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 tap water without additives (Control rabbits, C); 2\textsuperscript{nd} (T\textsubscript{1}), 3\textsuperscript{rd} (T\textsubscript{2}), and 4\textsuperscript{th} (T\textsubscript{3}) groups received drinking tap water supplemented with different probiotic sources at 1 ml of Grow star, 0.5 ml of FIDAL, and 1 ml of effective micro-organisms (EMI) 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\textsubscript{2} and T\textsubscript{3}, while feed intake was a significantly increased in T\textsubscript{3} as compared to other groups. However, feed conversion ratio mathematically decreased in T\textsubscript{1} and T\textsubscript{2} groups, while performance index mathematically improved in T\textsubscript{2} and T\textsubscript{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≤0.05) in T\textsubscript{2} and T\textsubscript{3} groups when compared to control group. Plasma levels of calcium and phosphorus concentrations were higher of rabbits given Grow Star (T\textsubscript{1}) group than other group's rabbits. Ileum and caecum were more developed in the T\textsubscript{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\textsubscript{3} compared to other treatments.

Rabbits received FIDAL 0.5 ml or EMI 1 ml/liter of drinking water had significantly (P≤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. About 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 3×10⁹ 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
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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 tap 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)
- **T1**, received 1 ml/l water of Grow star
- **T2**, received 0.5 ml/l water of FIDAL
- **T3**, received 1 ml/l water of EM1
Grow Star®, each one liter contains (Vit. A 500000 IU, Vit. D₃ 100000 IU, Vit. E 100 mg, Vit. B₆ 1000 mg, vit. B₃ 2500 mg, Vit. K₃ 250 mg, Bacillus sutilis 1.25×10¹¹ CFU, Bacillus licheniforms 1.25×10¹¹ 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.) 20×10¹² 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 T₁, T₂ and T₃ 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:

\[
THI = db °C - [0.31 - 0.31 \times RH\%] \times (db °C - 14.4)
\]

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 (28.9-28.9) 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, \( \mu \) = 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 T2 and T3.
Table 1. Averages of ambient temperature (AT, °C), relative humidity (RH%) and temperature humidity index (THI units), during experimental period

<table>
<thead>
<tr>
<th>Months</th>
<th>AT (°C)</th>
<th>RH (%)</th>
<th>THI (Units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>June</td>
<td>29.6 ± 0.52</td>
<td>69.3 ± 0.61</td>
<td>28.2 ± 0.57</td>
</tr>
<tr>
<td>July</td>
<td>29.8 ± 0.51</td>
<td>71.0 ± 0.57</td>
<td>28.4 ± 0.56</td>
</tr>
<tr>
<td>August</td>
<td>31.6 ± 0.55</td>
<td>68.5 ± 0.68</td>
<td>29.9 ± 0.55</td>
</tr>
<tr>
<td>Average</td>
<td>30.3 ± 0.53</td>
<td>69.6 ± 0.63</td>
<td>28.8 ± 0.56</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Items</th>
<th>Control</th>
<th>T₁</th>
<th>T₂</th>
<th>T₃</th>
<th>SEM</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILBW</td>
<td>594.00</td>
<td>567.80</td>
<td>573.00</td>
<td>566.67</td>
<td>85.72</td>
<td>NS</td>
</tr>
<tr>
<td>FLBW</td>
<td>1710.00c</td>
<td>1707.00c</td>
<td>1795.00b</td>
<td>1861.67a</td>
<td>91.93</td>
<td>**</td>
</tr>
<tr>
<td>BWG</td>
<td>1112.50c</td>
<td>1139.20c</td>
<td>1217.13b</td>
<td>1303.89a</td>
<td>95.33</td>
<td>**</td>
</tr>
<tr>
<td>FI</td>
<td>4299.78b</td>
<td>4229.00b</td>
<td>4315.33b</td>
<td>4903.72a</td>
<td>567.97</td>
<td>**</td>
</tr>
<tr>
<td>FCR</td>
<td>3.81</td>
<td>3.71</td>
<td>3.57</td>
<td>3.84</td>
<td>0.57</td>
<td>NS</td>
</tr>
<tr>
<td>PI</td>
<td>46.28</td>
<td>46.08</td>
<td>50.84</td>
<td>50.45</td>
<td>7.55</td>
<td>NS</td>
</tr>
</tbody>
</table>

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 (10⁹ 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 (5.0×10⁸ 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.,
who found that \textit{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 (\textit{Saccharomyces cerevisiae}) 0.5, 1 and 1.5 g and \textit{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 \textit{L. acidophilus} in high dose compare with other experimental groups. Also, Phuoc and Jamikorn (2017), who concluded that supplementation of \textit{L. acidophilus} alone or combined with \textit{B. subtilis} at a partial dose, may enhance feed efficacy and growth performance, but rabbits fed only \textit{B. subtilis} alone were not different compared with the control. Also, El-Sawy \textit{et al.}, (2022) reported that Feed intake was improved significantly (P≤0.01) for all experimental groups fed diet supplemented with \textit{Saccharomyces cerevisiae boulardii} 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 \textit{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 \textit{et al.}, (2022) found that PI significantly (P≤0.01) increased through all experimental groups fed diet supplemented with \textit{Saccharomyces cerevisiae} by 10.3%, 38.7% and 92.7% comparable with control group during period from 5 to 10 weeks of age.

\textbf{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 (%)

<table>
<thead>
<tr>
<th>Items</th>
<th>Different Probiotic sources (ml/l)</th>
<th>SEM</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>T₁</td>
<td>T₂</td>
</tr>
<tr>
<td>Carcass traits%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carcass, %</td>
<td>58.21</td>
<td>58.34</td>
<td>56.75</td>
</tr>
<tr>
<td>Liver, %</td>
<td>2.75</td>
<td>2.92</td>
<td>2.78</td>
</tr>
<tr>
<td>Heart, %</td>
<td>0.43&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.39&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>0.34&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cuts of carcass%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulders%</td>
<td>15.57&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>16.56&lt;sup&gt;a&lt;/sup&gt;</td>
<td>14.79&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Legs%</td>
<td>20.67</td>
<td>20.54</td>
<td>20.75</td>
</tr>
<tr>
<td>Thorax%</td>
<td>9.80</td>
<td>9.06</td>
<td>7.84</td>
</tr>
<tr>
<td>Loin%</td>
<td>5.92</td>
<td>5.55</td>
<td>7.26</td>
</tr>
</tbody>
</table>

<sup>a,b</sup> 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 supplementation in rabbit’s drinking water on carcass traits% and organs% except heart% and shoulders%, where those decrease significantly in treated groups T₂ and T₃ compared to the control group. These results might be related to the increasing of LBW in T₂ and T₃ compared with control. These results are similarity with what found by Hegab <i>et al.</i>, (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 <i>Bacillus Cereus Var. Toyoi</i>, 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
T2 and T3 in compared to control. Liver enzymes (AST and ALT) were decreased mathematically in T2 and T3 in compared to control. In addition, total calcium in plasma was significantly higher in T1 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 T2 and T3 in compared to control group. These results might be related to those rabbits in both T2 and T3 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%, 109 CFU/g of feed). However, Abdelhady and El-Abasy (2015) who observed that rabbits when fed diet supplemented with probiotic

(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 (T1) have high calcium content.

<table>
<thead>
<tr>
<th>Items</th>
<th>Different Probiotic sources (ml/l)</th>
<th>SEM</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>T1</td>
<td>T2</td>
</tr>
<tr>
<td>TP, g/dl</td>
<td>5.89</td>
<td>5.69</td>
<td>5.97</td>
</tr>
<tr>
<td>ALB, g/dl</td>
<td>3.22</td>
<td>3.26</td>
<td>2.71</td>
</tr>
<tr>
<td>GL, g/dl</td>
<td>2.67</td>
<td>2.43</td>
<td>3.26</td>
</tr>
<tr>
<td>Tri-glycerides, mg/dl</td>
<td>141.69b</td>
<td>159.70b</td>
<td>191.83a</td>
</tr>
<tr>
<td>Cholesterol, mg/dl</td>
<td>70.59bc</td>
<td>76.59b</td>
<td>67.82c</td>
</tr>
<tr>
<td>AST, U/l</td>
<td>27.89</td>
<td>28.53</td>
<td>27.36</td>
</tr>
<tr>
<td>ALT, U/l</td>
<td>36.19</td>
<td>34.49</td>
<td>35.17</td>
</tr>
<tr>
<td>Calcium, mg/dl</td>
<td>6.41b</td>
<td>13.32a</td>
<td>11.63a</td>
</tr>
<tr>
<td>Phosphors, mg/l</td>
<td>3.34</td>
<td>3.73</td>
<td>2.96</td>
</tr>
</tbody>
</table>

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.
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 T3 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 T1, Bacillus lichinoforis in T2, and micro-organism in later group (T3) 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.
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FIG. 1. Histology of the ileum of non-supplemented group showed thinner and shorter villi.

FIG. 2. a) Histology of the ileum of rabbits in Group 1 showed an increase in the number of villi (V) and increased muscularis externa (M) and muscularis interna (I).

FIG. 2. b) Histology of the ileum of rabbits in Group 2 showed an increase in the number of villi (V) and increased muscularis externa (M) and muscularis interna (I).
Fig. 3.a. Histology of the ileum of rabbits in T2 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 T2 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 T2 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 T3 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 T3 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

<table>
<thead>
<tr>
<th>Items</th>
<th>Experimental groups</th>
<th>SEM</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>T$_1$</td>
<td>T$_2$</td>
</tr>
<tr>
<td>Final body weight, g (A)</td>
<td>1710$^c$</td>
<td>1707$^c$</td>
<td>1795$^b$</td>
</tr>
<tr>
<td>body weight price, L.E. /kg (B)</td>
<td>40.00</td>
<td>40.00</td>
<td>40.00</td>
</tr>
<tr>
<td>Net profit, L.E./rabbit (C)**</td>
<td>68.40$^b$</td>
<td>68.28$^b$</td>
<td>71.80$^b$</td>
</tr>
<tr>
<td>Total feed intake, kg (D) /5 weeks</td>
<td>4.29</td>
<td>4.22</td>
<td>4.32</td>
</tr>
<tr>
<td>Price of kg feed, L.E. (E)</td>
<td>5.40</td>
<td>5.40</td>
<td>5.40</td>
</tr>
<tr>
<td>Feed intake cost, L.E. (F)**</td>
<td>23.16$^b$</td>
<td>22.78$^b$</td>
<td>23.33$^b$</td>
</tr>
<tr>
<td>Weaned rabbits cost, L.E. (J)</td>
<td>25.00</td>
<td>25.00</td>
<td>25.00</td>
</tr>
<tr>
<td>Additives cost/rabbit/35 days, L.E.</td>
<td>0.00</td>
<td>1.57</td>
<td>1.09</td>
</tr>
<tr>
<td>Total cost, L.E. (H)**</td>
<td>48.16$^b$</td>
<td>49.35$^b$</td>
<td>49.42$^b$</td>
</tr>
<tr>
<td>Net revenue L.E. (I)**</td>
<td>20.24$^b$</td>
<td>18.93$^b$</td>
<td>22.38$^b$</td>
</tr>
<tr>
<td>Economic efficiency (G)**</td>
<td>42.03$^b$</td>
<td>38.36$^b$</td>
<td>45.29$^a$</td>
</tr>
<tr>
<td>Relative economic efficiency</td>
<td>100.00</td>
<td>91.27</td>
<td>107.76</td>
</tr>
</tbody>
</table>

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= AxB, F= DxE, H= F+I, 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.

ACKNOWLEDGEMENT:
The authors are thankful to Dr. Mourad El-Sanhory Professor of Poultry Nutrition, Faculty of Agric, Ain Shams Univ. and Mr. Walid Ezzat, Chief Executive Officer, Elnoor for investment for help in this work.

REFERENCES


تأثير مصدر البروبيوتوكس على الإنتاجية، الاستجابة الفسيولوجية وهيستولوجيا الأعصاب للأرانب الناضجة تحت ظروف الصيف

محمد عبد العزيز الصاوي¹ - أحمد محمد تمام سلام ص² - شيرين سلامة غنمي³

فيصل بومي عبد السلام بدرى

1- مهندس بحوث الأتاد الحيوياً - مركز البحوث الزراعية - مصر.
2- قسم تغذية الدواجن - كلية الزراعة - جامعة عين شمس - مصر.
3- قسم فسيولوجيا الدواجن - كلية الزراعة - جامعة عين شمس - مصر.

تهدف الدراسة إلى بحث تأثير مصادر مختلفة من منشطات النمو (البروبيوتوكس) على النمو الاقتصادى والاستجابة الفسيولوجية وتأثيرها على التغيرات الهيستولوجية في أمعاء الأرانب الناضجة وكذلك الكفاءة الإنتاجية لها وذلك تحت ظروف الصيف. استخدمت هذه الدراسة عدد 80 ذكر أربعة مخلوط عمر 5 أسابيع بمتوسط وزن 4.7±5.3 كجم من حпаكة إسكندنافية، حيث تم توزيعهم عشوائياً على 4 مجموعات (A) كل مئละ م同等، حيث تلقى المجموعة الأولى ماء شرب فقط دون إضافات كمجمعة ضابطة (C) بينما تلقى المجموعة الثانية ماء شرب مضادًا وأم/و أمل/وتر ماء شرب من البروبيوتوكس جرو ستار (T1)، وتحت المجموعات الثالثة ورابعة ماء شرب مضادًا وأم/و أمل/وتر ماء شرب من البروبيوتوكس فيدال (T2)، بينما تلقى المجموعة الرابعة ماء شرب ماء شرب (T3) EM1.

وقد أوضحت النتائج:

1- أوضحت فيم THI أوجب أن الأرانب تعرضت لجهد حراري متوسط خلال فترة التجربة.
2- حدد زيادة معنوية عند مستوي (%1) نتيجة إضافة ترفيهية في كل من وزن الجسم EM1 أو FIDAL ومعدل الزيادة المكتسبة في الوزن (FLBW) (نهاية الدراسة).
3- أدى استخدام EM1 إلى زيادة كمية الغذاء المكملة مقارنة بباقي مجموعات التجربة، بينما كان أفضل معدل للFCR مقارنة بباقي المجموعات.
4- أدى استخدام EM1 أو FIDAL ومعدل الزيادة المكتسبة في الوزن في مجموعة T2 إلى زيادة بانفسة من النام وتحسين إنلعاع في المعدلات المختلفة.
5- أوضحت زيادة في مستوى الكالسيوم والفوسفور في بلازما الدم في المراحل المتلازمة التي تستخدم عن مقارنة بباقي المجموعات.
6- أوضح تأثير البروتينات الدهنية والكليوسيلويك والخليطات الكبدية EM1 حدد تطور واضح في المواد الدقيقة والأعراض نتيجة إضافة التغذية المختلفة وبخاصة تنزيل FIDAL وزيادة إنتاج الخلايا وحدود الحديد في الأعواء Tunica serosa.
7- تم تسجيل نتائج معنوية في معدلات AST and ALT.

التوصية: إضافة 1مل/تر من البروبيوتوكس EM1 أو 0.5 مل/تر من البروبيوتوكس FIDAL لاماء شرب Grow star أو EM1 ومستوى الكالسيوم والفوسفور مقارنة بباقي المجموعات.

الكفاءة الاقتصادية والكفاءة الاقتصادية النسبية مقارنة بالكثير أو معنوية في مصادر EM1 أو FIDAL.

النوعية: تحسين النمو والفعالية الاقتصادية خلال موسم الصيف، بينما إضافة Grow star أو EM1 إلى مل/تر ميتحسن كل من صفات النمو والصحة الاقتصادية داخل موسم الصيف، بينما إضافةGrow star أو EM1 أو FIDAL إلى مل/تر ميتحسن كل من صفات النمو والصحة الاقتصادية داخل موسم الصيف.