital pH meter (Model 20, Digital pH meter for Orion Research). Then, to determine total volatile fatty acids (VFA) and ammonia nitrogen by steam distillation (UDK 139- Semi - Automatic Distillation Unit) according to Warner (1964), the caecal content was collected and filtrated throughout 4 gauze pleats. The Gastrointestinal tracts of slaughter rabbit were washed with 70% ethanol in order to reduce the number of incidental organisms. After that, the large intestinal tract aseptically cut and separate proximal from the distal part. Then, aseptically opened both parts and the caecum content removed so can retrieve a smear from caecum wall using a bacteriological loop. Then, the loop implanted inside previously made broths (tryptic soy broth, De Man, Rogosa and Sharpe (MRS) broth (CM0359, oxide)) and anaerobically incubated at 37°C for 24-48 h. Then each broth from each experimental unit plated on previously made MRS agar and tryptic soy agar plates and anaerobically incubated for 24 - 48 hours at 37°C. Then, choose milky white, circular, convex, elevated and non-pigmented colonies on MRS agar for additional sub-cultured. On MRS agar, the colonies were stained to ensure for a pure culture that was covered with glycerol and kept for more study (Pal et al., 2005).

**Total bacterial count using spectrophotometer:**

The caecum aseptically cut, ground using sterile mortars and pestles into a fine paste. Then put that paste in a tube represent each treatment for centrifugation, and then take supernatant to make 10 fold serial dilutions inside 10 tubes previously prepared from tryptic soy broth and MRS broth with one extra tube as a blank where take a known 1 ml volume of supernatant and place it into 9ml volume of broth in order to produce 10 ml of the dilute solution. So the diluted solution has 1 ml of extract /10 ml, producing a 10-fold dilution. This process can be repeated to make successive dilutions. Then all diluted tubes incubated at 37°C for 24-48 h.

The spectrophotometer needs to be adjusted to 100% transmittance (0% absorbance) for turbidimetric measurements. This is prepared using a sample of the blank tube (without inoculation). Then measure percent transmittance of various dilutions of the bacterial culture and the values converted to an optical density (O.D.) using the slandered formula: Absorbance (O.D.) = 2 - log % Transmittance. Using a wavelength of 570 nm when the solution is light yellow (tryptic soy broth), and 700 nm is used for yellow to brown solutions (MRS broth), Record results. Then make a scatter graph, then record CFU’s/mL of a new culture.

**Blood samples:**

Blood samples collected from slaughtered rabbits and put in centrifuge tubes, left to clot and centrifuged for separation from the serum, up to the biochemical parameters, serum samples were kept at -20°C. 

**Serum parameters of blood biochemical:**

According to Johnson et al. (1999), albumin (A) and total protein were measured; subtracting albumin values from the corresponding total protein values also obtained globulin (G) values, also ratio of albumin to globulin (A/G) was computed. According to Fringes et al. (1972), Richmond (1973), Fawcett and Scott (1960), Fabiny and Ertingshausen (1971), respectively, the blood serum total lipids, and triglycerides, urea, creatinine were gauged using commercial test kits and the spectrophotometer. Total cholesterol (TC), lipoproteins of low density (LDL) and lipoproteins of high density (HDL) have been identified according to Burstein et al. (1970), Wieland and Seidel (1983) and Bogin and Keller (1987), additionally very low-density lipoproteins (vLDL) was calculated as one-fifth of triglycerides. Alanine aminotransferase (ALT) and aspartate aminotransferase (AST) and were assayed according to Reitman and Frankel (1957), respectively.
Statistical analysis

The experiment data were analyzed using one-way ANOVA from the SAS ® GLM procedure (SAS Institute, 2000), using the following model: \( y_{ij} = \mu + T_i + e_{ij} \), Where: \( \mu \) = Overall mean \( y_{ij} \), \( T \) = treatment effect and \( e_{ij} \) = experimental error. Using Duncan multi-range test (Duncan, 1955), the significant differences between means were detected.

RESULTS AND DISCUSSION

Growth performance:

Oral administration of anaerobic probiotic (ZAD®) of growing NZW rabbits on body weight, FI, FCR and mortality% are summarized in Table (2). Results presented that the initial live body weight was not significantly different (P>0.05) between groups. However, average daily gain (ADG) of rabbits by oral administration 0.25 and 0.5 ml ZAD®/rabbit/day were significantly (P≤0.01) higher than other groups. Voluntary FI was significantly influenced by oral administration of ZAD®. Total FI of rabbits by oral administration of ZAD® were significantly (P≤0.01) depress than the control group. The results of FI and weight gain were currently reflected on values of the FCR (g feed/g gain), where it was better for rabbits oral administration 0.25 and 0.5 ml ZAD®/rabbit/day being 2.31 and 2.24 respectively, than 2.46 for 1.0 ZAD® and 2.67 for control group. Mortality% of rabbit’s oral administration 0.25 and 0.5 ml of ZAD were significantly (P≤0.01) lower than those fed other groups. On the other hand, mortality of oral administration of 0.25 and 0.5 ml ZAD®/rabbit/day was significantly (P≤0.01) improved than other groups.

A gradual rise in weight of body with doses of probiotic ZAD was noted in this study. The enhancements in weight of body were 10.4, 13.4 and 1.8% for groups T2, T3, and T4 at 56 days of age respectively.

In this connect, EL-Sagheer and Hassanein (2014) indicated that the use of 1 or 2 g of Vetazyme/kg diet (probiotic + enzymes) significantly enhanced rabbit body weight compared to those fed the basal diet during the experimental period.

The present results agree with experiments in pre-mature Hy-Plus rabbit reported by Gado and Salem (2014), where ZADO® up to 5 g/kg diet has been inserted without weakening performance. Additionally, Gado et al. (2017) confirmed that a mixture of enzymes obtained from anaerobic bacteria present in ZAD® had a beneficial effect to converts the polysaccharide into monomers by the enzyme catalytic process in growing rabbits.

Table (2): Growth performance and mortality of New Zealand White rabbits (NZW) supplemented different levels of anaerobic probiotics (ZAD®).

| Item                | Treatment                  | SEM² | P-value² |
|---------------------|----------------------------|------|----------|
|                     | Control 0.25 ml ZAD®³/rabbit/day |      |          |
| Initial body weight, g | 542.4                        | 13.35| 0.9827   |
| Final body weight, g  | 1850.3³                       | 32.10| 0.0001   |
| Body weight gain, g   | 1307.8³                       | 32.33| 0.0001   |
| Feed intake g         | 4926.7³                      | 64.18| 0.0064   |
| Feed conversion ratio | 2.67³                        | 0.05 | 0.0001   |
| Mortality %           | 13.00³                       | 0.072| 0.0001   |

#SEM= standard error of the mean; ²Means within a row having different superscripts are significantly different (P≤0.05).
Besides, Bhatt et al. (2017) showed that supplementation in rabbit diets of probiotics (107 CFU/g concentrate) Lactococcus lactis and Lactobacillus acidophilus increased (P≤0.05) the gain of weight (24.5 vs. 22.5 g/d) as compared with the control group. On the contrary, Matusievicius et al. (2006) compared with control group of rabbits, the weight gain of NZW rabbits fed 400 mg/kg of probiotic Bio Plus 2B® was not significantly different. Recently, Sherif (2018) found that rabbits reared under stress summer conditions receiving enzymes at 0.5 g/kg, β-pro® at 0.2 g/kg, organic acids at 1.0 g/kg or their mixture of enzymes, β-pro® and organic acids in the diet had the positive effects on daily weight gain compared with control group.

In the present study, during the experimental periods, the control group noted the highest FI significant differences between 1.0, 0.25, or 0.5 ZAD®. On conflict to our results, Eiben et al. (2004) utilized the supplementation of cellulose in rabbit growing diets between the ages of 23 and 77 days and Oso et al. (2013) and Bhatt et al. (2017) utilized probiotic-supplemented diets had a significantly upper FI compared to the control group.

In the present experiment, the lowest doses of ZAD® (0.25 and 0.5 ml/rabbit) resulted in the best FCR and minimal mortality (P=0.0001). The better rate of growth, FCR and rate of mortality with oral administration of ZAD® may be because of including probiotics that can improve the intestinal balance of the host animal, impact of caecal fermentation and the bowel weight in rabbits (Kermauner and Struklec, 1999); improved the status of health and intestinal function of growing rabbits (Trocino et al., 2005 and Kritas et al., 2008). In the other wise, dietary β-pro® (probiotics+ enzymes) or a mixture of organic acids, β-pro and enzymes can be improving the rabbit performance (Sherif, 2018).

**Digestibility and nitrogen balance trials:**

The effect of oral intake of anaerobic probiotic (ZAD®) on nutrients digestibility (OM, CP, EE, CF and NFE), nutritive value (DCP, TDN and DE) and nitrogen balance of NZW rabbits is summarized in Table (3). The oral administration of 0.25 and 0.5 ml ZAD®/rabbit/day of rabbits were higher (P≤0.01) nutrients digestibility (CP, CF and EE), nutritive values (DCP and TDN), digestible nitrogen and retained nitrogen compared to other groups. Crude protein, CF and EE digestibility ranged between 72.94-76.69, 49.53-51.73 and 65.53-69.75, respectively. The highest significant of CP and CF were recorded for rabbits treated in 0.5 ZAD followed in descending order by rabbits groups treated by 0.25 and 1.0 ml ZAD®/rabbit/day. However, EE digestibility was significantly decreased (P=0.013) with increasing doses of ZAD®. Rabbit treated by 0.0 ZAD showed the lowest CP and CF digestibility in comparison to the different anaerobic probiotic ZAD® doses. Organic matter and NFE digestibility between rabbit groups were not significant affected by administration orally with different doses of anaerobic probiotic ZAD®.

The nutritive values as DCP, TDN and DE ranged between 12.53-13.18, 55.85-57.54 and 2473.94–2548.69, respectively. Compared with the control group, the highest significant of DCP was recorded for rabbit treated in 0.5 ZAD® followed in descending order by rabbit groups oral intake 0.25 and 1.0 ml ZAD®/rabbit/day. However, oral administration of anaerobic probiotic ZAD® did not influenced on the TDN and DE nutritive value.

Effect of oral intake of anaerobic probiotic ZAD® at different doses on nitrogen metabolism is shown in Table (3). The NI, FN, UN and NR, g/d had significant (P≤0.01) affected. In comparison with the control treatment, the high significant (P≤0.01) of DN, g/d was recorded for rabbits received different doses of anaerobic probiotic ZAD®. However, the intake efficiency N converted to digestible N (DN/NL,%) recorded higher significant for rabbits treated in 0.5 and 1.0 ml ZAD®/rabbit/day followed in descending order by rabbit groups in 0.25 ml ZAD®/rabbit/day as compared with the control treatment. While, higher significant of NR/NI% and NR/DN% were recorded for those rabbit administrated orally with 0.25 and 1.0 ml ZAD®/rabbit/day followed in descending order by rabbit groups intake 0.0 and 0.5 ZAD® ml ZAD®/rabbit/day, respectively.

In this study, nutrient digestibility and nutritive values of CP, EE and DCP were higher in the rabbits received oral administration compared to rabbits in the control group. The lowest digestibility of CF were in the rabbits not given probiotic ZAD® as compared with rabbits supplemented with high doses of ZAD®. However, ZAD® is a mixture of enzymes obtained from anaerobic bacteria that had a beneficial impact on the digestibility of low quality roughages (Gado et al., 2017). Also, El-Hindawy et al. (1993) found that addition probiotic Lacto-Sacc caused improvement in the digestibility of all the nutrients. Similar improvement was found by Kamra et al. (1996) in CP digestibility and Yamani et al. (1992) in CF digestibility of rabbits. Also, Amber et al. (2004) proved that Lactobacillus acidophilus supplementation caused improving energy and most analytical fractions (CP, EE, and DM) digestibility, comprising CF. This
improvement tend to that the probiotics stimulate the enzyme production by the host (Mateos et al., 2010), perhaps nutrient digestibility may be improved in probiotic-supplemented groups. The present study showed a similar trend followed by nitrogen utilization as a percentage of intake and absorption. The data of N balance were well correlated with the growth performance in different groups. This improvement is due to the probiotics ZAD® oral administration colonizing the intestine, which contributes to maintaining the flora balance, which in the end supplies an intestinal fence versus pathogens (Bhatt et al., 2017). A higher digestibility of CP and EE in ZAD® treated groups could result from maintaining a relatively better gastrointestinal health and environment of bowel that reinforced improvement in N use and efficient FCR beside growth.

Table (3): Effects of ZAD® supplement on apparent digestibility and nitrogen retention of growing rabbits.

| Item                                      | Treatments          | SEM* | P-value² |
|-------------------------------------------|---------------------|------|----------|
| Nutrients digestibility (%)               | Control             |      |          |
| Organic matter                            | 61.04               |      |          |
| Crude protein                             | 75.48               |      |          |
| Crude fiber                               | 51.19               |      |          |
| Ether extract                             | 67.95               |      |          |
| Nitrogen-free extract                     | 64.45               |      |          |
| Digestible crude protein                  | 12.97ab             |      |          |
| Total digestible nutrient                 | 57.25               |      |          |
| Digestible energy (Kcal/Kg)               | 2536.1              |      |          |
| Nitrogen intake (NI, g/d)                 | 2.96               |      |          |
| Fecal nitrogen (FN, g/d)                  | 0.72               |      |          |
| Urinary nitrogen (UN, g/d)                | 0.68               |      |          |
| Digestible nitrogen (DN, g/d)¹           | 2.23               |      |          |
| Nitrogen retained (NR, g/d)²             | 1.55               |      |          |
| DN/NI (%)³                               | 75.92ab             |      |          |
| NR/NI (%)³                               | 52.56               |      |          |
| NR/DN (%)³                               | 67.60               |      |          |
| DN/NI (%)³                               | 1.42               |      |          |
| NR/NI (%)³                               | 1.52               |      |          |
| NR/DN (%)³                               | 1.22               |      |          |

*SEM= standard error of the mean.
**Means within a row having different superscripts are significantly different (P≤0.05).
¹DN =NI-FN;
²NR = NI-FN-UN;
³DN/NI (%) = the intake efficiency N converted to digestible N.
⁴NR/NI% = the intake efficiency N converted to retained N.
⁵NR/DN(%)= the digestible N efficiency converted to digestible N.

Carcass traits:

Oral administration of anaerobic probiotic (ZAD®), on carcass characteristics of growing NZW rabbits is summarized in Table (4). Pre-slaughter weight (g) values ranged from 1860-2093.33 g within significant differences among the different rabbit treatments (Table 4). Dressing, edible giblets, total edible parts and total non-edible parts% were significantly varied from 57.38-62.61, from 2.51-3.02, from 59.89-65.39 and from 34.61-40.11, respectively. The highest significant averages of dressing% was recorded for rabbit intake 0.25 ZAD®. However, the higher significant averages of edible giblets% was recorded for rabbit
administration orally in 1.0 ZAD®. A significant, dose in treatment 0.25 ZAD® increase (P=0.0001) for total edible parts. An opposite effect was noticed regarding total non-edible parts%, where, the values were significantly (P=0.0001) decreased as compared control group.

Table (4): Effects of anaerobic probiotic ZAD® supplement on carcass characteristics% of growing rabbits.

| Item                  | Control | 0.25 ml ZAD® /rabbit/day | 0.5 ml ZAD® /rabbit/day | 1.0 ml ZAD® /rabbit/day | SEM# | P-value² |
|-----------------------|---------|--------------------------|-------------------------|-------------------------|------|----------|
| Pre-slaughter weight  |         |                          |                         |                         |      |          |
| (g)                   | 1860.0b | 2000.0ab                 | 2093.3a                 | 1820.0b                 | 59.50| 0.0152   |
| Dressing              | 57.38c  | 62.61a                   | 60.40b                  | 58.72bc                 | 0.59 | 0.0001   |
| Edible giblets        | 2.51b   | 2.79ab                   | 2.73ab                  | 3.02a                   | 0.10 | 0.0337   |
| Total edible parts    | 59.89c  | 65.39a                   | 63.13b                  | 61.74bc                 | 0.60 | 0.0001   |
| Total non-edible parts| 40.11a  | 34.61c                   | 36.87b                  | 38.26ab                 | 0.60 | 0.0001   |
| Liver                 | 1.70b   | 1.85a                    | 1.89a                   | 1.89a                   | 0.04 | 0.0160   |
| Heart                 | 0.22    | 0.23                     | 0.22                    | 0.23                    | 0.01 | 0.9334   |
| Kidney                | 0.53    | 0.52                     | 0.49                    | 0.53                    | 0.03 | 0.7744   |
| Perirenal fat         | 2.82a   | 2.31b                    | 2.41b                   | 2.38b                   | 0.07 | 0.0001   |
| Scapular fat          | 0.32a   | 0.27b                    | 0.26b                   | 0.24c                   | 0.00 | 0.0001   |

#SEM= standard error of the mean. a,b,c Means within a row having different superscripts are significantly different (P≤0.05).

The percentage of liver in each ZAD® dosage groups was significantly increased (P=0.0160) compared to the control group. Anaerobic probiotic ZAD® doses had no significant effects on the percentages of heart and kidney. However, the total edible parts percentage has been augmented (P=0.0001) and the perirenal fat, and scapular fat percentage were decreased (P=0.0001) with increasing ZAD® doses when compared with the control treatment.

The present results are consistent with the findings of Kermauner and Struklec (1996) observed that addition of probiotic Acid-Pack-4-way on the diet of rabbit increased (P≤0.05) the dressing percentage and carcass weight. Also, Fathi et al. (2017) indicated that supplementation of dietary with probiotic compared to other dietary treatments resulted in a significantly higher percentage of dressing.

In our experiment dressing and total edible parts (%) in group 0.25 ZAD® was significantly increased by 9.12% and 9.26% rather than control group, respectively. These results are consistent with the results of Abdel-Azeem et al. (2009) who revealed that NZW rabbits (35 days aged) when received diet supplemented with 20 mg virginiamycin, 100 mg zinc bacitracin, 1.5 g bioaction (probiotic) and 3.0 g yeast culture (Saccharomycyes cerevisiae) significantly (P≤0.05) increased dressing and carcass weight percentages. However, these results were contrary to El-Sagheer and Hassanein (2014), who found that there were no significant effects of dietary Vetazyme or strain supplementation on rabbit carcass traits excluding the percentage of the liver. Also, Bhatt et al. (2017) as using probiotics (10⁷ CFU/g concentrate) Lactococcus lactis and Lactobacillus acidophilus in weaning Chinchilla rabbits diets.

Caecum activity:

The effect of oral administration anaerobic probiotic (ZAD®), on caecum performance, pH, ammonia concentration and VFA, butyric acid mmol/L, acetic acid mmol/L, and propionic acid mmol/L of growing NZW rabbits is summarized in Table (5). Caecum length (cm), full caecum weight (g), empty caecum weight (g) and caecum pH significantly varied from 40.47-49.20, from 98.85-120.00, from 25.97-28.87 and
from 5.73-6.59, respectively. The higher significant averages of caecum length (cm) and caecum pH were recorded for rabbit received oral administration of 0.25 ZAD®. However, higher significant averages of full and empty caecum weight (g) were recorded for rabbit received oral administration of 0.5 ZAD®. The opposite trends was observed by ammonia mmol/L where it was significantly decreased (P=0.0001) with increasing oral doses of anaerobic probiotic ZAD®.

Table (5): Effect of anaerobic probiotic ZAD® oral administration on caecum pH and volatile fatty acids (VFA) of growing rabbits.

| Item                     | Treatment | Control | 0.25 ml ZAD®/rabbit/day | 0.5 ml ZAD®/rabbit/day | 1.0 ml ZAD®/rabbit/day | SEM# | P-value² |
|--------------------------|-----------|---------|-------------------------|------------------------|------------------------|------|----------|
| Caecum length (cm)       |           | 40.47c  | 49.20a                  | 48.69ab                | 48.30b                 | 0.14 | 0.0001   |
| Full caecum weight (g)   |           | 98.85b  | 116.67a                 | 120.00ª                | 105.00b                | 1.55 | 0.0007   |
| Empty caecum weight (g)  |           | 25.97b  | 27.33ª                  | 28.87ª                 | 27.35ª                 | 0.42 | 0.0182   |
| Caecum pH                |           | 5.73c   | 6.59ª                   | 6.44ª                  | 6.17ª                  | 0.09 | 0.0009   |
| Amonia (mmol/L)          |           | 13.38ª  | 11.59b                  | 10.54ª                 | 9.67ª                  | 0.24 | 0.0001   |
| VFA (mmol/L)             |           | 51.62c  | 64.34ª                  | 71.80ª                 | 70.25ª                 | 3.89 | 0.05     |
| Butyric acid (mmol/L)    |           | 9.14ª   | 10.23ª                  | 10.30ª                 | 10.15ª                 | 0.17 | 0.0171   |
| Acetic acid (mmol/L)     |           | 50.40ª  | 68.95ª                  | 67.09ª                 | 65.49ª                 | 0.40 | 0.0001   |
| Propionic acid (mmol/L)  |           | 5.02ª   | 6.47ª                   | 6.23ª                  | 5.94ª                  | 0.08 | 0.0001   |

SEM= standard error of the mean.

Means within a row having different superscripts are significantly different (P≤0.05).

Compared with the control group, the VFA mmol/L, butyric acid mmol/L,acetic acid mmol/L, and propionic acid mmol/L were significantly increased at every administration of anaerobic probiotic ZAD® dose.

The caecum is the rabbit's largest digestive part (forty percent of the entire digestive tract). As a major fermentation site (e.g., degradation of fiber), it acts as a key role in digestion. The present study showed that all rabbits intake orally ZAD® tends to increase a significant improves in caecum performance and activity. In this connect, Abdel-Aziz et al. (2014) found that feeding rabbits with Lactobacillus acidophilus diet insignificantly decreased the alimentary tract weight (empty) as a percentage of the total body weight than those fed the control diets. Caecum pH is affected by VFA and ammonia resulting from degradation and fermentation of caecal. Our results performed that the improvements in caecum pH amounted at 56 days of age to 15, 12.4 and 7.68% for groups 0.25, 0.5 and 1.0 ZAD®, respectively. The content of caecum is somewhat acidic (pH 5.4–6.8) (Garcia et al., 2002). Processes of fermentation result in VFA production, butyric acid, acetic acid, propionic acid and ammonia (NH₃) obtained from proteolysis, while, the VFA and NH₃ are absorbed via the colon and caecum walls and are a source of energy for the host.

In this results, caecal ammonia concentrations was reduced (P=0.0001) by 15.44, 27 and 37.1% for rabbits intake orally 0.25, 0.5 and 1.0 ZAD®, respectively.
The concentration of VFA in the rabbit caecum is around 75% acetate, 15% and 10% butyrate propionate (Bellier et al., 1995). The high total VFA concentration produced from the caecal content of rabbit's oral intake ZAD® probiotics indicates high available energy that affected growth performance. The concentration of acetic acid generated from the caecum content of rabbit's administration orally ZAD® there were also higher numeric values for probiotics. This agreed with previous findings Gado et al. (2017) who showed that inclusion of the ZADO® treatment has been increased (P≤0.05) the rumen ammonia N and total VFA concentrations before and 3 h post-feeding.

**Bacterial load:**

Table (6) shows the total number of different microbial counts grown on different media as affected by the different oral administration with three doses of 0.25, 0.5 and 1.0 ZAD® comparing with control diet of NZW growing rabbits.

| Item                  | Control 0.25 ml ZAD®/rabbit/day | 0.5 ml ZAD®/rabbit/day | 1.0 ml ZAD®/rabbit/day | SEM* | P-Value² |
|-----------------------|---------------------------------|------------------------|------------------------|------|----------|
| Total bacterial       | 4.75a                           | 3.7b                   | 3.1b                   | 2.91b| 0.13     | 0.0001  |
| Total coliform        | 3.4a                            | 3.01ab                 | 2.79b                  | 2.61b| 0.10     | 0.005   |
| Total anaerobic       | 1.91a                           | 1.42ab                 | 1.09b                  | 0.91b| 0.29     | 0.0015  |
| *L. acidiophilus*     | 0.85b                           | 1.75a                  | 1.99a                  | 2.31a| 0.14     | 0.0179  |
| *L. cellobiosus*      | 1.41b                           | 1.89a                  | 2.11a                  | 2.46a| 0.09     | 0.015   |

*SEM= standard error of the mean.
²a,b Means within a row having different superscripts are significantly different (P≤0.05).

Colonies grown on plate count agar ranged between 2.91x 10^5 and 4.75 x 10^5 cfu/ml as the percentage of anaerobic probiotic ZAD®, decreased the total microbial count.

Colonies appeared on Mckoney agar ranged from 2.61 x 10^5 for 1.0 ZAD® to 3.4 x 10^5 cfu/ml for 0.0 ZAD®. Similar to total microbial count as the amount of ZAD®, the number of coliform group decreased.

The total number of anaerobic bacteria was less than those of total microbial count and coliform group but they have the same trend of decreasing the number as the dose of ZAD® increased. The total number of anaerobic bacteria was ranged between 0.91x 10^5 and 1.91 x 10^5 cfu/ml.

Fermentation of lactobacilli as *L. acidiophilus* and *L. cellobiosus* take opposite trend as the dose of ZAD® increased the *L. acidiophilus* and *L. cellobiosus* number increased. It was ranged from 0.85x 10^5 and 2.31x 10^5 cfu/ml and 1.41x 10^5 and 2.46x 10^5 cfu/ml, respectively.

**Isolation and identification of some colonies:**

From the four medium, 91 colonies were isolated, the number and percentages of isolates represents the different microbial counts of the caecum of NZW growing rabbits are found in Tables (7) and (8). Generally, identification were grouped into 6 groups 16 isolates were gram negative, 17 isolates were gram positive, 13 isolates were mixed strains, 19 isolates were gram positive-cocci, 10 isolates were streptococci and 16 isolates are lactobacilli group. Isolates of each bacterial group were shown at the same table as affected by the doses of anaerobic probiotic ZAD®. The highest isolates were for gram positive bacteria (19 isolates), while the lowest isolates were for mixed (contaminated). As it is expected streptococci isolates was lower than lactobacilli group. For the first 6 groups as the concentration of anaerobic probiotic ZAD®, increased the number of isolates decreased, while lactobacilli enumeration increased with the increase of ZAD®, orally
administration. This is one of the advantages of this anaerobic probiotic ZAD® administrate orally is to encourage the growth of lactobacilli which is regarded as very useful bacteria in the caecum and possibly to be addition of probiotics. Then by using the biochemical and carbohydrate fermentation testes identify type of useful bacteria (*Lactobacillus acidophilus* and *Lactobacillus cellobiosus* isolates from the caecum of rabbit), as shown in Table (9).

The adverse effects of bacterial diseases are a major concern to the rabbit production especially those dealing in economically viable species like the growing rabbits (Bagone Vantus *et al.*, 2014). Due to increased growing rabbits mortality and poor performance, farmers have turned to the use of commercial antibiotics to salvage their investments. The prolonged use of antibiotics has significant public health consequences on the environment as well as spawning antibiotic resistant pathogens (Alderman and Hastings, 1998). As an alternative, probiotic organisms have been suggested (Verschuere *et al.*, 2000). Results indicated that the total microbial, total coliform count and total anaerobic count markedly decreased with increasing doses of anaerobic probiotic ZAD®, in this respect Oso *et al.* (2013) said that rabbits consumed diets including several additives as mannan oligosaccharides (1g/ kg), *Prediococcus acidilactis* (1×10^10 cfu/ g; 0.5g/ kg), arabinoxylans oligosaccharides(1g/kg), oxytetracycline (1g/ kg), *Bacillus cereus* (1×10^9 cfu/ g; 0.5g/ kg), caused a reduction of count of coliform in their caecum content when compared to those consumed the control diet.

The opposite trend was observed in lactobacillus number that increase with addition different doses of probiotic ZAD®, as well as the lactobacilli numbers in the cecum, ileum, and the mean number in all gut segments of the rabbits fed diets including 0.5×10^6 cfu/g *B. subtilis* plus 0.5×10^7 cfu/g *L. acidophilus* or 1×10^7 cfu/g *L. acidophilus* were higher (P≤0.001) than those of rabbits fed diets including 1×10^6 cfu/g *B. subtilis*, or those have no probiotic in their diet (Phuoc and Jamikorn 2017). In a rabbit, Foster *et al.*, (1980) found that the model of *E. coli* enterotoxin-induced diarrhea and injected the infected ileal loops with a *Lactobacillus*-containing preparation the results was a significant anti-enterotoxin response.

From the four medium, 91 colonies were isolated, the highest isolates were for gram positive bacteria (17 isolates), while, the lowest isolates were for mixed (contaminated). As it is expected streptococci isolates (10 isolates) was lower than lactobacilli group. Results obtained those lactobacilli enumeration increased with the increase of anaerobic bacteria of ZAD® oral administration. This is one of the advantages of this anaerobic bacteria mixed enzymes is to encourage the growth of lactobacilli which is regarded as very useful bacteria in the caecum and possibly to be a member of probiotics.

| Item                  | No   | %    | Control | 0.25 ml ZAD®/rabbit/day | 0.5 ml ZAD®/rabbit/day | 1.0 ml ZAD®/rabbit/day |
|-----------------------|------|------|---------|-------------------------|------------------------|------------------------|
| Gram negative bacteria| 16   | (17.6)| 4       | 4 (16.7)                | 3 (15.8)               | 5 (20)                |
| Gram positive bacteria| 17   | (18.7)| 5       | 3 (12.5)                | 3 (15.8)               | 6 (24)                |
| Mixed (contaminated)  | 13   | (14.3)| 3       | 4 (16.7)                | 3 (15.8)               | 3 (12)                |
| Gram positive coeci   | 19   | (20.9)| 5       | 6 (25)                  | 4 (21.1)               | 4 (16)                |
| Streptococci          | 10   | (11) | 4       | 2 (8.3)                 | 2 (10.5)               | 2 (8)                 |
| Lactobacilli          | 16   | (17.6)| 2       | 5 (20.8)                | 4 (15.8)               | 5 (16)                |
| Total                 | 91   | (100)| 23      | 24 (21.2)               | 19 (21.1)              | 25 (20)               |
Table (8): Identification of bacteria *Lactobacillus acidophilus* and *Lactobacillus cellobiosus* isolates from the caecum of NZW growing rabbit intake orally by different doses of anaerobic probiotic ZAD.

| CODE      | Lactobacillus acidophilus | Lactobacillus cellobiosus |
|-----------|---------------------------|---------------------------|
| Arabinose | V                         |                           |
| Glucose   | + without gas production  | +                         |
| Lactose   | +                         | V                         |
| Maltose   | +                         | +                         |
| Sorbitol  | +                         | V                         |
| Sucrose   | +                         | V                         |
| Malate    | V                         | +                         |
| Mannitol  | V                         | +                         |
| Mannose   | V                         | +                         |
| Trehalose | V                         | +                         |
| Dextrose  | +                         | +                         |
| Salicin   | +                         | V                         |
| Fructose  | +                         |                           |

(+)= Positive, (-)= Negative; NR = Not recognized; V= Variable; VP = Voges-Proskauer Test

Table (9): Carbohydrate fermentation by *Lactobacillus acidophilus* and *Lactobacillus cellobiosus* isolates from the caecum of NZW growing rabbit intake orally by different doses of anaerobic probiotic ZAD.

| Test          | Lactobacillus acidophilus | Lactobacillus cellobiosus |
|---------------|---------------------------|---------------------------|
| Color         | Yellow                    | Yellow                    |
| Shape         | Rods                      | Rods                      |
| Gram stain    | +                         | +                         |
| Oxidative     | +                         | +                         |
| Catalase      | -                         | +                         |
| Citrate, Simmons | NR                    | V                         |
| Gelatinase    | NR                        | +                         |
| Indole        | +                         | V                         |
| Motility      | -                         | +                         |
| VP            | -                         | +                         |
| H₂S           | -                         | V                         |
| Urease        | +                         | +                         |
| Methyl Red    | -                         | -                         |

(+)= Fermented, (-)= Not fermented; V= Variable

**Serum blood biochemical components:**

Table (10) displayed that the effect of anaerobic probiotic oral administration (ZAD®) on some serum biochemical blood parameters of growing NZW rabbits. Serum biochemical components data indicated that the serum TP, A, G, and A/G concentration of rabbits received anaerobic probiotic (ZAD®) groups were significantly augmented compared to those group of control. Increased TP and A of growing rabbits received anaerobic probiotic (ZAD®) oral administration was an indication of the relatively good quality of protein and the dietary protein level and availability. Additionally, TP and A were also within healthy rabbit ranges (Ajayi and Raji, 2012). This refers to the anaerobic probiotic was improved relatively dietary protein quality and availability. Higher TP and A values within a normal range obtained from the rabbits received 1.0 ZAD® groups indicates that the high ZAD® level was safe and beneficial. The protein and globulin are the part of immunity components that albumin-based antibodies are the main protein component of serum which synthesized in the hepatic tissues, which acts the response of humoral immune and that could support the
augmentation of immune organs. Accordingly, in the current study, findings of globulin in serum are supported by Gao et al. (2007), who recommended that supplementing xylanase to wheat-based cockerel diets from 7 to 21 d of age augmented the response of humoral immune. The functions of albumin include regulation of the distribution of extracellular fluid, and transport agent of many substances as bilirubin, fatty acids, hormones, and vitamins (Attia et al., 2015). These results, in turn, affected the A/G ratio as in the other treatment groups it descended from 0.966 in the control to 0.843 to 0.887. The reduction in the A/G ratio may indicate an augment in the immunity of rabbits.

Serum levels of cholesterol, LDL, vLDL, triglycerides, total lipids, and LDL/ HDL ratio were significantly decreased (P<0.05) with augmenting levels of anaerobic probiotic oral administration. But, the HDL/total cholesterol and HDL/LDL ratio augmented significantly (P<0.001) with anaerobic probiotic oral administration (ZAD®) levels. The results revealed a significant enhancement in good cholesterol (HDL) and HDL: LDL ratio from (3.28 to 7.54% and 0.15 to 7.68%) with ZAD ®, respectively. Hermansen et al. (2003) stated that the ratio of LDL: HDL ratio is a robust heart events predictor. Findings (Table 10) showed that the LDL: HDL ratio decreased by 0.07% to 7.1% with anaerobic probiotic oral administration (ZAD®) levels. The current experiment has shown a positive effect on the decrease of serum lipid metabolites from anaerobic probiotic oral administration (ZAD®), indicating that supplementation of enzymes could play a role in the metabolism of rabbit. The results showed significant improvement in good cholesterol from 3.28 to 7.54% lipids. Regrettably, slight reports on the influences of enzyme supplementation on blood lipid metabolites in rabbit diets published. By supplementing enzymes, it can inhibit the merger of 14C-labeled acetate to the non-saponifiable lipid fraction and therefore decrease the biosynthesis of lipid profiles and /or may have indirect inhibitory effects in the lipid biosynthesis enzyme hydroxymethyl-glutaryl coenzyme-A reductase levels (Fukushima and Nakano, 1995). This would indicate to the anaerobic probiotic oral administration of rabbit could reduce the lipid profile of serum, and thus aiding to reduce total cholesterol deposition in the muscles and skin. This also means the possibility of incorporating the anaerobic probiotic oral administration (ZAD®) which will lead to products of an animal with the decreased cholesterol. The decline in rabbit serum cholesterol levels received anaerobic probiotic oral (ZAD®) is likely to indicate an overall decline in the mobilization of lipid.

With respect to kidney functions; creatinine (mg/dl) and urea (mg/dl) were not significantly affected by ZAD® (P>0.05) and noted that numerical reduction creatinine and urea value for 0.25 and 0.50 ZAD® groups, respectively. That refers to the ZAD® levels were safe and healthy.

With regard to liver function stated as ALT and AST enzymes of serum, the data documented in Table (10) obviously reveal were significantly decreased (P<0.05) with augmenting levels of anaerobic probiotic oral administration. Serum liver enzymes activities values (ALT and AST) in the current trial are within the normal range (Ajayi and Raji, 2012). Levels of serum ALT and AST activity are those commonly utilized specifically to diagnose domestic animal hepatic damage and are utilized to detect bile obstruction (i.e. mild and progressive liver damage) (McGill, 2016). That none of these blood metabolites changed between groups received ZAD® and that they all fell within normal ranges for rabbits insinuate that no liver damage had occurred. Rabbits, particularly those receiving the high level of ZAD® at this experiment, indicated no clinical signs of toxicity or signs of morbidity, additional the high level of ZAD® (1 ml each day) was safe and healthy.

Liong and Shah (2005), Sudha et al. (2009), Ooi and Liong (2010), and Abdelhady and El-Abasy (2015) stated alike results. They assumed that the microorganism probiotic effect on lipid metabolism as some microorganisms such as Lactobacillus and Bifidobacterium pose activity of bile salt hydrolase and cholesterol merger or combining to bacteria, and probiotic bacteria creating short-chain fatty acids. Likewise, decrease serum cholesterol of broiler chickens supplemented with probiotic diet may be ascribed to lower synthesis and/or cholesterol absorption in the gut (Mohan et al., 1995&1996 and Safaa, 2013).

CONCLUSION

The present study concludes that anaerobic probiotic ZAD® positively improved growth performance and mortality of NZW rabbits as well as improved the nutrient digestible coefficient and nitrogen balance. In addition, this study found that the optimum rate of probiotic ZAD® in the rabbit practical intake orally is 0.25 or 0.5 ml/rabbit as growth promoter for rabbits without any adverse effects on rabbit growth and increase the concentration of Lactobacillus number in the caecum. As well as the enhancement of some blood biochemical parameters such as decline the lipid profile of serum.
Table (10): Effects of ZAD® supplement on some blood biochemical parameters of growing rabbits.

| Item                      | Treatment          | Control 0.25 ml ZAD® /rabbit/day | 0.5 ml ZAD® /rabbit/day | 1.0 ml ZAD® /rabbit/day | SEM* | P- value* |
|---------------------------|--------------------|----------------------------------|-------------------------|-------------------------|------|-----------|
| Serum protein metabolites:|                    |                                  |                         |                         |      |           |
| Total protein (mg/dl)     |                    | 5.34c                           | 6.15b                   | 6.75ab                  | 7.14a| 0.38      | 0.041    |
| Albumin (mg/dl)           |                    | 2.58c                           | 2.89b                   | 3.13ab                  | 3.32a| 0.16      | 0.032    |
| Globulin (mg/dl)          |                    | 2.67c                           | 3.26b                   | 3.62a                   | 3.82a| 0.13      | 0.007    |
| Albumin / Globulin        |                    | 0.966a                          | 0.887b                  | 0.865bc                 | 0.843c| 0.81      | 0.052    |
| Serum lipid metabolites:  |                    |                                  |                         |                         |      |           |
| Total lipid (mg/dl)       |                    | 250.56a                         | 214.82b                 | 212.13b                 | 211.82b| 12.21    | 0.010    |
| Triglyceride (mg/dl)      |                    | 76.81c                          | 62.14b                  | 59.58b                  | 56.73b| 4.87      | 0.050    |
| Total cholesterol (TC mg/dl) |              | 67.41c                          | 62.00b                  | 58.95bc                 | 55.3c| 3.13      | 0.031    |
| HDL (mg/dl)               |                    | 20.53c                          | 19.56ab                 | 18.92b                  | 18.12b| 2.03      | 0.050    |
| LDL (mg/dl)               |                    | 31.52c                          | 30.01ab                 | 28.11b                  | 25.84c| 2.86      | 0.051    |
| vLDL (mg/dl)              |                    | 15.36c                          | 12.43b                  | 11.92b                  | 11.34b| 1.81      | 0.020    |
| HDL / TC ratio            |                    | 0.303b                          | 0.315a                  | 0.321b                  | 0.328b| 0.02      | 0.001    |
| LDL / TC ratio            |                    | 0.468c                          | 0.484a                  | 0.477b                  | 0.467c| 0.04      | 0.053    |
| HDL / LDL ratio           |                    | 0.651c                          | 0.652c                  | 0.673b                  | 0.701c| 0.05      | 0.031    |
| LDL / HDL ratio           |                    | 1.535c                          | 1.534a                  | 1.486b                  | 1.426b| 0.59      | 0.022    |

kidney function:

| Creatinine (mg/dl)        |                    | 0.61                            | 0.60                    | 0.59                    | 0.63  | 0.04      | 0.178    |
| Urea (mg/dl)              |                    | 60.56                           | 58.38                   | 59.76                   | 61.22 | 2.79      | 0.954    |

Liver function:

| ALT (IU)                  |                    | 37.13c                          | 30.26b                  | 29.17b                  | 28.31b| 0.29      | 0.0467   |
| AST (IU)                  |                    | 68.21c                          | 58.83b                  | 56.31b                  | 54.36b| 0.63      | 0.0317   |

*SEM= standard error of the mean; a,b,c Means within a row having different superscripts are significantly different (P≤0.05). HDL= High density lipoproteins; LDL= Low density lipoproteins; vLDL= very low-density lipoproteins; AST= Aspartate aminotransferase; ALT= Alanine aminotransferase.

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نمو الأرانب، خصائص الدهنة، الهضم، تخمرات الأعور، الميكروفلورا، وبعض مكونات الدم البيوكيميائية المتأثرة بتناول البروبيوتيك (ZAD) تجريغ بالفم

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يهدف البحث الحالي إلى دراسة تأثيرات الجرعات المتعددة لتناول الفم بالبروبيوتيك اللاهوائي (ZAD) على اداء النمو، وخصائص الدجاج، ومعامل الهضم، ونشاط الأعور، والميكروفلاوريا، وبعض المكونات البيوكيميائية لدم لدى الأرانب النامية. تم توزيع فئة (NZW) وتماماً من تكزير الأرانب المقطومة بعد 6 أسابيع (متوسط وزن الجسم 539.87 ± 13.35 جم) من نوع البوليزيدي أبيض (ZAD). تقلب المجموعة الضابطة على طريقة الفم ونوع الماء، والمكونات الجذعية الجذعية.  كانت المجموعة الضابطة على طريقة الفم 0.5 مل، و ZAD 0.25 مل. تناولت الفئة التجريبية لمدة 8 أسابيع. تحسن معايير التحكم الغذائية وزيادة وزن الجسم وأقل معدل الوفيات بالمجموعات 0.25 و 0.5 ZAD بالإضافة إلى ذلك، تحسن معايير التحكم الغذائية، وانخفاض الفقدان (P≤0.001) بالأجزاء الأخرى المكونة من المجموعة الضابطة. (ZAD) 0.25 مل أمام الفم و ZAD 0.5 مل. نتائج البحث تدل على فعالية استخدام الفم بالبروبيوتيك في تحسين حالة الأرانب، وزيادة معدلات النمو، وانخفاض الفقدان. 

الكلمات المفتاحية: ZAD