Egypt. Poult. Sci. Vol (37)(II): (407-431)(2017) **(1718)**

Egyptian Poultry Science Journal

http://www.epsaegypt.com

ISSN: 1110-5623 (Print) – 2090-0570 (Online)

EFFECT OF FEED RESTRICTION WITH SUPPLEMENTATION OF PROBIOTIC ON PRODUCTIVE AND ECONOMICAL PERFORMANCE IN LOCAL GROWING RABBITS

M.M. Beshara, M.A. Ragab, A.El.M.I. El Desoky , H.N. Fahim, A.M. El-Fhhat, A.M. Alazab and A.A. El-gamal

Anim. Prod. Res. Inst., Agric. Res. Center, Minis. of Agric. Dokki, Giza

Corresponding author: Malak Mansour: E-mail: malakman88@yahoo.com

Received:07/04/2017 Accepted:27/04/2017

ABSTRACT: The objective of this study was to investigate the effect of dietary different levels of feed restriction (FR) and probiotics (PR) (Lacobacillus lactis 2.5 x 10^8 CUF, Bacillus subtilis 1.8 x 10^9 CUF/g) on productive performance and economic efficiency for growing rabbits. A total number of 54 local growing rabbits,7 weeks old were weighed and divided into six dietary treatments of 9 rabbits each (5 males+4femals) The dietary levels of FR and PR included 3x2 factorial design as follow: T_1: Rabbits fed basal diet ad-libitum without PR ,T_2: Rabbits fed basal diet ad libitum and supplemented with 0.4g PR/ kg diet, T_3 : Rabbits fed restricted diet by 120% of the energy requirements for maintenance without PR, T_4: Rabbits fed restricted diet by 120% of the energy requirements for maintenance with 0.4g PR/kg diet, T5: Rabbits fed restricted diet by 140% of the energy requirements for maintenance without PR and T_6: Rabbits fed restricted diet by 140% of the energy for maintenance with 0.4g PR/kg diet.

The results illustrated that dietary ad-libitum with 0.4 g PR/kg diet were higher significantly ($P\leq0.05$) live body weight than other treatment groups. But, the restricted diets120 or 140 % of the energy for maintenance with 0.4g PR/ kg diet did not significantly ($P\geq0.05$) as compared to the control diet. The rabbits fed ad-libitum and supplemented with 0.4g PR/kg diet returned to the first position of daily weight gain and significantly ($P\leq0.05$) exceeded the other treatment groups. Regarding feed conversion, rabbits fed 120% of energy for maintenance with or without PR and those received ad libitum diet with 0.4g PR /kg diet improved significantly ($P\leq0.05$) as compared to control diet. All dietary treatments tend to have greater gastrointestinal tract and cecum% than control diet. Conversely, the rabbits fed different treatments had ($P\leq0.05$) the lowest values of lipase and protease except for the restricted diet120% of energy for maintenance without PR as compared to the control diet. The best value of EE was found for rabbits fed 120% of the maintenance energy with 0.4g PR/kg diet.

Conclusively, these results imply an important FR strategy by 120% of energy requirements for maintenance and supplemented with 0.4g PR/ kg diet, where feed conversion, performance index, E. coli /TBC ratio and economic efficiency improved under environmental Egyptian condition.

Key words: Rabbits, Probiotic, Growth performance, Digestive enzymes, Microbial activity

INTRODUCTION

Rabbits feeding represent a great challenge in intensive rearing systems, for both economic and sanitary reasons. The post-weaning period is particularly important to establish growth and resistance to digestive disorders that are common in rabbits between 5 and 10 weeks of age. For example, infectious digestive disorders account for a high incidence of mortality after rabbit weaning (Marlier et al., 2003). Post-weaning intake limitation is now widely practiced (Lebas, 2007), as beneficial effects have been obtained on resistance to digestive troubles and on feed efficiency. Thus since several years, rabbit nutritionists are looking for developing strategies capable of reducing digestive disorders and increasing feed efficiency so lowering feeding and total production costs (Maertens 2009). In practical condition, a moderate feed restriction in growing rabbits could be used with some advantages in comparison with ad libitum feeding where it increase digestive efficiency, modifies the partition of body energy retention as protein instead of fat and it could reduce mortality and morbidity due to digestive troubles as well as improve the feed conversion ratio (Tudela 2009; Xiccato and Trocino 2010).

Two main classes of restriction techniques are used: a quantitative intake limitation by modification the feed composition for example, energy intake is frequently reduced by using high-fiber diets for young reproducing females and the second class is a qualitative restriction. A quantitative restriction can be applied in two ways: either the time of access to the feeder or the quantity of feed distributed can be reduced. To achieve a correct control of the post-weaning intake, the most precise technique is to give a defined quantity of pelleted feed every day; however, this quantity could be given all at once (Gidenne et al., 2009b and 2009c),where the favorable effect of an intake limitation originates from the feed quantity itself or not from the feed distribution technique. Also a quantity restriction can be classified into two classes; a moderate restriction during growth by feeding plans (80% of ad libitum from 35 to 77 day; restriction at 70% from 35 to 56 day followed by restriction at 90% from 56 d; and restriction at 90% from 35 to 56 d followed by restriction at 70%) (Perrier and Ouhayoun 1996) and a strong feed restriction level 50% or 70% of ad libitum were applied from 35 to 56 day (Perrier 1998).

Probiotics are direct-fed microbial feed supplements which modulate the gut micro flora by successfully competing with pathogens through a competitive exclusion process (Mountzouris et al., 2007). The mode of action of probiotics is that they produce specific and intermediate metabolites which stimulate the body immune systems (Sherman et al., 2009). Moreover, probiotics are mono- or mixed cultures of living micro- organisms which beneficially affect the host by improving the properties of the indigenous micro biota (Fuller, 1992). The positive effect of probiotics on the control of certain pathogens in animals has been shown in several studies, where they appear to control enteric diseases associated with Escherichia coli or other enteric pathogens (Timmerman et al., 2005). It is well known that probiotic supplementation improves growth rate, enhances efficiency of feed conversion in rabbits, and also influences the intestinal micro biota through the action of beneficial microbes (Pogany Simonova et al., 2009). The use of probiotics and prebiotics showed promising results in enteric disease prevention, enhancement of growth performance, carcass quality, and immune response in rabbits (Oso et al., 2013). Although there are several scientific publications about the effect probiotic on the productive performance in rabbits (Szaboova et al., 2012; Pogany Simonova et al., 2013), their effect on the growing rabbits fed restricted feeding has not been documented sufficiently (Oso et al., 2013). For this reason, the effects of feed restriction and probiotics strain Lactobacillus lactis and Bacillus subtilis on the growth performance post-weaning, nutrients digestibility and economic efficiency in rabbits were studied.

MATERIAL AND METHODS

This study was conducted at El-Serw Poultry Research Station, Animal Poultry Research Institute, Agriculture Research Center, Ministry of Agriculture, Egypt. Fifty four Black Balady rabbits 7 weeks of age were randomly assigned to one of six dietary experimental groups of (9 rabbits each) that was conducted from 7 to 14 weeks of age. At the onset of the experiment, rabbits were weighed and assigned to 6 treatments based on body weight so that mean body weight were similar for rabbits on all treatments with an average live body weight of 950 ±14gm. and each treatment had three replicates (3 rabbits in each). The rabbits in each replicate were kept on in grower cages and fed their respective experimental diets (Table 1).

The basal and experimental diets:

The dietary levels of FR and PR included (3x2) factorial design as follow: T_1: Rabbits fed basal diet ad-libitum without supplemented probiotic ,T_2: Rabbits fed basal diet ad libitum and supplemented with 0.4g probiotic/ kg diet, T_3 : Rabbits fed restricted by 120% from the energy requirements for maintenance without probiotic , T_4: Rabbits fed restricted by 120% from the energy for maintenance with 0.4g probiotic/ kg diet, T5: Rabbits fed restricted by 140% of the energy requirements for maintenance without probiotic and T_6: Rabbits fed restricted by 140% of the energy requirements for maintenance with 0.4g probiotic/ kg diet during the period from7 to 14 weeks of age. The ingredients and the nutrient composition of the basal diet presented in Table (1), calculated analysis of basal diet according to feed composition tables for rabbits feedstuffs used by Villamide et al., (2010) and De Blas and Wiseman (2010) and the requirements of digestible energy (DE Kcal/kg diet) and crude protein % according to FEDNA (2013). Saltose Ex is a thermo stable probiotic where each 1 kg contains lactic acid bacteria (Lacobacillus lactis) 2.5 x 10^8 CFU, Bacillus subtilis 1.8 x 10^9 CFU and calcium carbonate up to 1 gram as carrier. This probiotic produced by Pic-Bio, Inc. Company- Japan and it was taken from El-Yousr Company for medicine trade - Cairo. All rabbits were kept under the same managerial conditions. The quantity of feed restriction given all at once and not several meals each day, where recently results illustrated that favorable effect of an intake limitation originates from the feed quantity itself and not from the feed distribution technique. The amount of feed allocated to restricted rabbits each distribution was calculated according to the live body weight and the energy requirements for maintenance (430 Kj DE/d/kg LW $^{0.75}$) according to **Xiccato and Trocino (2010)** then convert the energy from Kcal /kg to grams/day afterward addition 20 and 40% on the energy requirements for maintenance. For example the body weight is 0.95 kg, the energy for maintenance= 413.77 Kj DE/d/rabbit (98.89 Kcal/d/rabbit) where1Kcal= 4.184 Kj, then the energy requirements for maintenance+120% = 118.67 Kcal/d/rabbit and the energy requirements for maintenance+140% = 138.45 Kcal/d/rabbit finally, the energy requirement for growing rabbits = 2416 Kcal DE/Kg diet this mean the amount of restricted feed for the this rabbit = 49.2 g/day (120%) and equal 57.4g/day (140%), respectively and this restricted diets were changed every week according to the body weight.

Growth performance traits:

Live body weight, daily feed intake and number of dead rabbits were recorded. Daily weight gain, feed conversion ratio was determined every week and mortality rate were estimated daily. The performance index was calculated according to North (1981) on a group basis:

Performance index (%) = (final live body weight (kg)/ feed conversion ratio from 7 to 14 weeks of age) x 100

Digestive enzymes and microbial diagnosis:

The digestive enzymes were carried out on samples of stomach and small intestine contents (3 males in each) in 10 ml distiller water. The microbial diagnosis examination was carried out on samples of caecum contents (3 males in each) according to Mackie and Mc Carteny (1953), American Public Health Association, APHA (1960) and Difco Mannual (1977).

Serum biochemical parameters and Hematological:

At the end of study (14 weeks of age), three rabbits (3 males) were taken randomly from each treatment, fasted for 12 hrs, weighed and slaughtered to estimate some of carcass traits. Carcass parts were presented as a percent of live body weight which included carcass, heart, liver, giblets, kidney, abdominal fat gastrointestinal tract and cecum%. Blood samples were collected without anticoagulant and kept at room temperature then the tubes were centrifuged at 3500 rpm for 20 minutes to separate clear serum, afterward blood serum was used to determine serum total protein, triglycerides, total cholesterol and liver enzymes activities by using commercial kits. Another blood samples were taken in vial tubes containing EDTA as anticoagulant from three rabbits per treatment to determine some hematological traits which included RBC x10^{12}, HCT %, HEB (g/dl), WBC x10^{9}, N%, N/L, M% and E%.

Economic efficiency:

At the end of the study, economical efficiency for weight gain was expressed as rabbit-production thought the study and calculated using the following equation:

Economic efficiency (%) = (Net return LE/Total feed cost LE) × 100. Where net return= Total return- the cost of feeding

Statistical analysis:

Data were statistically analyzed using General Linear Models Procedure of the SPSS program (2008), A factorial design 3x2 was used; the following model was used to study the effect of main factors and interaction between feed restriction (FR) and probiotics (PR) on parameters investigated as follows:

Yijk = μ + Ti + Rj + (TR) ij + eij

Where :Yijk=An observation;μ = overall mean ;T= effect of FR level; I = (1,2 and 3); R= effect of PR level; j=(1 and 2); TR= effect of interaction between FR and PR (ij (1,2….6); and ejik= Experimental error.

Differences means among treatments were subjected to Duncan´s Multiple Range- test (Duncan, 1955).

RESULTS AND DISCUSSION

Body weight and daily weight gain:

The growth performance traits of growing rabbits fed diets with different levels of feed restriction (FR) and probiotics (PR) from 7 to 14 weeks of age is shown in Table (2). It is clearly observed that the rabbits fed ad-libitum always had significantly ($P \leq 0.05$) the highest body weight (BW) at 10 and 14 weeks of age. Also, the restricted diet with 140% of the energy requirements for maintenance showed significantly ($P \leq 0.05$) higher BW records than the diet 120% of this energy at the same age study. However, in this respect the two levels of FR did not significantly differ from each other as their final BW was more or less equal to 90.0-92.91% of the ad-libitum diet.

Regarding the effect of interaction on the BW and daily WG, the results showed that the rabbits fed the basal diet (Ad-libitum with PR) had the highest live BW and daily WG as compared the other dietary treatment groups, while those fed restricted diet 120 % of the energy requirements for maintenance without or with 0.4g PR/kg diet had the lowest live BW and WG at the same period studied. In this respect, dietary ad-libitum supplemented with 0.4 g PR/kg diet resulted in significantly higher ($P\leq0.05$) live BW than other treatment groups studied at 10 and 14 weeks of age, where the recorded of final BW was about 1065 of control rabbits.

As for daily weight gain (g/rabbit/day), the values were closely related to live body weight records where, rabbits fed ad-libitum + 0.4g PR/kg diet returned to the first position of daily weight gain and significantly ($P\leq0.05$) exceeded the control diet during interval periods it could be concluded that irrespective of fluctuations observed, rabbits fed the diet ad libitum + 0.4g probiotics/kg diet recorded the highest weight gain ($P\leq0.05$) than the other treatments studied.

Feed intake and feed conversion ratio:

The daily feed intake (FI) and feed conversion ratio (FC) of growing rabbits fed diets with different levels of FR and PR from 7 to 14 weeks of age are shown in Table (3). The results of FI were logically where the rabbits fed ad-libitum consumed significantly higher ($P\leq0.05$) feed than those fed restricted diets. The feed intake decreased by about 30.7 and 16.63% as a result of FR 120 and 140% of the energy for maintenance respectively as compared to the control diet during the collective period. The ad-libitum and FR supplemented with140% of energy for maintenance did not significantly differ from each other in FC. However, the most remarkable result, the best value of FC was to the rabbits fed restricted diet 120% of energy for maintenance being significantly greater than those fed ad-libitum and 140% of this energy

Average daily feed intake was not affected by the dietary PR applied irrespective of the fluctuations observed while; the feed conversion ratio was enhanced by supplemented 0.4g BR/Kg diet by about 8.16% compared to the diet without BR.

The effect of interaction indicated that FI significantly ($P\leq0.05$) decreased from 82 to 71.3 g/rabbit/day for rabbits fed ad-libitum diet + 0.4g probiotics / kg during the first week of study, also logically the other treatments resulted in a significant ($P\leq0.05$) decrease with respect to daily feed intake as compared to the control diet.

Regarding of feed conversion (FC), the results illustrated that the rabbits received 140% of the energy for maintenance with 0.4g PR /kg diet did not actually differ from control diet. On the other hand it was observed that rabbits fed 120% of energy for maintenance without or with PR supplementation and those received unrestricted feeding with 0.4g probiotics /kg diet were significantly ($P\leq0.05$) better than control diet by about 24.5, 15.1 and 15% respectively. However, it could be mentioned that all dietary treatments improved feed conversion irrespective of the fluctuations observed during the experiment periods from 7 to 14 weeks of age.

The most remarkable result is that the mean feed restriction ranged from 66.24% of ad libitum (120% of energy for maintenance – strong feed restriction) to 82.39 % (140% of energy for maintenance – moderate feed restriction) however, the reduction in body weight at 14 weeks of age was only 10.57 to 3.77% but the FC and performance index (PI) improved due to decrease feed intake especially in rabbits fed 120% of energy for maintenance. This is supported by Bergaoui et al., 2008; Gidenne et al., 2009a and 2009b who reported that the growth reduction is usually less than the intake reduction during the post-weaning restriction period, and for a 20% intake reduction the mean growth reduction is 15.6%.

For example, at the end of the restriction period the live weight is reduced by 7% to 10% for restriction levels of 15% to 25%. In addition, the effect of an intake limitation on weight gain is generally more severe at the beginning of the restriction period than later (Martignon et al., 2010). The results in the current study are supported by Dalle Zotte et al. (2005); Tumova et al. (2002) who reported that feed efficiency improve in a restricted feeding. Gidenne and Feugier, (2009) stated that decrease daily weight gain due to increasing intensity of feed restriction (90, 80, 70 or 60% of Ad-libitum). One likely explanation to understand these results is that in practical condition, feed restriction sometimes decreases the incidence of post-weaning digestive disorders (Boisot et al., 2003; Di Meo et al., 2007). In addition, a moderate feed restriction in growing rabbits could be used with some advantages such as increase digestive efficiency, modifies the partition of body energy retention as protein instead of fat and it could reduce mortality and morbidity due to digestive troubles (Xiccato and Trocino 2010). Biosot et al. (2003) and Gidenne, (2003) reported that feed restriction after weaning had significant beneficial effects on health only bellow 80% of ad libitum feeding, while moderate restrictions (80-90% of ad-libitum) were not effective or negative; thus may be some studies referred to feed restriction did not affect on feed efficiency or mortality in growing rabbits post weaning (Tumova et al., 2002; Gidenne et al., 2009c). From productive and economic points of view, feed rationing was more severe (60-70%), mortality was significantly reduced with the minimum levels in growing rabbits (Xiccato and Trocino 2010).

The most interesting result that there was an improvement in FC and PI by dietary BR, these results are in the line with the findings of previous study where some studies indicated that dietary BR improved growth rate and enhanced efficiency of feed conversion (Amber et al., 2004). Also, Abdel-Azeem et al. (2009), found an improvement in the performance index for rabbits fed diets supplementing with 200 or 400 mg Bio plus/ kg diet. The beneficial effects of these microorganisms for their ability to modulate the intestinal micro flora have been postulated to include competition for substrate as well as competing for receptor sites at the mucosal surface (Rinkinen et al., 2003; Vesterlund et al., 2006). Probiotics also have the ability to have a direct effect on pathogens by the production of an acidic environment, promoting the growth of a more beneficial micro flora (Miettinen et al., 1996). Also, the PR inclusion could be attributed to encouraging digestion by producing enzymes and vitamins, these functions strengthen the animal’s own non-specific immune defense (Kustos et al., 2004). Pogány Simonová et al., (2015) mentioned that probiotic supplementation improves intestinal environment and gut health directly influence the health status and growth performance of animals due to better nutrient absorption in the gut.

Carcass traits:

Results of carcass traits as shown in Table (4) observed that the moderate restricted diet resulted in significantly ($P \leq 0.05$) decrease in carcass, fat liver and giblets% when compared to ad-libitum diet. No statistical significant influence on all carcass traits due to the dietary PR could be detected except for the giblets % where the diet with 0.4g PR/Kg diet had significantly ($P \leq 0.05$) higher giblets % than diet without PR.

In addition all dietary interaction effect (FR x PR) had no significant influence on carcass % except for the rabbits fed 140% of energy for maintenance without BR where significantly decrease ($P \leq 0.05$) was observed by about 6.6 % compared to the control diet. No significant influence of dietary restricted with or without probiotics on heart, kidney, head, abdominal fat and gastrointestinal tract (GIT) could be observed, however all dietary treatments tended to have greater GIT and cecum% than control diet but only the rabbits fed 140% of energy for maintenance had significantly ($P \leq 0.05$) greater cecum% than control rabbits. It is evident that liver and giblets % decreased significantly ($P \leq 0.05$) with fed restricted by 140% without BR compared to the control diet. On the other hand abdominal fat% decreased insignificantly ($P \geq 0.05$) due to different dietary treatments.

These results are consistent with Boisot et al. (2003); Bergaoui et al. (2008); Gidenne et al. (2009a and b) who reported that at the end of the restriction period live weight is reduced by 7% to 10% for restriction levels of 15% to 25%. In respect of carcass fat, feed resection reduces fat in carcasses (Gondret et al., 2000; Tumova et al., 2007). From our results, it could be stated that the increase in digesta content seems to be the main contributor to the increased weight of the entire digestive tract. However, this increased development of the digestive tract depends on the restriction strategy and the weight gain (Je´rome et al., 1998). Finally, the weight of the entire digestive tract (gastrointestinal tract and caecum) reached about 23.48 and 41.11% higher (Table 4) than ad-libitum rabbits.

Performance index (PI) and viability:

As shown in Table (5), no significant effect due to feed restriction or PR applied could be demonstrated on PI with exception the rabbits fed dietary BR had significantly higher PI than the diet without PR. The performance index of rabbits fed 120% of energy requirements for maintenance + BR was significantly ($P \leq 0.05$) higher than the value recorded by the control diet, also PI of other dietary treatments were improved but slightly comparing with the control diet.

In terms of viability, no significant alternations could be detected du to dietary treatments, but the most remarkable result is that viability of rabbits fed 120% of energy for maintenance + 0.4g PR/ kg and those fed 140% of energy for maintenance without probiotics adding where viability was 100% while it was 88.9% for rabbits fed the control diet. This in the line with Matusevicius et al. (2006) who found that supplementing of 400 mg Bio Plus /kg in growing rabbit diet resulting in lower morbidity and mortality rate by 3% and 17%, respectively, as compared with control group.

Digestive enzymes

Lipase and protease concentration:

Table (5) shows the rabbits fed restricted diet with restricted by 140% of energy for maintenance recorded significantly the lowest lipase and protease values as compared to the ad-libitum diet. Also, the diet with 0.4 PR/Kg diet had the lowest values of lipase and protease enzymes. Also, the results illustrated that rabbits fed different dietary interaction treatments had ($P \leq 0.05$) the lowest values of lipase and protease with exception the restricted rabbits by 120% of energy requirements for maintenance without probiotics inclusion where it resulted in a significant (P≤0.05) increase in the digestible enzymes compared to the control rabbits.

The reduction in digestive enzymes as a result of restriction strategy in this study by reduced intake during the grower period may be due to impairs the maturation of the gut that develops quickly in the young rabbit. For instance, the ileal villus height and area, as well as crypt depth, increased after weaning (Gallois et al., 2005), but were not affected by a 25% reduction in intake from 28 days to 53 days of age (Martignon et al., 2010). In addition, it is acknowledged that the digestive enzyme secretion is related to substrate availability (i.e. intake level). Probiotics can improve the condition of digestive canal that is short of digestive enzymes (Wang et al., 2008).

Microbial activity:

In respect of the caecum micro flora, the rabbits fed ad-libitum diet resulted in a significant decrease (P≤0.05) in caecum total bacterial count (TBC) compared to the restricted diets (Table 5). Although the dietary restricted did not effect on the pathogenic bacteria (Escherichia coli) but the Escherichia coli / total bacterial count ratio was significantly decreased due to the tow levels of restricted diets comparing with the ad-libitum diet. In addition, both TBC and E. coli were significantly decrease by using the diet with PR while the ratio TBC/E. coli did not affect with dietary PR.

The results clearly observed that caecum of total bacterial count (TBC) tended to be significantly higher for rabbits fed on restricted by 140% of energy for maintenance without or with probiotics adding followed by the rabbits fed 120% of this energy than ad-libitum and the other treatments. Conversely, dietary treatments recorded significantly the lowest value of caecum E. coli and Escherichia coli/TBC ratio except for the rabbits fed 120% of energy for maintenance with probiotics inclusion and those received 140% of this energy without probiotics where no significant influence of these treatments on E. coli concentration could be detected. Also, the restricted diet by 120% of energy for maintenance with 0.4g probiotics/kg diet did not differ from the control diet in Escherichia coli/TBC ratio.

Regarding feed restriction on caecum content of bacterial community, the results in the current study seem to contradict the findings by Martignon et al., (2010) who mentioned that the feed intake level had no significant effect on the bacterial community structure or diversity. However it should be noted that adding 0.4mg / kg diet resulted in decrease E. coli bacteria as shown in rabbits fed ad-libitum with probiotic inclusion and 140% of energy for maintenance with adding the probiotic, this results are consist with Daniel et al. (2009) who stated that the addition of Lactobacilli lactis to the rabbits diet was effective at decreasing pathogenic bacteria colonization and translocation in a long-term neonatal model and it resulted in appropriate growth without any colonization or translocation of the probiotic outside of the GI tract . Similarly, Abdel-Azeem et al. (2009) found that addition of Bioplus 2B (400 mg/ kg diet) in rabbit diets reduced number of total bacterial count (especially pathogenic bacteria) in caecum content of rabbits. Also, Amber et al., (2014) pointed out that Pathogenic bacteria (Escherichia coli and Clostridium spp.) decreased by supplementing Bio-Mos, Bio-Plus or their mix in diets. This effect may be due to Lactobacilli are able to produce lactic acid from carbohydrate and are resistant to acidity as a result, while acid is fatal to other bacteria e.g. Escherichia coli (Gippert et al., 1992).In general, The reduction of pathogenic microbial species in the intestine could be due to a direct action of the probiotic or the indirect result of the stimulation of the beneficial bacteria (Nicodemus et al., 2004). Changes in the physical microenvironment inhibit pathogen growth in two ways. First, probiotic organisms compete with pathogens for nutrients thus preventing them from acquiring energy to grow and function in the gut environment (Cummings and Macfarlane, 1997). Second, probiotics produce a variety of organic acid end products, such as volatile fatty acids as a part of their metabolism of nutrients in the gut digest (Gibson, 1999).

Serum biochemical:

Serum biochemical data within normal range for growing rabbits fed different levels of restricted diets BR is shown in Table (6). Serum total protein and triglycerides were significantly increased ($P \leq 0.05$) by the two levels of dietary restriction but conversely the cholesterol, AST (aspartic transaminase) and ALT (alanine aminotransferase) were decreased as compared to ad-libitum diet. No significant influence of dietary PR on serum total protein while the cholesterol, AST and ALT was significantly ($P \leq 0.05$) decreased compared to the diet without PR. According to Van Harten and Cardoso (2010) many metabolic parameters are modified under restriction diets. The ad-libitum diet with adding 0.4 probiotics/ kg diet, 120% of energy for maintenance without or with probiotics inclusion did not significantly ($P \geq 0.05$) influence on serum protein as compared with the control diet, while the diet fed 140% of energy for maintenance with or without probiotics adding ted to significantly ($P \leq 0.05$) higher in serum protein than control diet. This might be due to the higher digestibility of CP in these diets (Amber, 2000). Also, the values of serum triglycerides were slightly significantly ($P \leq 0.05$) greater for restricted groups than for the ad libitum groups. However, the opposite trend was recorded for serum cholesterol, AST and ALT concentration in blood serum which significantly ($P \leq 0.05$) decreased in response to restricted diets without or with probiotics adding compared to the ad libitum diet. On the other hand, rabbits received ad libitum diet with 0.4g probiotics/ kg diet had significantly ($P \leq 0.05$) the highest level of liver function enzymes compared to control rabbits.

In respect of total protein, the results in the line with Abd El-Maksoud et al., (2014) who mentioned that the highest ($P<0.05$) total protein values were obtained with rabbits that supplemented probiotic during (10-14) weeks period (9.10 g/dl) Also, El-deek et al., (2013) reported that the concentration of serum total protein was significantly higher in groups fed diets supplemented with probiotic. Amber et al., (2014) reported that serum total protein, albumin and globulin significantly increased with supplementing Bio-Mos, Bio-Plus or their mix in diets. The decrement in serum cholesterol is in agreement with Arun et al. (2006) who found that serum total cholesterol and triglycerides were reduced significantly by dietary supplementation of PR containing L. sporogene at 100 mg per kg diet. El-deek et al., (2013) observed that serum cholesterol was significantly deceased in groups fed diets supplemented with probiotic. Amber et al., (2014) reported that serum cholesterol and triglycerides were significantly decreased by supplementing Bio-Mos, Bio-Plus or their mix in diets. Panda et al., (2003) hypothesized that the cholesterol - lowering effect was due to reduced cholesterol absorption from the gastrointestinal tract and/or by the deconjugation of bile salts in the intestine, which would prevent their reabsorption via the enterohepatic circulation. The reduction in enzymatic liver function could not be considered an evidence for the presence of any serious damages to the liver but may be due to decrease feed intake. On the other hand, Amber et al. (2014) reported that were not significant differences among treatments in liver function enzymes (AST, and ALT).

Hematology traits:

Results concerning the hematology traits within normal range of growing rabbits fed restricted diets without or with 0.4 g probiotics/ kg diet at 13 weeks of age are presented in Table (7). No significant differences were detected among rabbits fed restricted and ad-libitum diets in red blood cells (RBC), hematocrit (HCT), hemoglobin (HEB) and eosinophil cells while the rabbits fed a moderate and strong feed restriction recorded the highest values of white blood cells (WBC), neutrophils (N) and N/L ratio. Generally, these results indicated that all hematology traits were not affected by the dietary PR inclusion.

No significant influence of restricted feeding without or with PR adding on RBC, HCT, HEB, WBC and M values could be detected. However, in respect of neutrophils (N), the rabbits fed 120% of energy for maintenance without PR adding recorded significantly ($P \leq 0.05$) the least value comparing with the control diet. Also, lymphocyte cells (L) showed a significant ($P \leq 0.05$) decrease as the rabbits fed restricted by 120% of energy for maintenance and with 0.4g PR/kg diet compared to control rabbits. Regarding N/L, restricted diet 140% of energy for maintenance with adding 0.4g PR/ kg diet resulted in a enhanced N/L ratio as compared to the control and other treatments except for the restricted by 140% of energy requirements for maintenance without PR adding.

The immune status of restricted rabbits was briefly described through some blood characteristics, such as the cell profile. Tumova et al. (2007) mentioned an increased number of lymphocytes in restricted rabbits. The mode of action of PR is that they produce specific and intermediate metabolites which stimulate the body immune systems (Sherman et al., 2009).

Economic efficiency:

As shown in Table (8), it is interesting to note from economical view that the total feed cost/ rabbit was lower for rabbits fed restricted diets without or with probiotics adding than ad-libitum diet, logically this decrement in feed cost due to decrease feed intake/ rabbit in restricted diets. Although both weight gain and total return/ rabbit was decreased as a result from feed restriction, the results illustrated that the net return improved for rabbits received ad-libitum with 0.4 g BR/ kg diet followed by those fed 120% of energy for maintenance with PR adding. Indeed, comparing with the control diet, all dietary treatments resulted in a significant improve in the economic efficiency (EE), but the best value of EE was found for rabbits fed 120% of the maintenance energy with 0.4g probiotics/kg diet followed by the rabbits fed 120% of this energy without probiotics inclusion then those received ad-libitum diet with 0.4g probiotics/ kg diet.

This result is consistent with Duperray and Gyonvarch, (2009) who reported that the FC is improved by 10% to 20% after the application of strategy of intake restriction post-weaning. Consequently, when an intake limitation strategy is applied, the margin on the feed cost is generally improved by 2% to 10%. Also El-deek et al., (2013) found that the highest economical efficiency value was recorded with group fed diet supplemented with probiotic.

CONCLUSION

These results imply an important FR strategies by 120% of energy requirements for maintenance and supplemented with 0.4g PR/ kg diet in the growing rabbits from 7-14 weeks of age, where in general both the two levels of restricted diets especially strong feed restriction (120% of energy requirements for maintenance) and ad-libitum diet with PR inclusion improved feed conversion, performance index, Escherichia coli /TBC ratio as well as economic efficiency under environmental Egyptian condition.

Table (1): Composition and calculated analysis of the basal diet

Ingredients	%
Barley grain	24.60
Alfalfa hay	31.00
Soy bean meal (44 %)	13.25
Wheat brain	28.00
Di-calcium phosphate	1.60
Limestone	0.95
Sodium chloride	0.30
Mineral-vitamin premix [1]	0.30
Total	100
Calculated Analysis [2]	
Dry matter %	
Crude protein %	17.08
DE (Kcal / kg)	2416
ME (Kcal / kg) [3]	2119
Crude fiber %	12.55
Ether extract %	2.20
Calcium %	1.20
T. Phosphorus %	0.76
Lysine (%)	0.84
Methionine (%)	0.23
Lysine (%)	0.86
Price (LE/kg) [4]	2.50

(1) One kilogram of mineral–vitamin premix provided: Vitamin A, 150,000 UI; Vitamin E, 100 mg; Vitamin K3, 21mg; Vitamin B1, 10 mg; VitaminB2, 40mg; Vitamin B6, 15mg; Pantothenic acid, 100 mg; Vitamin B12, 0.1mg; Niacin, 200 mg; Folic acid, 10mg; Biotin, 0.5mg; Choline chloride, 5000 mg; Fe, 0.3mg; Mn, 600 mg; Cu, 50 mg; Co, 2 mg; Se, 1mg; and Zn, 450mg.

(2) Calculated analysis according to feed composition tables for rabbits feedstuffs used by De Blas and Mateos (2010); (3) ME (Kcal/kg diet) estimated as 0.95 DE according to Santoma et al. (1989)

(4) Price of one kg (Egyptian pound/Kg) for different ingredients: Barley grain, 2.6.; Alfalfa hay, 1.8.; Yellow corn, 3.95; Soy been meal, 4.2.; Wheat bran, 2.1.; Di-calcium, 4.8; limestone, 0.20; Premix, 27.0; Sodium chloride, 0.50 and Probiotics, 200

Table (2): Effect of feed restriction, probiotics and their interaction between them on bogy weight and daily weight of grower rabbits from 7 to 14 weeks of age

Traits / Factors		Body weight (g/rabbit)			Daily weight gain (g/rabbit/day)		
		7	**10**	**14**	**7-10**	**10--14**	**7-14**
Feed restriction (FR)							
Ad-lib[1]		947.2	1360.4^{a}	1816.0^{a}	19.7^{a}	16.3^{a}	17.7^{a}
120 % [2]		943.9	1241.6^{c}	1636.8^{b}	14.2^{b}	14.1^{b}	14.1^{b}
140 % [3]		960.8	1279.2^{b}	1687.2^{b}	15.2^{b}	14.6^{b}	14.8^{b}
±SE mean		12.06	11.41	17.28	0.84	0.44	0.44
Signi.		NS	0.05	0.05	0.05	0.05	0.05
Probiotics (PR)							
(0)[4]		951.1	1274.1^{b}	1673.6^{b}	15.4	14.3^{b}	14.7^{b}
0.4g[5]		950.2	1313.4^{a}	1753.1^{a}	17.3	15.7^{a}	16.4^{a}
±SE		9.85	9.31	14.11	0.68	0.36	0.46
Signi.		NS	0.05	0.05	NS	0.05	0.05
Interaction effect (FR x PR)							
Ad-lib	0	950	1341.7^{ab}	1763.2^{b}	18.7^{ab}	15.1^{b}	16.6^{b}
	0.4	944.3	1379.2^{a}	1868.9^{a}	20.7^{a}	17.5^{a}	18.9^{a}
120%	0	937.7	1190.7^{d}	1576.9^{d}	12.0^{c}	13.8^{b}	13.0^{c}
	0.4	950	1292.6^{bc}	1696.7^{bc}	16.3^{b}	14.4^{b}	15.2^{b}
140%	0	965.3	1290.0^{bc}	1680.6^{c}	15.5^{bc}	14.0^{b}	14.6^{bc}
	0.4	956	1268.3^{c}	1693.8^{bc}	14.9^{bc}	16.2^{b}	15.1^{b}
±SE mean		0.01	15.34	23.1	0.78	0.37	0.51
Signi.		NS	0.05	0.05	0.05	0.05	0.05

[1]The basal diet, which without probiotic and fed ad-lib; [2] the basal diet fed 120% of the energy for maintenance regardless the supplementation of the probiotic; [3] the basal diet fed 140% of the energy for maintenance regardless the supplementation of the probiotic; [4]fed the basal diets without probiotic regardless feed restriction; [5]fed the basal diet with 0.04g probiotic/Kg diet regardless feed restriction.
a, b, c :means in the same column bearing different superscripts are significantly different ($p \leq 0.05$).
NS= non-significant

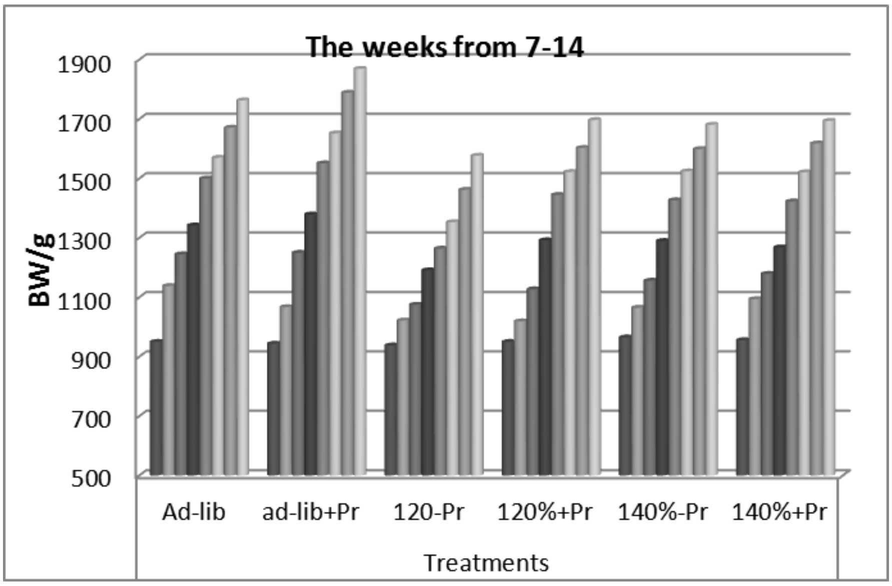

Figure (1): Effect of interaction between feed restriction and probiotics on body weight (g) every week from 7-14 weeks of age

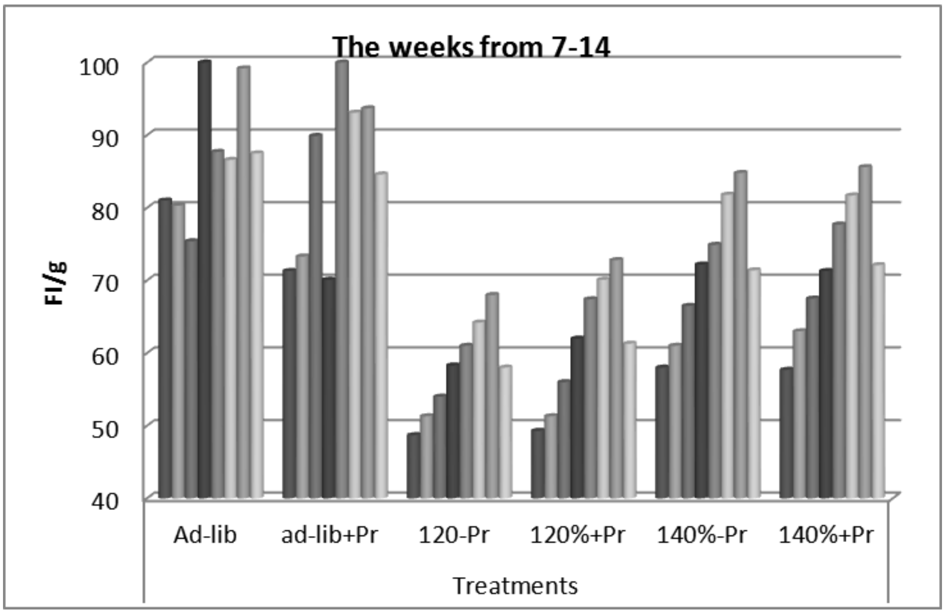

Figure (2): Effect of interaction between feed restriction and probiotics on feed intake every week (g/day/rabbit) from 7-14 and overall period

Table (3): Effect of feed restriction, probiotics and their interaction between them on feed intake and feed conversion ratio of grower rabbits from 7 to 14 weeks of age

Traits / Factors		Feed intake (g/rabbit)			Feed conversion ratio		
		7-10	**10-14**	**7-14**	**7-10**	**10--14**	**7-14**
Feed restriction (FR)							
Ad-lib		78.5^{a}	91.7^{a}	86.0^{a}	4.3	6.3^{a}	4.9^{a}
120 %		51.8^{c}	65.5^{c}	59.6^{c}	4.2	5.0^{b}	4.2^{b}
140 %		62.4^{b}	78.8^{b}	71.7^{b}	4.5	5.9^{a}	4.9^{a}
±SE mean		1.34	0.78	0.60	0.12	0.17	0.12
Signi.		0.05	0.05	0.05	NS	0.05	0.05
Probiotics (PR)							
(0)		64.1	78.4	72.3	4.5	5.9	4.9^{a}
0.4g		64.5	78.9	72.7	4.2	5.5	4.5^{b}
±SE		1.09	0.64	0.49	0.18	0.14	0.10
Signi.		NS	NS	NS	NS	NS	0.05
Interaction effect (FR x PR)							
Ad-lib	0	78.9^{a}	94.0^{a}	87.5^{a}	4.6^{ab}	6.8^{a}	5.3^{a}
	0.4	78.1^{a}	89.4^{b}	84.6^{b}	4.0^{ab}	5.7^{bc}	4.5^{bc}
120%	0	51.4^{c}	62.9^{e}	58.0e	4.8^{a}	4.8^{d}	4.5^{bc}
	0.4	52.2^{c}	68.1^{d}	61.3^{d}	3.7^{b}	5.2^{cd}	4.0^{c}
140%	0	62.0^{b}	78.4^{c}	71.4^{c}	4.1^{ab}	6.1^{ab}	5.0^{ab}
	0.4	62.8^{b}	79.1^{c}	72.1^{c}	4.9^{a}	5.7^{bc}	4.8^{ab}
±SE mean		1.73	2.67	2.66	0.15	0.18	0.11
Signi.		0.05	0.05	0.05	0.05	0.05	0.05

a, b, c, d, e: means in the same column bearing different superscripts are significantly different ($p \leq 0.05$). NS= non-significant

Table (4): Effect of feed restriction, probiotics and their interaction between them on carcass quality traits of grower rabbits at 14 weeks of age

Traits / Factors		Carcass	Heart	Liver	Giblets	Kidney	Ab. fat	GIT*	Cecum
		Carcass quality traits %							
Feed restriction (FR)									
Ad-lib		60.8^{a}	0.25	3.3^{a}	3.5^{a}	0.71	0.99	15.9	5.5^{b}
120 %		59.8^{ab}	0.30	3.4^{a}	3.6^{a}	0.71	0.74	16.8	5.8^{b}
140 %		58.0^{b}	0.24	2.8^{b}	3.0^{b}	0.73	0.55	18.3	7.0^{a}
±SE mean		0.73	0.02	0.13	0.14	0.04	0.14	0.94	0.42
Signi.		0.05	NS	0.05	0.05	NS	NS	NS	0.05
Probiotics (PR)									
(0)		59.8	0.27	3.3	3.5^{a}	0.68	0.77	17.4	6.3
0.4g		59.3	0.26	3.0	3.1^{b}	0.75	0.74	16.7	6.0
±SE		0.59	0.02	0.11	0.11	0.03	0.11	0.77	0.35
Signi.		NS	NS	NS	0.05	NS	NS	NS	NS
Interaction effect (FR x PR)									
Ad-lib	0	61.0^{a}	0.23^{ab}	3.39^{ab}	3.58^{ab}	0.63	1.05	15.76	5.23^{b}
	0.4	60.7^{a}	0.27^{ab}	3.25^{bc}	3.43^{bc}	0.79	0.93	16.09	5.83^{b}
120 %	0	61.3^{a}	0.31^{a}	3.90^{a}	4.14^{a}	0.74	0.78	16.82	6.16^{ab}
	0.4	58.3^{ab}	0.28^{ab}	2.80^{bc}	2.96^{bc}	0.68	0.7	16.82	5.45^{ab}
140%	0	57.0^{b}	0.27^{ab}	2.704^{c}	2.91^{c}	0.68	0.50	19.46	7.38^{a}
	0.4	59.0^{ab}	0.21^{b}	2.79^{bc}	3.00^{bc}	0.77	0.60	17.04	6.69^{ab}
±SE mean		0.52	0.01	0.12	0.13	0.02	0.08	0.54	0.27
Signi.		0.05	0.05	0.05	0.05	NS	NS	NS	0.05

*GIT= Gastrointestinal tract

a, b, c: means in the same column bearing different superscripts are significantly different ($p \leq 0.05$). NS= non-significant; Carcass weight (%) = Empty body weight/Pre slaughter x 100; Dressing weight=Carcass weight %+Giblets weight % (Liver+ Heart+ Kidneys weight %)

Table (5): Effect of feed restriction, probiotics and their interaction between them on performance index, viability, digestive enzymes and microbial activity of grower rabbits

Traits / Factors		PI and viability %		Digestive enzymes		Microbial activity		
		PI[1]	**V[2]**	**Lipase (u/l)**	**Protease (mu/ml)**	**TBC[3]**	**E coli[4]**	**E. coli / TBC**
Feed restriction (FR)								
Ad-lib		37.6	93.3	100.4^{b}	24.2^{a}	1.8^{c}	0.83	0.46^{a}
120 %		38.9	94.4	128.5^{a}	24.5^{a}	3.6^{b}	1.0	0.27^{b}
140 %		34.9	94.4	49.8^{c}	19.1^{b}	8.3^{a}	1.4	0.17^{c}
±SE mean		1.25	6.42	2.88	0.80	0.13	0.22	0.03
Signi.		NS	NS	0.05	0.05	0.05	NS	0.05
Probiotics (PR)								
(0)		34.4^{b}	92.6	110.5^{a}	24.2^{a}	5.6^{a}	1.6^{a}	0.29
With 0.4g		39.8^{a}	88.9	75.3^{b}	20.9^{b}	3.5^{b}	0.6^{b}	0.17
±SE		1.02	5.24	2.36	0.65	0.10	0.18	0.03
Signi.		0.05	NS	0.05	0.05	0.05	0.05	NS
Interaction effect (FR x PR)								
Ad-lib	0	33.4^{b}	88.9	132.3^{b}	27.8^{a}	3.3^{d}	1.60^{a}	0.48^{a}
	0.4	41.7^{a}	77.8	68.5^{d}	20.5^{bc}	0.2^{e}	0.05^{c}	0.28^{b}
120 %	0	35.5^{b}	88.9	147.2^{a}	26.2^{a}	3.1^{d}	0.31^{c}	0.10^{c}
	0.4	42.2^{a}	100	109.8^{c}	22.7^{b}	4.0^{c}	1.70^{b}	0.43^{a}
140%	0	34.4^{b}	100	52.0^{d}	18.7^{c}	10.3^{a}	2.83^{a}	0.28^{b}
	0.4	35.4^{b}	88.9	47.6^{d}	19.4^{bc}	6.2^{b}	0.05^{c}	0.01^{c}
±SE mean		1.04	3.62	9.55	0.92	0.76	0.27	0.04
Signi.		0.05	NS	0.05	0.05	0.05	0.05	0.05

[1] = Performance index; [2]= viability; [3]= total bacterial count (x 10^{7}) germ counts expressed in CFU/g caecal digesta; [4]= Escherichia coli (x 10^{4}) germ counts expressed in CFU/g caecal digesta; a, b, c, d: means in the same column bearing different superscripts are significantly different ($P \leq 0.05$). NS= non-significant

Table (6): Effect of feed restriction, probiotics and their interaction between them on some serum biochemical of grower rabbits at 14 weeks of age

Traits / Factors		T. protein (g/dl)	Triglyceride (mg/dl)	Cholesterol (mg/dl)	AST (U/dl)	ALT (U/dl)
		Serum biochemical				
Feed restriction (FR)						
Ad-lib		6.17^{c}	99.3^{c}	195.2^{a}	43.2^{a}	51.8^{a}
120 %		7.00^{b}	119.3^{b}	171.5^{b}	30.0^{b}	41.7^{b}
140 %		7.83^{a}	129.8^{a}	154.2^{c}	22.8^{c}	32.8^{c}
±SE mean		0.14	1.18	1.88	0.40	0.69
Signi.		0.05	0.05	0.05	0.05	0.05
Probiotics (PR)						
(0)		6.89	113.0^{b}	179.7^{a}	34.3^{a}	44.6^{a}
With 0.4g		7.11	119.3^{a}	167.6^{b}	29.7^{b}	39.7^{b}
±SE		0.11	0.97	1.53	0.32	0.56
Signi.		NS	0.05	0.05	0.05	0.05
Interaction effect (FR x PR)						
Ad-lib	0	6.0^{a}	99^{d}	197^{a}	46^{a}	55^{a}
	0.4	6.3^{a}	100^{d}	193^{a}	40^{b}	49^{b}
120 %	0	7.0^{b}	114^{c}	182^{b}	33^{c}	44^{c}
	0.4	7.0^{b}	124^{b}	161^{c}	27^{d}	39^{d}
140%	0	7.7^{a}	126^{b}	160^{c}	24^{e}	35^{e}
	0.4	8.0^{a}	134^{a}	148^{d}	22^{e}	31^{f}
±SE mean		0.18	3.25	4.51	2.14	2.01
Signi.		0.05	0.05	0.05	0.05	0.05

a, b, c, e, f: means in the same column bearing different superscripts are significantly different (p ≤ 0.05).
NS= non-significant;

Table (7): Effect of feed restriction, probiotics and their interaction between them on hematology traits of grower rabbits at 14 weeks of age

Traits / Factors		RBC ($x10^{12}$)	HCT %	HEB (g/dl)	WBC ($x10^9$	N %	L %	N/L	M %	E %
Feed restriction (FR)										
Ad-lib		5.8	34.3	11.7	5.0^b	54.3^b	41.7^a	1.3^b	2.7^{ab}	0.67
120 %		6.0	34.5	12.2	5.5^{ab}	50.7^b	42.7^a	1.9^b	4.5^a	2.17
140 %		6.0	34.7	12.3	6.5^a	61.0^a	36.3^b	1.7^a	1.5^b	1.17
±SE mean		0.17	0.79	12.1	0.45	1.37	1.37	0.09	0.92	0.50
Signi.		NS	NS	12.0	0.05	0.05	0.05	0.05	0.05	NS
Probiotics (PR)										
(0)		6.0	34.7	12.1	5.9	53.7	40.7	1.3	3.3	2.0^a
With 0.4g		5.9	34.3	12.0	5.4	57.0	39.8	1.5	2.4	0.67^b
±SE		0.14	0.70	0.21	0.37	1.12	1.12	0.08	0.75	0.41
Signi.		NS	NS	NS	NS	NS	NS	NS	NS	0.05
Interaction effect (FR x PR)										
Ad-lib	0	5.67	35.0	11.7	5.3	53.0^{abc}	42.0^a	1.26^b	3.3	0.67^b
	0.4	6.0	33.7	11.7	4.7	55.67^{bc}	41.3^a	1.35^b	2.0	0.67^b
120 %	0	6.0	34.0	12.0	6.0	49.0^d	42.0^a	1.17^b	5.3	3.7^a
	0.4	6.0	35.0	12.3	5.0	52.33^{cd}	43.3^a	1.12^b	3.7	0.67^b
140%	0	6.3	35.0	12.7	6.3	59.0^{ab}	38.0^{ab}	1.59^{ab}	1.3	1.7^{ab}
	0.4	5.7	34.4	12.0	6.7	63.0^a	34.7^b	1.85^a	1.7	0.67^b
±SE mean		0.10	0.41	0.51	0.33	1.30	0.98	0.08	0.56	0.36
Signi.		NS	NS	NS	NS	0.05	0.05	0.05	NS	0.05

a, b, c, d: means in the same column bearing different superscripts are significantly different ($p \leq 0.05$).
NS= non-significant;

Table (8): Effect of feed restriction, probiotics and their interaction between them on economic efficiency of grower rabbits at 14 weeks of age

Traits / Factors	Economic efficiency							
	TFI/ rabbit[1]	**Price/kg feed[2]**	**TFC/ rabbit[3]**	**WG/ rabbit[4]**	**Price/ kg BW[5]**	**T. return**	**Net return**	**R EEF[6,7]**
Feed restriction (FR)								
Ad-lib	4.22	2.54	10.72	868.8	28	24.3	13.6	113.1^{b}
120 %	2.92	2.54	7.43	692.9	28	19.4	12.0	143.1^{a}
140 %	3.52	2.54	8.94	726.4	28	20.3	11.4	113.7^{b}
Mean ±SE								5.25
Significant								0.05
Probiotics (PR)								
(0)	3.54	2.50	8.87	722.4	28	20.2	11.4	116.6^{b}
With 0.4g	3.56	2.58	9.20	802.9	28	22.2	13.3	130.0^{a}
Mean ±SE								4.29
Significant								0.05
Interaction effect (FR x PR)								
Ad-lib 0	4.288	2.50	10.72	813.3	28	22.8	12.08	100^{c}
Ad-lib 0.4	4.144	2.58	10.69	924.4	28	25.9	15.21	126.3^{b}
120% 0	2.84,	2.50	7.10	639.2	28	17.9	10.80	135.2^{ab}
120% 0.4	3.002	2.58	7.75	746.7	28	20.9	13.15	151.1^{a}
140% 0	3.497	2.50	8.74	715.0	28	20.0	11.26	114.7^{bc}
140% 0.4	3.533	2.58	9.12	737.7	28	20.7	11.58	112.7^{bc}
Mean ±SE								4.76
Significant								0.05

[1] = Total feed intake/rabbit/overall period; [2]Price/ kg feed= the price of 1Kg feed by Egyptian pound; 3=Total feed cost/rabbit; [4]= Total weight gain/rabbit; [5]= the price 1 Kg of live body weight by Egyptian pound; [6]EEF= Economic efficiency (%) = (Net return/Total feed cost) x 100; [7]R FEE= (EEF of treatments/EEF of control diet) x100; a. b. c means in the same column bearing superscripts are significantly different (P≤ 0.05)

REFERENCES

Abdel-Azeem, F.; Hashim, N. A.; Badawi, Y. K. E. H.; and Farid, A., 2009. Comparative study between probiotic (Bioplus 2B) and antibiotic (lincofeed) on the performance of growing rabbits. Egypt. J. Rabbit Sci., 19(1): 7-22.

Abd El-Maksoud, A.; Salama, A. A.; and El-Sheikh, S. E. M., 2014. Effect of supplementation time of probiotic in drinking water on New Zealand white productive performance. Egypt. Poult. Sci. 34(3): 779-794.

APHA, 1960. American Health Association. Standard Methods for the Examination of Diary Products. American Published Health Association 11th Edition, New York.

Amber, Kh., 2000. Effect of replacing mung beans (Phaseolus aureus) for soybean meal in diets for growing rabbits. Proc. of 7th World Rabbit Congress, Valencia, Vol. A, pp. 69-75

Amber, K. H.; Yakout, H. M.; and Hamed, R. S., 2004. Effect of feeding diets containing yucca extract or probiotic on growth, digestibility, nitrogen balance and caecal microbial activity of growing New Zealand white rabbits. In: Proceedings of the 8th World Rabbit Congress, Puebla, Mexico, 7–10 September, pp:737–745.

Amber, K. H.; Fatma, M. Abd El-Nabil, Morsy, W. A.; and Shama, H. A. Morsy, 2014. Effect of dietary supplementation of probiotic and prebiotic on preventing post weaning digestive disorders and productive of growing rabbits. Egypt. Poult. Sci., 34(1): 19-38.

Arun, K. P.; Rao, R.; Savaram, V.; Mantena, V. L. N.; Raju, S. and Sharma, R., 2006. Dietary supplementation of Lactobacillus Sporogenes on performance and serum biochemico-lipid profile of broiler chickens. Journal of Poultry Science. 43: 235–240.

Bergaoui, R. M.; Kammoun M.; and Ouerdiane, K., 2008. Effects of feed restriction on the performance and carcass of growing rabbits. Proceedings of the 9th World Rabbit Congress, June 10–13, 2008, Verona, Italy, pp. 547–550. Fond. Ini. Zooprofilattiche E Zoot. publ. Brescia Italy.

Boisot, P.; Licois, D.; and Gidenne, D., 2003. Feed restriction reduces the sanitary impact of an experimental reproduction of Epizootic Rabbit Enteropathy syndrome (ERE) in the growing rabbit. In: Proc. 10th French Rabbit Days, Paris, France, 267–270.

Cummings, J. H.; and Macfarlane, G. T., 1997. Role of intestinal bacteria in nutrient metabolism. J.Parenteral and Enteral Nutr., 21: 357-365.

Dalle Zotte, A.; Reignon, H.; and Ouyayoun, J., 2005. Effect of feed rationing during post weaning growth on meat quality, muscle energy metabolism and fiber properties of Biceps femurs muscle in the rabbit. Meat Science. 70.2: 301-306.

Daniel, R.; Copelanda, B.; Marcene, R.; McVaya, B.; Dassingera, M. S.; Jacksona, R. J.; and Smith, S. D., 2009. Probiotic fortified diet reduces bacterial colonization and translocation in a long-term neonatal rabbit model. Journal of Pediatric Surgery (2009) 44, 1061–1064

De Blas, J. C.; and Wiseman, J., 2010. ‘Nutrition of the Rabbit’ CABI Publishing (2nd Revised edition) Wallingford, Oxford.

Difco Mannual, 1977. Dehydrated Culture Media and Reagents. Difco Laboratories 8th Edition, Detruit, Michigan, USA.

Di Meo, C.; Bovera, F.; Marono, S.; Vella, N.; and Nizza, A., 2007. Effect of feed restriction on performance and feed digestibility in rabbits. Italian Journal of Animal Science, 6, 765–767.

Duncan, D.B., 1955. Multiple ranges and multiple f- test, Biometries 11: 1-42.

Duperray, J.; and Gyonvarch, A., 2009. Effect of different quantitative feed restriction strategies on fattening performance, and interest of a high energy and protein feed. In Proceedings of the 13e`mes Journe´ es de la Recherche Cunicole Francaise (ed. G Bolet), pp. 59–62. ITAVI Publishing, Le Mans, France.

El-deek, A.A.; Albanoby, M.A.; and Abou El- Naga, M. K., 2013. Evaluation of super action probiotic as a natural growth promoter for growing rabbits . Egypt. Poult. Sci. (33) (ii): (407-419).

FEDNA, 2013. Nutritional guidelines for feeding pet rabbits. European pet food industry federation/ Av. Louse 89/ B-Bruxells/ www.fediar.org.

Fuller, R., 1992. Historyand development of probiotics. In:Fuller,R.(Ed.), Probiotics—The Scientific Basis,Chapmanand Hall, London,pp.1–8.

Gallois, M.; Gidenne, T.; Fortun-Lamothe, L.; and Huerou-Luron, I. L., 2005. An early stimulation of solid feed intake slightly influences the morphological gut maturation in the rabbit. Reproduction Nutrition Development 45, 109–122.

Gibson, G. R., 1999. Dietary modulation of the human gut microflora using the prebiotics oligofructose and inulin. J. Nutr., 129: 1438S-1441S.

Gippert, T.; Virag, G. Y.; and Nagy, I., 1992. Lacto-sacc in rabbit nutrition. J. Appl. Rabbit Res. 15: 1101-1104.

Gidenne, T., 2003. Fibers in rabbit feeding for digestive troubles prevention: respective role of low-digested and digestible fiber. Livestock Production Science 81, 105-117.

Gidenne, T.; and Feugier, A., 2009. Feed restriction strategy in the growing rabbit. 1. Impact on digestion, rate of passage and microbial activity. Animal, 3, 501–508.

Gidenne, T.; Combes, S.; Feugier, A.; Jehl, N.; Arveux, P.; Boisot, P.; Briens, C.; Corrent, E.; Fortune, H.; Montessuy, S.; and Verdelhan, S., 2009a. Feed restriction strategy in the growing rabbit. 2. Impact on digestive health, growth and carcass characteristics. Animal, 3, 509–515.

Gidenne, T.; Murr, S.; Travel, A.; Corrent, E.; Foubert, C.; Bebin, K.; Mevel, L.; Rebours, G.; and Renouf, B., 2009b. Effets du niveau de rationnement et du mode de distribution de l'aliment sur les performances et les troubles digestifs postsevrage du lapereau. Premiers re´ sultats d'une e´ tude concerte´e du re´ seau GEC. Cuniculture Magazine 36, 65–72.

Gidenne, T.; Bannelier, C.; Combes, S.; and Fortun - Lamothe L., 2009c. Interaction between the energetic feed concentration and the restriction strategy – impact on feeding behaviour, growth and health of the rabbit. 13e`me Journe´ es de Recherches Cunicoles, Le Mans, France, pp. 63–66.

Gondret, F.; Lebas, F.; and Bonneau, M., 2000. Restricted feed intake during fattening reduces intramuscular lipid deposition without modifying muscle fiber characteristics in rabbits. Journal of Nutrition, 130, 228–233.

Je´rome N.; Mousset, J. L.; Messager, B.; Deglaire, I.; and Marie P., 1998. Influence de diffe´ rentes me´ thodes de rationnement sur les performances de croissance et d'abattage du lapin. In A7e`mes Journe´ es de Recherches Cunicoles (ed. JM Perez), pp. 175–178. ITAVI Publishing, Paris, Lyon.

Kustos, K.; Kovacs, D.; Gódor-surmann, K.; and Eiben, C.S., 2004. Effect of probiotic BioPlus 2B® on performance of growing rabbits. Proc. 8th World Rabbit Congress, Pueblá, Mexico, pp. 874-878.

Lebas, F., 2007. L'utilisation de la restriction alimentaire dans le filie` re cunicole. Cuniculture Magazine, ASFC. Retrieved January 30, 2012, from http://www .asfc-lapin.com/Docs/Activite/T-ronde-2007/T-ronde2007-1.htm

Marlier, D.; Dewree, R.; Delleur, V.; Licois, D.; Lassence, C.; Poulipoulis, A.; and Vindevogel, H., 2003. A review of the major causes of digestive disorders in the European rabbit. Annales de Medecine Veterinaire 147, 385–392.

Martignon, M.H.; Combes, S.; and Gidenne, T., 2010. Digestive physiology and hindgut bacterial community of the young rabbit (Oryctolagus cuniculus): effects of age and short-term intake limitation. Comparative Biochemistry and Physiology – Part A: Molecular & Integrative Physiology 156, 156–162.

Maertens, L., 2009. Possibilities to reduce the feed conversion in rabbit production. In: Proceedings Giornate di Coniglicoltura ASIC, Forli. Italy, pp. 1-10.

Mackie, and Mc Carteny, 1953. Handbook of Practical Bacteriology. A guide Bacteriology laboratory work. 9th Edition, Liv

Matusevicius, P.; Asmenskaite, L.; Zilinskiene, A.; Gugolek, A.; Lorek, M.O.; and Hartman, A., 2006. Effect of probiotic Bioplus 2B® on performance of growing rabbit. Veterinarija Ir Zootechnika T. , 36 (58): 132-141.

Miettinen, M.; Vuopio-Varkila, J.; and Varkila, K.; 1996. Production of human tumor necrosis factor alpha, interleukin-6, and interleukin-10 is induced by lactic acid bacteria. Infect Immun ;64:5403-5.

Mountzouris, K. C.; Tsirtsikos, P.; Kalamara, E.; Nitsch, S.; Schatzmayr, G.; and Fegeros, K., 2007. Evaluationoftheefficacyofaprobioticcontaining lactobacillus, bifidobacterium,enterococcus,andpediococcusstrains in promoting broiler performance and modulating cecal micro flora composition and metabolic activities.Poult.Sci.86,309–317.

Nicodemus, N.; Cararano, R.; Garcia, J.; DE Blas J. C., 2004. Performance response of doe rabbits to toyocerin® (Bacillus cereus var. Toyoi) supplementation. World Rabbit Sci. 12: 109 – 118

North, M. O., 1981. Commercial Chicken. Production Annual. 2nd Edition, Production 6th Ed. Interstate Printers and Publishers. INC., USA.

Oso A.O.; Idowu, O. M. O.; Haastrup, A. S.; Ajibade, A. J.; Olowonefa, K. O.; Aluko, A. O.; Ogunade, L. M., Osho, S. O.; and Barngbose A. M., 2013. Growth performance, apparent nutrient digestibility, caecal fermentation, ileal morphology and caecal microflora of growing rabbits fed diets containing probiotics and prebiotics. Livestock Science, 157, 184–190.

Panda, A. K.; Reddy, M.R.; Ramarao, S. V.; and Praharaj, N.K., 2003. Production performance, serum/yolk cholesterol and immune competence of White Leghorn layers as influenced by dietary supplementation with probiotic. Tropical Animal Health and Production 35: 85-94.

Perrier, G., 1998. Influence de deux niveaux durees de restriction alimentaire sur L'efficacite productive du Iapin et les caracteristiques boucheres de la carcasse. In: Proceedings 7emes Journees de la Recherche Cunicole, Lyon, France, pp. 179-182.

Perrier, G.; and Ouhayoun, J., 1996. Growth and carcass traits of the rabbit. A comparative study of three modes of feed rationing during fattening. In: Proceedings 6th World Rabbit Congress, Toulouse, France, Vol. 3, pp 225-232.

Pogany Simonova, M.; Laukova, A.; Chrastinova, L.; Strompfova, V.; Faix, S.; Vasilkova, Z.; Ondruska, L.; Jurcik, R.; and Rafay, J., 2009. Enterococcus faecium CCM7420, bacteriocin PPB CCM7420 and their effect in the digestive tract of rabbits. Czech Journal of Animal Science, 54, 376–386.

Pogany Simonova, M.; Laukova, A.; Chrastinova, L., Placha, L., Strompfova, V., Cobanova, K.; Formelova, Z.; and Chrenkova, M., 2013. Combined administration of bacteriocin producing probiotic strain Enterococcus faecium CCM7420 with Eleutherococcus senticosus and their effect in rabbits. Polish Journal of Veterinary Science, 16, 619–627.

Pogány Simonová1, M.; Lauková1, A.; Žitňan, R.; and Chrastinová, Ľ., 2015. Effect of rabbit-origin enterocin-producing probiotic strain Enterococcus faecium CCM7420 application on growth performance and gut morphometry in rabbits. Czech J. Anim. Sci., 60 (11): 509–512.

Rinkinen, M.; Westermarck, E.; and Salminen, S., 2003. Absence of host specificity for in vitro adhesion of probiotic lactic acid bacteria to intestinal mucus. Vet Microbiol 97:55-61.

Santoma, G.; de Blas, J. C.; Carabano, R.; and Fraga, M., 1989. Nutrition of rabbits. In: Haresign, W. and Lewis, D. (eds) Recent Advances in Animal Nutrition. Butterworths, London, UK, pp. 97–138.

Sherman, P.M.; Ossa, J.C.; and Johnson-Henry, K., 2009. Un raveling mechanisms of action of probiotics.Nutr.Clin.Pract.21,10–14.

SPSS, (2008). SPSS User´s Guide Statistics. Ver. 17. Copyright SPSS Inc., USA.

Szaboova, R.; Chrastinova, L.; Laukova, A.; Strompfova, V.; Pogany Simonova, M.; Vasilkova, Z.; Placha, I.; Cobanova, K.; and Chrenkova, M., 2012. Effect of combinative administration of bacteriocin-producing and probiotic strain Enterococcus faecium CCM 4231 and sage plant extract on rabbits. African Journal of Microbiological Research, 6, 4868–4873.

Timmerman, H. M.; Mulder, L.; Everts, H.; van Espen, D. C.; van der Wal, E.; Klaassen, G.; Rouwers, S. M.; Hartemink, R.; Rombouts, F. M. and Beynen, A. C., 2005. Health and growth of veal calves fed milk replacers with or without probiotics. J. Dairy Sci., 88(6), 2154-2165.

Tudela, F., 2009. Produccion de conejos con restricciones alimentarias. In: Proccedings XXXIII Symposium ASESCU, Sevlla, Apain, pp. 14-21.

Tumova, E.; Skrivan, M.; Skrivanova, V.; and Kacorovsk, L., 2002. Effect of early feed restriction on growth in Broiler chickens, turkeys and rabbits. Czech J. Anim. Sci. 47:418-428.

Tůmová, E.; Zita, L.; Skřivanová, V.; Fučíková, A.; Skřivan, M.; and Burešová, M., 2007. Digestibility of nutrients, organ development and blood picture in restricted and ad libitum fed broiler rabbits. Archiv für Geflügelkunde, 71, 6–12.

Van Harten, S.; and Cardoso, L. A., 2010. Feed restriction and genetic selection on the expression and activity of metabolism regulatory enzymes in rabbits. Animal 4, 1873–1883.

Vesterlund, S.; Karp, M.; and Salminen, S., 2006. Staphylococcus aureus adheres to human intestinal mucus but can be displaced by certain lactic acid bacteria. Microbiology 152:1819-1826.

Villamide M.J; Maertens, L.; and De Blas, J. C., 2010. Feed evaluation. In: The Nutrition of the Rabbit. (Edit. De Blas J. C. and Wiseman J.), 2nd Ed. CABI, Wallingford, pp. 151-162.

Wang, Z.; Gu, Z.; Huo, Y.; Chen, B.; Liu, Y.; Zhao, Z. and Zhang, G., 2008. Effects of probiotics and nanometer implement on growth performance of rex rabbit. 9th World rabbits Congress-June 10-13, Verona-Italy, 837-840.

Xiccato, G.; and Trocino, A., 2010. Feed and energy intake in rabbits and consequence on farm global efficiency. The 6th Inter. Con. On Rabbit Prod. In Hot Clim., Assiut, Egypt, 1-18.

الملخص العربي

تأثير تحديد كمية العليقة مع إضافة البكتريا الداعمة للحيوية على الأداء الإنتاجي والاقتصادي للأرانب النامية المحلية

ملاك منصور بشاره، مني احمد رجب، عادل السيد الدسوقي، هاني نبيل فهيم، عبد الغني محمد الشحات، احمد منير العزب، احمد احمد الجمل

معهد بحوث الإنتاج الحيواني- مركز البحوث الزراعية- الدقي- الجيزة

اجري هذا البحث لدراسة تأثير استخدام مستويات مختلفة من التحديد الغذائي وكذلك اضافة بكتريا (Lacobacillus lactis 2.5 x 10^8 CFU/g, Bacillus subtilis 1.8 x 10^9 CFU/g) الداعمة للحيوية علي الأداء الإنتاجي و الإقتصادي للأرانب النامية المحلية. استخدم في هذه الدراسة عدد 54 أرنب محلي بلدي اسود في مرحلة النمو عمر 7 أسابيع حيث تم وزنها وتوزيعها في تصميم عاملي 3x2 علي 6 معاملات تجريبية و لكل معاملة 9أرانب (5♂+4♀) كما يلي: ارانب غذيت علي العليقة الأساسية حتي الشبع بدون اضافة بكتريا حيوية (مقارنة)- العليقة الأساسية حتي الشبع مع اضافة 0.4جم بكتريا داعمة للحيوية/كجم عليقة- ارانب غذيت علي عليقة محددة 120% من الطاقة الازمة لحفظ الحياة وبدون اضافة بكتريا حيوية- عليقة محددة 120% من الطاقة اللازمة لحفظ الحياة مع اضافة 0.4جم بكتريا داعمة للحيوية/كجم علف- ارانب غذيت علي عليقة محددة 140% من الطاقة اللازمة لحفظ الحياة وبدون اضافة بكتريا حيوية – عليقة محددة 140% من الطاقة اللازمة لحفظ الحياة مع اضافة 0.4حم بكتريا داعمة للحيوية. اوضحت النتائج ان العليقة التي اتيحت حتي الشبع مع اضافة البكتريا الداعمة للحيوية ادت الي زيادة معنوية في وزن الجسم الحي مقارنة بأرانب العليقة المقارنة. من ناحية اخري لم تختلف ارانب العليقة المحددة 120أو 140% من الطاقة الحافظة معنويا عن ارانب المقارنة في وزن الجسم النهائي. احتلت ارانب العليقة حتي الشبع مع اضافة البكتريا الداعمة للحيوية المركز الأول في زيادة وزن الجسم اليومية وتفوقت معنويا علي ارانب المقارنة. تحسن معنويا معدل التحويل الغذائي بتغذية الأرانب علي عليقة محددة 120% من الطاقة الحافظة بإضافة البكتريا الحيوية أو بدون اضافتها وكذلك العليقة حتي الشبع مع اضافة البكتيريا الداعمة للحيوية مقارنة بالعليقة المقارنة. انخفض تركيز الإنزيمات الهاضمة بالمعاملات التجريبية المختلفة بإستثناء العليقة المحددة 120% من الطاقة الحافظة بدون اضافة البكتريا الحيوية. ادت كل المعاملات التجريبية الي تحسن في الأداء الإقتصادي خاصة العليقة المحددة 120% من الطاقة الحافظة مع اضاقة البكتريا الحيوية. وقد خلصت الدراسة الي اهمية تحديد كمية العلف المقدم للأرانب النامية بما يعادل 120% من الطاقة الحافظة للحياة مع اضافة البكتريا الداعمة للحيوية (0.4جم/كجم عليقة) حيث تحسن معدل التحويل الغذائي و دليل النمو والنشاط الميكروبي في الأعور وكذلك الأداء الإقتصادي تحت ظروف البيئة في مصر.