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IMPACT OF PROBIOTIC SOURCES ON PRODUCTIVITY, PHYSIOLOGICAL RESPONSE, AND INTESTINAL HISTOLOGY OF GROWING RABBITS UNDER SUMMER CONDITIONS

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ABSTRACT: *Eighty weaned Alexandria line male rabbits, about 5 weeks old with an average body weight of 575.4±85.7 g, were randomly distributed into four experimental groups of 20 rabbits each and 5 replicates per treatment (4 rabbits each), fed a basal diet and drinking tab water without additives (Control rabbits, C); 2nd (T_1), 3rd (T_2), and 4th (T_3) groups received drinking tab water supplemented with different probiotic sources at 1 ml of Grow star, 0.5 ml of FIDAL, and 1 ml of effective micro-organisms (EM1) of the additives mixture per liter, respectively. Experimental period was lasted for 5 weeks until 10 weeks of age.*

These results showed that a significant increase in body weight and body weight gain of T_2 and T_3, while feed intake was a significantly increased in T_3 as compared to other groups. However, feed conversion ratio mathematically decreased in T_1 and T_2 groups, while performance index mathematically improved in T_2 and T_3. Carcass traits and different parts of carcass did not affected by treatments, except head as % and shoulders as %, where those were decreased significantly ($P \leq 0.05$) in T_2 and T_3 groups when compared to control group. Plasma levels of calcium and phosphorus concentrations were higher of rabbits given Grow Star (T_1) group than other group's rabbits. Ileum and caecum were more developed in the T_3 group, as noted by increasing villi height and the thickness of the tunica muscular and serosa layer. Also, the number of caecal crypt glands was increased significantly in T_3 compared to other treatments. Rabbits received FIDAL 0.5 ml or EM1 1 ml/liter of drinking water had significantly ($P \leq 0.05$) higher economic efficiency in compared to other groups.

Conclusively, *from these results it could be concluded that using 0.5 ml/l FIDAL or 1 ml/l of effective* *micro-organisms (EM1) as a water supplementation in rabbits drinking water can be improve productive performance and increase feed utilization without any negative effect on carcass traits and achieve good relative economic efficiency, during summer season. Using Grow Star 1 ml/l of drinking water improved FCR and increased calcium and phosphorus in plasma.*

Key words: Blood, carcass, economic efficiency, probiotics, productive performance, rabbits.

INTRODUCTION

Studies have found that average mortality rate in rabbits of 24%, achieved from suckling and newly weaned rabbits because they are more sensitive to intestinal infection. A bout 18% of mortality was related to diarrhea that may be related to the imbalance of microflora that can lead to alteration of pH and proliferation of pathogens in growing rabbits, which often leads to finally death (Falcão-e-Cunha *et al*., 2007; Combes *et al*., 2011 and Bauerl and Collado 2014).

The establishment of healthy stable and diverse digestive tract microflora is great significance for rabbits to resist intestinal diseases. Several studies have shown that supplementation of rabbit diets with certain 'probiotic' organisms activates immune and metabolic pathways that restore tissue homeostasis and promote overall health (Litonjua and Weiss, 2007; Floch *et al.*, 2011 and Ravel *et al.*, 2011).

Probiotics are defining as a live microbial feed supplement that beneficially affects the host animal (FAO/WHO, 2002). Probiotics can be reducing early mortality, improves feed conversion ratio, activity of digestive enzymes and make balance of bacteria in the digestive tract (Soomro *et al.*, 2019 and Rehman *et al*., 2020).

The strain microorganisms can be using as probiotics are *Lactobacillus bulgaricus, Lactobacillus plantarum, Bifidobacterim bifidum, Streptococcus thermophils, Aspergillus oryzae, etc*. (Khaksefidi and Rahimi, 2005).

Hegab *et al.,* (2019) reported that using probiotics in rabbit as orally supplementation (*Saccharomyces cerevisiae*) 0.5, 1 and 1.5 g per liter of drinking water; *Lactobacillus acidophilus* (1, 2 and 3×10^9 CFU/ kg) under heat stress condition can be increasing live body weight in all tested groups against control. Also, Youssef, *et al.,* (2018) found that growth rates improved significantly in rabbits that were given water supplemented with 700 ppm nitrate plus1000 ppm probiotic. As well, El-Dimerdash *et al.* (2011) investigated that using probiotics in rabbit's drinking water improved

the growth rate in infected (*E. coli)* and un-infected rabbits in compared to control group. Also, Abdelhady and Abasy, (2015) found that probiotics improved live body weight and gut health for rabbit infected by *Pasteurella multocida*. Abd-El-Hady (2014) reported that using probiotic of rabbit diets at 300 g and 400 g/ton feed showed increased in average body weight at 10 week of age in compared to control.

Therefore, the objective of this study was evaluating the effects of different probiotic sources as drinking water supplementation on productivity and physiological responses of Alexandria growing rabbits under summer conditions.

MATERIALS AND METHODS

Animal and diets

This experiment was carried out at private rabbit's farm, Qalyubia Governorate, Egypt during June to August 2021 (summer season). Experimental design and protocol within this study were conducted according to ethical guidelines approved by the Experimental Animal Care and Research Ethics Committee of Ain Shams University, Agriculture Sector Committee (Approval No 5-2023-5).

Eighty weaning Alexandria line male rabbits aged 5 weeks with average initial weight 575.4±85.7 g were randomly distributed to four experimental groups (20 each) of five replicates (four rabbits per replicate). The experimental period lasted for 5 weeks until 10 weeks of age. The basal diet composition was formulated to cover all essential nutrient requirements for growing rabbits according to NRC (1977). Feed was allowed to a standard pelleted diet all times containing 17% crude protein, 2.56% crude fat, 13% crude fiber and contains 2530 Kcal/kg-ration digestible energy (DE). Fresh tab water was offered all times. Animals were kept under similar managerial and hygienic conditions and were healthy and clinically free of external and internal parasites. The lighting program provided was 16 hrs of light per day including natural light during period from 5 to 10 weeks of age.

The study aimed to investigate the effect of using three different products of probiotics (Grow star®, FIDAL® and EM1®) in drinking water supplementation in rabbit's as follow:

C, received drinking water without additives (control group)

T_1, received 1 ml/l water of Grow star

T_2, received 0.5 ml/l water of FIDAL

T_3, received 1 ml/l water of EM1

Grow Star®, each one liter contains (Vit. A 500000 IU, Vit D_3 100000 IU, Vit. E 100 mg, Vit. B_6 1000 mg, vit. B_3 2500 mg, Vit. K_3 250 mg, *Bacillus sutillis* 1.25×10^{11} CFU, *Bacillus lichinoforms* 1.25×10^{11} CFU, zinc oxide 800 mg, sodium phosphate 500 mg, cupper 700 mg, cobalt 10 mg, Methionine 500 mg, Ferric citrate 1500 mg, Selenium 150 mg and Lysine 1500 mg), which manufacturing by Almotaheda Vet., Borg El-Arab City, Egypt.

FIDAL®, each one liter contains anaerobic bacteria (*Ruminococcus Flavefaciens SP*.) 20×10^{12} CFU, which manufacturing by Bactizad for feed additives, Cairo, Egypt.

EM1® is abbreviation of Effective Micro-organisms®, it contains about 80 natural kinds of micro-organisms and not genetic modification conclude (Photo trophic bacteria, Lactic acid bacteria, Saccharomyces spp, Actinomyces and Fermentative Fungus), produced by Ministry of Agriculture, Egypt. Drinking water of rabbits was supplemented with Grow Star (0.01%), FIDAL (0.05%) or EM1 (0.1%) for T_1, T_2 and T_3 groups, respectively.

Averages of ambient temperature (AT, °C), and relative humidity (RH, %) were daily recorded, then, the temperature humidity index (THI units) was calculated using the equation proposed by Marai *et al*., (2001) as follow:

$$\mathbf{THI = db\ ^{\circ}C - [(0.31 - 0.31 \times RH\%) \times (db\ ^{\circ}C - 14.4)]}$$

Where: db °C= Dry bulb temperature in celsius, RH% =Relative humidity percentage. The values obtained are then classified as absence of heat stress (<27.8), moderate heat stress (27.8-28.8), severe heat stress (28.9-29.9) and very severe heat stress (≥30.0).

Carcass traits

At the end of experimental period (10 weeks of age), 6 rabbits from each group were randomly taken, at the mean of live body weight (LBW) for slaughter procedure. After complete exsanguination, the carcass was weighed again and the difference between the pre-slaughter weight and weight after exsanguination was considered as the blood weight. The liver, heart, and carcass cuts (shoulders, legs, thorax, and loin) have recorded and express as relative to LBW at processing.

Samples from the ileum and caecum (six samples for each group, 5 cm each) were carefully dissected during the slaughter time, rinsed with saline solution (0.9% NaCl), and fixed in a 12% formalin solution. Thin transverse sections (4-5 micron) were cut using standard paraffin embedding procedures and mounted on glass slides, stained with the ordinary hematoxylin and eosin stain (H&E) according to Bancroft and Stevens (1990). The histological technique was performed at the Pathology Laboratory, National Cancer Institute, Cairo University, Egypt. Histological sections were examined by using a routine light microscope (OPTIKA, Model B-193) provided with a digital microscope camera (OPTIKA, Model C-B) under magnification powers of x10 and x40.

Blood parameters

At the age of 10 weeks, blood samples (3 ml each) were collected between 8.00 and 9.00 hr a.m. from the marginal ear vein of individual rabbits of random sample of 5 rabbits per group into heparinized under vacuum tubes. Non-coagulated blood samples were centrifuged at 3,000 rpm for 15 min, and the clear plasma was isolated and stocked frozen at −20 °C until biochemical analysis. Using commercial diagnosing kits provided by a bio-diagnostics business in Egypt, some biochemical parameters of plasma were calorimetrically measured such as total protein, albumin, triglycerides, cholesterol, AST, ALT, calcium and phosphorus.

Statistical analysis:

Statistical analysis of experiment was conducted using the general linear model (GLM) procedure of base SAS® (SAS instituted, 2002). Factors test using one way ANOVA according to Snedecor and Cochran (1982).

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

Where Y_{ij}= is the effect of the observation, μ = overall mean, T_i = the effect of i^{th} treatments and e_{ij}= random error.

Means were compared using Duncan´s range test (Duncan, 1955).

RESULTS AND DISCUSSION

Heat stress index

Averages of AT, RH% and THI units during the whole experimental period are shown in Table 1. The THI values clearly indicated that rabbits were exposed to moderate heat stress (28.8). It was suggested that the optimal temperature humidity index for the rabbit husbandry is 27.8 according to Marai *et al.,* (2001).

Productive performance:

Table 2 showed the effects of probiotics supplementation in rabbit's drinking water on ILBW, FLBW, BWG, FI, FCR and PI. The results showed that FLBW and BWG significantly increased (P≤0.01) in T_2 and T_3

Table 1. Averages of ambient temperature (AT, °C), relative humidity (RH%) and temperature humidity index (THI units), during experimental period

Months	AT (°C)	RH (%)	THI (Units)
June	29.6 ± 0.52	69.3 ± 0.61	28.2 ± 0.57
July	29.8 ± 0.51	71.0 ± 0.57	28.4 ± 0.56
August	31.6 ± 0.55	68.5 ± 0.68	29.9 ± 0.55
Average	**30.3 ± 0.53**	**69.6 ± 0.63**	**28.8 ± 0.56**

Table 2. Effects of the addition of different types of probiotics in drinking water on the productive performance of growing rabbits

Items	Different Probiotics Sources (ml/l)				SEM	Sig.
	Control	T_1	T_2	T_3		
ILBW	594.00	567.80	573.00	566.67	**85.72**	**NS**
FLBW	1710.00[c]	1707.00[c]	1795.00[b]	1861.67[a]	**91.93**	**
BWG	1112.50[c]	1139.20[c]	1217.13[b]	1303.89[a]	**95.33**	**
FI	4299.78[b]	4229.00[b]	4315.33[b]	4903.72[a]	**567.97**	**
FCR	3.81	3.71	3.57	3.84	**0.57**	**NS**
PI	46.28	46.08	50.84	50.45	**7.55**	**NS**

a,b Means in the same row with the same letters are not significantly different.
SEM: Mean standard error NS: Non-significant, *: (P≤ 0.05) and **: (P≤ 0.01). ILBW: initial live body weight; FLBW: Final live body weight; BWG: Body weight gain; FI: Feed intake; FCR: Feed conversion ratio and PI: performance index.

groups (105 and 108%, respectively) in compared to control group. These results might be related to the increase in feed intake and the improving of microflora status in digestive tract of treated growing rabbits due to increase the utilization of feed.

The same results achieved by Chrastinova *et al.*, (2010) who observed that application of probiotic strain *E. Faecium* AL41 strain (10^9 CFU/ml/animal/day) had highest body weight gains than that of control. Also, Simonova *et al.*, (2015) reported that administration of *Enterococcus faecium* CCM7420 (5.0×10^8 CFU/animal/day) to rabbits may improve weight gain due to better utilization of feed and larger absorption surface in the gut and also may positively influence the health status via enhancing the gut health in rabbits. Furthermore, Oyedeji *et al.*, (2008) reported that supplementing diets with 200, 250 and 300 mg/kg of *S. cerevisiae* (Levucel SB) resulted in an increase in total body weight gain. Also, El-Sawy *et al.*,

(2021) who found that *S. cerevisiae boulardii* improved LBW and BWG when supplemented 200 or 400 g/ton diet for growing rabbits.

Feed intake was increased significantly (P≤0.01) in T_3 group as compared with other groups. This result might be related to that EM1 increased appetite as a result of it contains effective micro flora which may produce some enzymes that break down complex organic matter, so increases the feeling of hunger.

This result agreement with observed by Hegab *et al.*, (2019) who used two kinds of probiotics (*Saccharomyces cerevisiae*) 0.5, 1 and 1.5 g and *Lactobacillus acidophilus* 1, 2 and $3×10^9$ CFU/kg body weight as orally and concluded that daily feed intake increased significantly with rabbits get *L. acidophilus* in high dose compare with other experimental groups. Also, Phuoc and Jamikorn (2017), who concluded that supplementation of *L. acidophilus* alone or combined with *B. subtilis* at a partial dose, may enhance feed efficacy and growth performance, but rabbits fed only *B. subtilis* alone were not different compared with the control. Also, El-Sawy *et al.*, (2022) reported that Feed intake was improved significantly (P≤0.01) for all experimental groups fed diet supplemented with *Saccharomyces ceriveisiae bolardii* compared to control one. They suggested that addition of SCB in growing rabbits feed might enhance the growth of lactic acid fermenting bacteria in the gut and improved the food digestibility and utilization of ammonia.

Feed conversion ratio was mathematically decreased in T_1 and T_2 groups while, performance index mathematically improved in T_2 and T_3 groups in compared to control.

These results agree with what found by Ezema and Eze (2012) who noted that using *Saccharomyces cerevisiae* with bioactive yeast (probiotic) at supplementation levels of 0.08, 0.12, and 0.16 g yeast/kg in rabbit diet weren’t affected by significantly in FCR among the treatment. On the other side, Onu and Oboke (2010) showed that rabbits fed 50% maize processing waste-based diet (MPW) supplemented with 200 mg probiotic (yeast) per kg feed had significantly superior feed conversion ratio as compared control. El-Sawy *et al.*, (2022) found that PI significantly (P≤0.01) increased through all experimental groups fed diet supplemented with *Saccharomyces cerevisiae* by 10.3%, 38.7% and 92.7% comparable with control group during period from 5 to 10 weeks of age.

Carcass traits

Data presented in Table 3 showed effects of probiotics supplementation in rabbit's drinking water on carcass traits and cuts of carcass as percentages

Table 3. Effects of the addition of different types of probiotics in drinking water on carcass traits and cuts (%)

Items	Different Probiotic sources (ml/l)				SEM	Sig.
	C	T_1	T_2	T_3		
Carcass traits%						
Carcass, %	58.21	58.34	56.75	56.04	**2.86**	**NS**
Liver,%	2.75	2.92	2.78	3.04	**0.25**	**NS**
Heart, %	0.43^{a}	0.39^{ab}	0.34^{bc}	0.30^{c}	**0.02**	**
Cuts of carcass%						
Shoulders%	15.57^{ab}	16.56^{a}	14.79^{b}	14.46^{b}	**0.71**	*
Legs%	20.67	20.54	20.75	21.23	**1.05**	**NS**
Thorax%	9.80	9.06	7.84	8.28	**0.90**	**NS**
Loin%	5.92	5.55	7.26	5.93	**1.25**	**NS**

a,b Means in the same row with the same letters are not significantly different.
SEM: Mean standard error NS: Non-significant, *: (P≤ 0.05) and **: (P≤ 0.01).

of LBW. Insignificant effects of probiotics supplementations in rabbit's drinking water on carcass traits% and organs% except heart% and shoulders%, where those decrease significantly in treated groups T_2 and T_3 compared to the control group. These results might be related to the increasing of LBW in T_2 and T_3 compared with control. These results are similarity with what found by Hegab *et al.*, (2019) who reported that using probiotics in rabbits as orally supplementation hadn't effect on the percentage of edible meat among all treated groups. Also, Onbasilar and Yalcin (2008) who noted that carcass yield and weight percentages are not different among groups when they supplemented NZW rabbit diets with probiotic and anti-coccoidal for 6 weeks. Further, El-Sagheer and Hassanein (2014) studied the effect of supplementation of enzymes and probiotic (1 or 2 g/kg commercial diet) mixture (Veta-zyme) on 81 growing NZW rabbits for 6 weeks. They observed no significant differences in carcass criteria such as carcass weight, dressing and liver percentages among all treatment groups. However, Brzozowski and Strezemacki (2013) reported that the addition of *Bacillus Cereus Var. Toyoi*, as a probiotic factor in the young rabbit's diet at a level of 400 mg/kg of a probiotic preparation showed positive results during fattening and dressing percentage.

Blood parameters

Data illustrated in Table 4 shows insignificant differences in plasma TP and its fractions (ALB and GL) but globulin was higher mathematically in

T_2 and T_3 in compared to control. Liver enzymes (AST and ALT) were decreased mathematically in T_2 and T_3 in compared to control. In addition, total calcium in plasma was significantly higher in T_1 mathematically in compared to control. Same trend noticed with total phosphorus but the differences were not significant. These results are disagreement with El-Dimerdash *et al*., (2011) who investigated that using probiotics in rabbit's drinking water affected significantly on plasma total protein and its fractions in rabbits. On the other hand, triglycerides and total cholesterol were increased significantly in T_2 and T_3 in compared to control group. These results might be related to those rabbits in both T_2 and T_3 groups consumed more feed than the other treatments. These results are in similarity with what found by Sarat Chandra *et al*., (2015) who found no significant differences were observed between the cholesterol content of rabbits when fed with probiotics (*Saccharomyces boulardii 50% and Pediococcus acidilacticii 50%, 10^9 CFU/g* of feed). However, Abdelhady and El-Abasy (2015) who observed that rabbits when fed diet supplemented with probiotic

Table 4. Effects of the addition of different types of probiotics in drinking water on blood components

Items	Different Probiotic sources (ml/l)				SEM	Sig.
	C	**T_1**	**T_2**	**T_3**		
TP, g/dl	5.89	5.69	5.97	6.59	**0.87**	**NS**
ALB, g/dl	3.22	3.26	2.71	2.81	**0.41**	**NS**
GL, g/dl	2.67	2.43	3.26	3.78	**1.03**	**NS**
Tri-glycerides, mg/dl	141.69^b	159.70^b	191.83^a	196.29^a	**14.79**	**
Cholesterol, mg/dl	70.59^{bc}	76.59^b	67.82^c	110.27^a	**23.40**	*
AST, U/l	27.89	28.53	27.36	26.77	**2.67**	**NS**
ALT, U/l	36.19	34.49	35.17	34.83	**4.84**	**NS**
Calcium, mg/dl	6.41^b	13.32^a	11.63^a	11.58^a	**1.78**	**
Phosphors, mg/l	3.34	3.73	2.96	3.28	**0.70**	**NS**

a,b Means in the same row with the same letters are not significantly different. MSE: Mean standard error NS: Non-significant, *: (P≤ 0.05) and **: (P≤ 0.01). SEM: Mean standard error; TP: total plasma protein; ALB: plasma albumin; GL: plasma globulin; AST: aspartate aminotransferase activities; ALT: alanine aminotransferase activities.

(*Bio-Plus® 2B, Bacillus subtilis and Bacillus licheniformis*) reduced cholesterol and tri-glycerides significantly compared with control group. Also, total calcium of plasma increased in all treated groups compared with control group. This result might be related to that the additive of treatments increase the feed utilization also Grow star product (T_1) have high calcium content.

Histological examination

The histological examination of the ileum and caecum of rabbits is presented in Figures 1, 2, 3, and 4. The supplemented rabbit groups had regular villi shapes with an increase in the villi height (µm) either in the ileum or caecum in compared to control group. The morphological changes recorded in the intestinal mucosa (increased villus length and crypt depth) might be complementary changes to meet the increased rates of digestion and absorption mediated through the coupled activities of exogenous and endogenous digestive enzymes or due to elimination of toxic molecules and degradation of large-size diet protein.

These observations were more obviously in T_3 that treated with (EM1) microorganism's probiotics. Also, supplemented rabbits with EM1 showed an increase in the intestinal glands' numbers. Increase the number of the villi may be a direct effect on the development of the gastrointestinal tract of the treated rabbits and improvement of the absorption due to increase the absorption surface. The treated groups had an increase in the number of mucosal glands in the intestine and caecum. The addition of different types of probiotics also increases the thickness of the muscularis externa and serosa layers in the caecum. Supplemented rabbits generally had a more developed intestine and caecum. *Rumminococcus bacillus* in T_1, *Bacillus lichinoforis* in T_2, and micro-organism in later group (T_3) are classified as probiotics that have useful function on the development and absorption of GIT, these effects were reflected on the productive performance, digestibility and viability in supplemented rabbits. Many studies have suggested that the morphological changes observed in the villi area so due to transient hyper-sensitivity to antigenic components of the diet (Lalles *et al.*, 1993 and Hong *et al.*, 2004). Similarly, the improvement of intestinal morphology may be associated with the degradation of antigenic materials after enzymatic fermentation. It was reported that increased enzymatic fermentation could degrade large-size protein to small-size peptides (Kiers *et al.*, 2003 and Hong *et al.*, 2004). The improvement of intestinal mucosa morphology in rabbits supplemented by probiotics may be partially responsible for the higher growth rate obtained in treated groups in the present study compared with control.

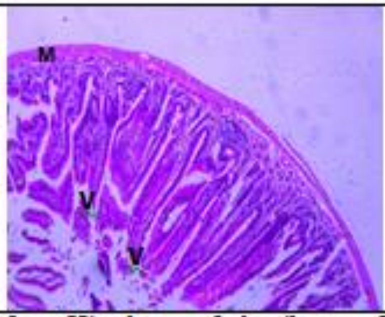

Fig. 1.a. Histology of the ileum of rabbits in the non-supplemented group showed short villi (v) and a thinner muscularis externa (M) (x 100). H&E stains

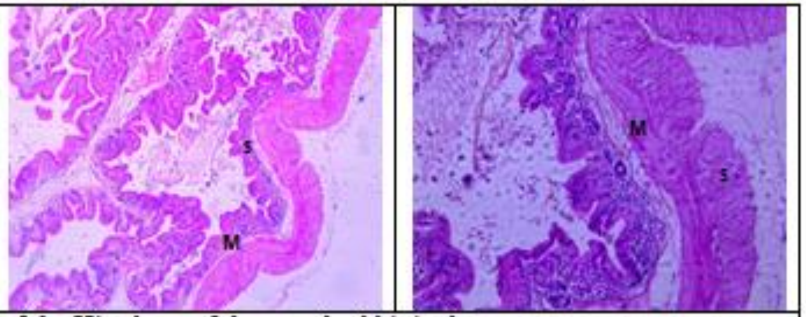

Fig. 1.b. Histology of the caecal rabbit in the non-supplemented group showed thinner muscularis externa (M) and serosa layers (S). (x 100). H&E stains

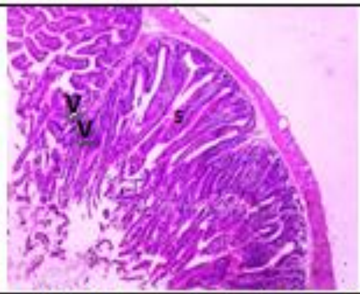

Fig. 2.a. Histology of the ileum of rabbits in T_1 showed an increase the number of villi (V) and muscularis externa thickness (S). (x 100). H &E stains.

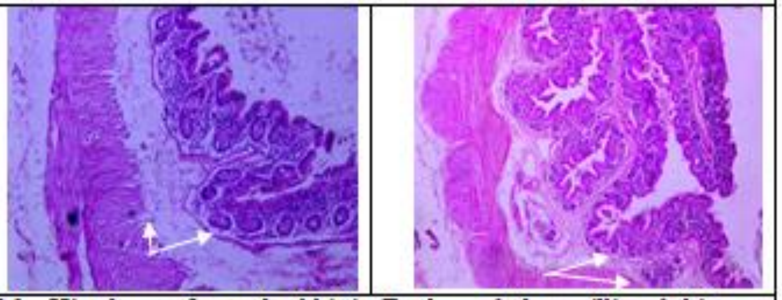

Fig. 2.b. Histology of caecal rabbit in T_1 showed short villi and thinner muscularis externa and serosa layers. Increase the caecal gland numbers (arrows) (x 100). H &E stains.

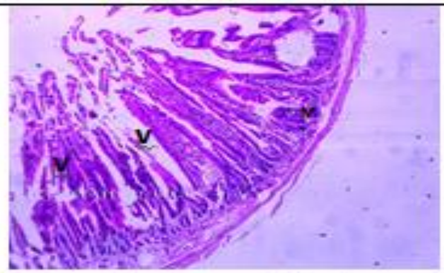

Fig. 3.a. Histology of the ileum of rabbits in T_2 showed an increase in the villi height (v) and thinner muscularis externa (M) and serosa. (x 100). H &E stains.

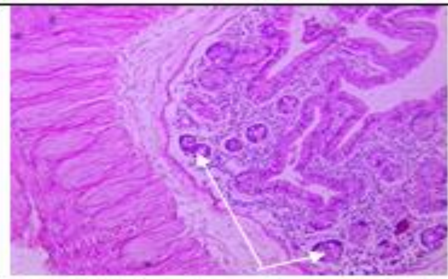

Fig. 3.b. Histology of caecal rabbit in T_2 showed short villi and thinner muscularis externa and serosa layers. Increase the caecal gland number (arrows). (x 100). H &E stains.

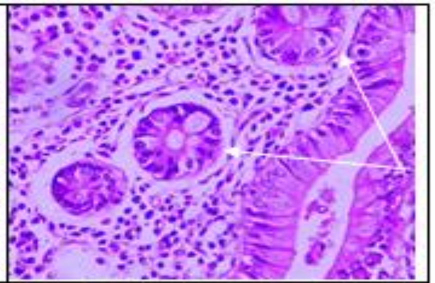

Fig. 3.a. Histology of caecal rabbit in T_2 showed an increase in the villi height and number with thicker muscularis externa. (x 400). H & E stains.

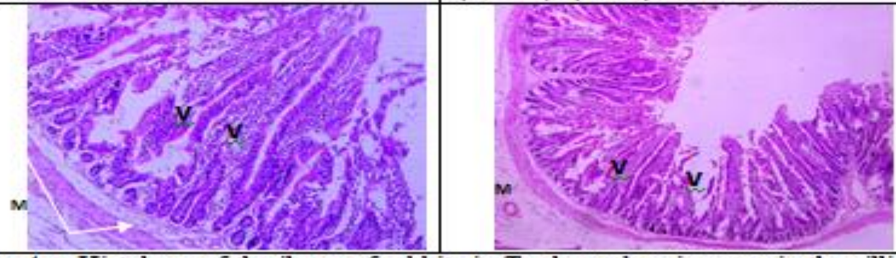

Fig. 4.a. Histology of the ileum of rabbits in T_3 showed an increase in the villi width, intestinal gland numbers (arrows) and muscularis externa. (x 100). H &E stains.

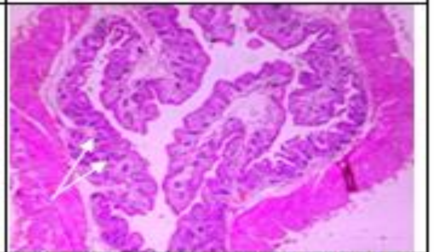

Fig. 4.b. Histology of caecal rabbit in T_3 showed short villi and thinner muscularis externa and serosa layers. Increase the caecal gland number (arrows). (x 100). H &E stains.

Economic evaluation:

The economic evaluation of using different sources of probiotic supplementation in rabbits drinking water showed that the treatment which received drinking water supplemented with 0.5 ml/l of FIDAL (T_2) achieved the best relative economic efficiency, followed by 1 ml/l of EM1 (T_3) in compared with T_1 and control groups during period from 5 to 10 weeks of age (Table 5). FIDAL (T_2) and EM1 (T_3) were significantly higher net profit and net revenue in compared to other groups. High feed consumed in T_3 and low price of EM1 may be played important role in economic efficiency compared with other probiotic sources.

Table 5. Economic evaluation of the addition of different types of probiotics in drinking water of growing rabbits, during period from 5 to 10 weeks of age

Items	Experimental groups				SEM	Sig.
	C	T_1	T_2	T_3		
Final **body weight, g (A)**	1710^c	1707^c	1795^b	1862^a	**91.9**	**
body weight price, L.E. /kg (B)	40.00	40.00	40.00	40.00		
Net profit, L.E./rabbit (C)**	68.40^b	68.28^b	71.80^{ab}	74.48^a	**8.4**	**
Total feed intake, kg (D) /5 weeks	4.29	4.22	4.32	4.90		
Price of kg feed, L.E. (E)	5.40	5.40	5.40	5.40		
Feed intake cost, L.E. (F)**	23.16^b	22.78^b	23.33^b	26.46^a	**2.6**	**
Weaned rabbits cost, L.E. (J)	25.00	25.00	25.00	25.00		
Additives cost/rabbit/35 days, L.E.	0.00	1.57	1.09	0.63		
Total cost, L.E. (H)**	48.16^b	49.35^b	49.42^b	52.09^a	**6.3**	*
Net revenue L.E. (I)**	20.24^b	18.93^b	22.38^a	22.39^a	**1.8**	*
Economic efficiency (G)**	42.03^b	38.36^c	45.29^a	42.98^b	**4.8**	*
Relative economic efficiency REE (K)**	100.00	91.27	107.76	102.27		

a,b Means in the same row with the same letters are not significantly different. SEM: Mean standard error NS: Non-significant, *: (P≤ 0.05) and **: (P≤ 0.01).

*Calculations included period from 35 to 70 day-old, fixed cost = price of weaning live rabbit + care + electricity + vaccination ….ect, according to price in June 2021.

** C= A×B, F= D×E, H= F+J, I= C-H, G= I/H×100, K= G of treatment/G of control×100.

Price of 1 liter Grow star = 180.0 LE, FIDAL = 250.0 LE and EM1 = 7.0 LE.

Each rabbit was consumed 250 ml of drinking water daily.

These results are agreement with El-Sawy *et al.*, (2022) who revealed that treated rabbits with *saccharomyces cerevisiae* boulardii in their diets had a highly significant increase in relative economic efficiency than the control group. Abo El-Maaty *et al.*, (2023) who found that best economical efficacy.

Conclusively, in summer season, from these results it could be concluded that using 0.5 ml/l FIDAL or 1 ml/l of effective micro-organisms (EM1) as a water supplementation in rabbits drinking water can be improve productive performance and increase feed utilization without any negative effect on carcass traits and achieve good relative economic efficiency. Using Grow Star 1 ml/l of drinking water improved FCR and increased calcium and phosphorus in plasma.

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REFERENCES

Abo El-Maaty, M. Eman; **Abd El-Azeem**, **F.; El-Sawy M.A. and I.H. El-Wardany (2023).** Physiological response of weaning rabbits to dietary supplementation of probiotics**.** M.Sc., Fac. Agric., Ain Shams Univ.**,** Egypt

Abd-El-Hady A.M. (2014). Performance, physiological parameters and slaughter characteristics in growing rabbits as affected by herbal feed additives. Journal of International Scientific Publications: *Agriculture and Food*, (2): 353-365.

Abdelhady, D. H., and El-Abasy, M. A. (2015). Effect of Prebiotic and Probiotic on Growth, Immuno-hematological responses and Biochemical Parameters of infected rabbits with Pasteurella multocida. *Benha Veterinary Medical Journal*, *28*(2), 40-51.

Bancroft J.D. and A. Stevens (1990). Theory and Practice of Histological Technique. *3rd Ed. New York, USA.*

Bauerl, C., and Collado, M.C., (2014). Changes in cecal microbiota and mucosal gene expression revealed new aspects of epizootic rabbit enteropathy. *PLoS.* One, 9: 105-107.

Brzozowski M. and Strzemecki P. (2013). Estimation the effectiveness of probiot-ics as a factor infl uencing the results of fattening rabbit. *Annals of Warsaw University of Life Sciences*, 52, 7-11.

Chrastinova L.; Chrenkova M.; Laukova A.; Polacikova M.; Simonova M.; Szaboova R.; Strompfova V.; Ondruska L.; Chlebec I.; Parkanyi V.; Rafay J. and Vasilkova Z. (2010). Influence of selected phytoadditives and probiotics on zootechnical performance, caecal parameters and meat quality of rabbits. *Archiva Zootechnica*, 13(2), 30-35.

Combes, S.; Michelland, R.J. and Monteils, V. (2011). Post-natal development of the rabbit caecal microbiota composition and activity. FEMS Microbiol Ecol., 77: 680- 689.

Duncan, D. B. (1955). Multiple range and multiple F tests. *Biometrics*, 11:1–42.

El-Dimerdash, M.Z.; Dalia, M.H.; Hanan, F.A. and Doaa, S.A. (2011). Studies on the effect of some probiotics in Rabbits. SCVMJ, XVI (2) -151:169.

El-Sagheer M. and Hassanein H.H.M. (2014). Effect of enzymes and probiotic mixture supplementation to the diet of growing female rabbits on performance and carcass criteria. *Egyptian Poultry Science Journal*, 34(1): 259-272.

El-Sawy, M.A. Basma; Ayman M.H. Ahmed; Yasser K. Badawi and Ibraheim H. El-Wardany (2021). Impact of *Saccharomyces cerevisiae* Boulardii Supplementation as Probiotic on Productive Performance and Economic Efficiency of Growing Rabbits. *Arab Univ. J. Agric. Sci., Ain Shams Univ., Egypt* 29(2): 795-800.

El-Sawy, M.A. Basma; Ayman M.H. Ahmed; Yasser K. Badawi and Ibraheim H. El-Wardany (2022). Effect of *Saccharomyces cerevisiae* on growth performance and digestive system development of weaning rabbits. M.Sc., Fac. Agric., Ain Shams Univ., Egypt.

Ezema C. and Eze D.C. (2012). Determination of the effect of probiotic (*Saccharomyces cerevisiae*) on growth performance and hematological parameters of rabbits. *Comparative Clinical Pathology*, 21: 73-76.

Falcão-e-Cunha, L.; Castro-Solla, L.; Maertens, L.; Marounek, M.; Pinheiro, V.; Freire, J. and Mourão, J.L. (2007). Alternatives to antibiotic growth promoters in rabbit feeding: a review. *World Rabbit Science*, *15*(3).

FAO/WHO. (2002). Guidelines for the evaluation of probiotics in food. [Cited April 30 and May 1, 2002]. http://www. *Who .int/ foodsafety/ fs_managem ent/en/probiotic_ guidelines. pdf.*

Floch M.H.; Walker W.A.; Madsen K.; Sanders M.E. and Macfarlane G.T. (2011). Recommendations for probiotic use-2011 update. *J. Clin. Gastroenterol*, 45: 168–171.

Hegab, I.M.; Eman, A. Attia; Rania, A. Hassan and F.E. El-Azzazi (2019). Effect Of Probiotics On Productive, Physiological And Microbiological Parameters Of New Zealand White Rabbits Reared Under Hot Summer Conditions. *Egypt. Poult. Sci*., 39 (3): 599-614.

Hong, K.J.; C.H. Lee and S.W. Kim. (2004). Aspergillusoryzae GB-107 fermentation improves nutritional quality of food soybeans and feed soybean meals. *J. Med. Food*, 7 : 430 – 434.

Khaksefidi, A. and Sh. Rahimi (2005). Effect of probiotic inclusion in the diet of broiler chickens on performance, feed efficiency and carcass quality. *Asian-Aust. J. Anim. Sci*., 18: 1153–1156.

Kiers, J.L.; J.C. Meijer; M.J.R. Nout; F.M. Rombouts; M.J.A. Nabuurs and J. Meulen (2003). Effect of fermented soya beans on diarrhoea and feed efficiency in weaned piglets. *J. Appl. Microbiol*., 95:545–555.

Lalles, J.P.; H. Salmon; N.P.M. Bakker and G.H. Tolman. (1993). Effects of dietary antigens on health, performance and immune system of calves and piglets. *Pages 253–270 in Recent Advances of Research in Antinutritional Factors in Legume Seeds*.

Litonjua, A.A. and Weiss S.T. (2007). Is vitamin D deficiency to blame for the asthma epidemic. *J. Allergy Clin. Immunol*. 120: 1031–1035.

Mahfouz, E.S. Sara; Abd El-Azeem, F.; El-Sawy, M.A. and Ibraheim H. El-Wardany (2023). Effect of using enzymes on productive and physiological performance of rabbits. M.Sc., Fac. Agric., Ain Shams Univ., Egypt.

Marai, I.F.M.; M.S. Ayyat and U.M. Abd El-Monem (2001). Growth performance and reproductive traits at first parity of New Zealand white female rabbits as affected by heat stress and its alleviation under Egyptian conditions. *Trop. Anim. Health Prod*., 33: 451–462.

NRC, (1977). *National Research Council*: Nutrient Requirements of Rabbits, 2nd Revised Edition. National Academy of Sciences, Washington, USA.

Onbasilar I. and Yalcin S. (2008). The effects of dietary supplementation of probiotic and anticoccidial additives on performance and blood parameters in growing rabbits. Revue de medicine Veterinaire, 159 (11): 570-574.

Onu P.N. and Oboke S.A. (2010). Evaluation of Enzyme and Probiotic Supplementation of Maize Processing Waste-Based Diets on Performance and Nutrient Utilization of Weaner Rabbits. *Indian Journal of Animal Research*, 44 (2): 87–93.

Oyedeji, J.O.; Ajayi, H.I. and Egere, T. (2008). The effect of increasing level of yeast culture (Levucel SB) in a high fibre diet, on the performance and nutrient retention of broiler chicken. *Asian J. Poul. Sci*., 2: 53–57.

Phuoc, T.L. and Jamikorn, U. (2017). Effects of probiotic supplement (*Bacillus subtilis* and *Lactobacillus acidophilus*) on feed efficiency, growth performance, and microbial population of weaning rabbits. *Asian Austral. J. Anim.* 30:198-205.

Ravel, J.; Gajer, P.; Abdo Z.; Schneider G.M. and Koenig S.S. (2011). Vaginal microbiome of reproductive-age women. *Proc. Natl. Acad. Sci.,* U.S.A. 108 Suppl. 1: 4680–4687.

Rehman, M.; Arif, N.; Sajjad, M.Q.; Al-Ghadiy M.; Alagawany, M.E.; Abd El-Hack A.R.; Alhimaidi S.S.; Elnesr B.O.; Almutairi R.A.; Amran E.O.S.; Hussein and A.A. Swelum (2020). Dietary effect of probiotics and prebiotics on broiler performance, carcass, and immunity. *Poultry Science,* 99: 6946 – 6953.

Sarat Chandra, A.; Mahender, M. and Harikrishna, C. (2015). Effect of Dietary Supplementation of Probiotics and Enzymes on the Blood Biochemistry and Immune Competence of Rabbits Reared Under Two Housing Systems. *Livestock Research International*, 3 (1): 20-24.

SAS, (2002). SAS/STAT User's guide statistics. SAS institute INC., Cary. NC, USA

Simonová, M.P.; Lauková, A.; Žitňan, R. and Chrastinová, L. (2015). Effect of rabbit-origin enterocin-producing probiotic strain Enterococcus faecium CCM7420 application on growth performance and gut morphometry in rabbits. *Czech Journal of Animal Science*., 60: 509 - 512.

Sendcor, G.W. and Cochran, W.G. (1982). *Statistical Methods* **2**nd Edition. Lowa University., Press Ames, Iowa, USA.

Soomro, R.N.; M.E. Abd El-Hack; S.S. Shah; A.E. Taha; M. Alagawany; A.A. Swelum; E.O.S. Hussein; H.A. Ba-Aawdh; I. Saadeldin; M.A. El-Edel and V. Tufarelli (2019). Impact of restricting feed and probiotic supplementation on growth performance, mortality and carcass traits of meat-type quails. *Anim. Sci. J.* 90: 1388 – 1395.

Youssef A. Attia; Mohammed A. Al-Harthia and Asmaa Sh. Elnaggar (2018). Productive, physiological and immunological responses of two broiler strains fed different dietary regimens and exposed to heat stress. *Italian Journal Of Animal Science*, 17 (3): 686–697.

تأثير مصدر البروبيوتيك على الإنتاجية، الاستجابة الفسيولوجية وهستولوجيا الامعاء للأرانب النامية تحت ظروف الصيف

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تهدف الدراسة إلى بحث تأثير مصادر مختلفة من منشطات النمو (البروبيوتيك) على الداء الإنتاجى والإستجابة القسيولوجية وتأثيرها على التغيرات الهستولوجية فى أمعاء الأرانب النامية وكذلك الكفاءة الإقتصادية لها وذلك تحت ظروف الصيف. إستخدم فى هذة التجربة عدد ٨٠ ذكر أرنب مفطوم عمر ٥ أسابيع بمتوسط وزن ٥٧٥.٤+٨٥.٧ جم من خط إسكندرية، حيث تم توزيعهم عشوائيا على ٤ مجاميع (٢٠ بكل معامله) وكل معاملة تم توزيعها على ٥ مكررات بكل مكررة ٤ أرانب، حيث تلقت المجموعة الأولى ماء شرب فقط بدون إضافات كمجموعة ضابطة (C) بينما تلقت المجموعة الثانية ماء شرب مضافا إليها ١مل/لتر ماء شرب من البروبيوتيك جرو ستار (T_1)، وتلقت المجموعة الثالثة ماء شرب مضافا إليها ٠.٥ مل/لتر ماء شرب من البروبيوتيك فيدال (T_2)، بينما تلقت المجموعة الرابعة ماء شرب مضافا إليها ١ مل/لتر ماء شرب من البروبيوتيك EM1 (T_3).

وقد أوضحت النتائج مايلى:

- أوضحت قيم THI أن الأرانب تعرضت لإجهاد حرارى متوسط خلال فترة التجربة.
- حدث زيادة معنوية عند مستوى (١%) نتيجة إضافة FIDALأوEM1 فى كل من وزن الجسم النهائى (FLBW) ومعدل الزيادة المكتسبة فى الوزن (BWG).
- أدى إستخدام EM1 إلى زيادة كمية الغذاء المأكول FI مقارنة بباقى مجاميع التجربة بينما كان أفضل معدل لل FCR عند إستخدام Grow star مقارنة بباقى المجاميع.
- دليل الأداء الإنتاجى PI تحسن عند إستخدام EM1أو FIDAL مقارنة بباقى المجاميع.
- لم تتأثر صفات الذبيحة معنويا بالمعاملات المختلفة.
- لوحظت زيادة فى مستوى الكالسيوم والفوسفور فى بلازما الدم فى المعاملة الثانية التى إستخدم فيها Grow star مقارنة بباقى المجاميع
- لم تتأثر بروتينات الدم الكلية والألبيومين والجلوبيولين وإنزيمات الكبد AST and ALT بالمعاملات المختلفة.
- حدث تطور واضح فى الأمعاء الدقيقة والأعور نتيجة إضافة البروبيوتك المختلفة وبخاصة EM1 متمثلا فى زيادة سمك طبقة Tunica serosa وزيادة إرتفاع الخملات وعدد الغدد فى الأعور معنويا مقارنة بباقى المجاميع.
- حدث تحسن معنوى فى كل المجاميع المعاملة بالبروبيوتيك EM1أو FIDAL فى معدلات الكفاءة الإقتصادية والكفاءة الإقتصادية النسبية مقارنة بالكنترول أو Grow star.

التوصية : إضافة ١مل/لتر من البروبيوتيك EM1 أو ٠.٥ مل/لتر من البروبيوتيك FIDAL لماء شرب الأرانب النامية أدى لتحسين كل من صفات النمو العائد الإقتصادى خلال موسم الصيف، بينما إضافة Grow star بمعدل ١ مل/لتر أدى لتحسن FCR ومستوى الكالسيوم والفوسفور مقارنة بباقى المجاميع.