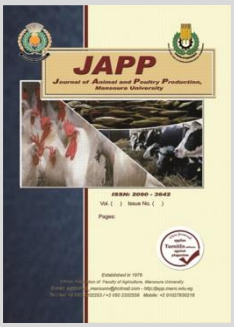
Journal of Animal and Poultry Production

Journal homepage: www.japp.mans.edu.eg
Available online at: www.jappmu.journals.ekb.eg

Effect of Using Biogen as a Feed Additive on Productive and Reproductive Performance of Rabbits

Fahim, H. N.[1]; M. M. El-Deeb[2*]; Mona A. Ragab[1] and Soheir A. Shazly[3]

[1]Rabbit, Turkey and Water-Fowl Breeding Research Department. Animal and Poultry Production Research Institute (APRI), Agricultural Research Center, Ministry of Agriculture, Dokki, Giza, Egypt.
[2] Animal Nutrition Research Department Animal and Poultry Production Research Institute (APRI), Agricultural Research Center, Ministry of Agriculture, Dokki, Giza, Egypt.
[3]Poultry Research Department, Animal and Poultry Production Research Institute (APRI), Agricultural Research Center, Ministry of Agriculture, Dokki, Giza, Egypt.



ABSTRACT

This study was conducted to evaluate the effect of using biogen in V-line rabbit diets on its productive and reproductive performance. Twenty eight rabbits (16 does of 10 months' age averaged 3325 ± 122 g and 12 bucks of 11 months' age averaged 3440 ± 268 g live body weight were randomly assigned to four groups and fed *ad libitum* as follows: T_1; Basal diet (Control), T_2, T_3 and T_4: Basal diet plus 0.5, 0.75 and 1 g biogen/Kg diet, respectively. Results showed that doe's in T_3 and T_4 gave better results for number of services per conception, litter size at weaning, litter weight, bunny weight and daily gain at birth and weaning. Mortality rate generally decreased than the control (T_1) and T_2. Parturition interval non-significantly decreased, with the lowest period being recorded for T_2. Total feed intake/parity showed significant ($P<0.05$) increase in biogen groups. Biogen in bucks' diets significantly ($P<0.05$) improved semen quality traits.Biogen significantly ($P<0.05$) increased hemoglobin, white blood cells, monocytes % and eosinophils % compared to the control. While red blood cells, hematocrit %, lymphocytes % and neutrophils were not significantly differed among groups. Biogen significantly ($P<0.05$) increased serum total protein, globulin and total cholesterol, whil significantly ($P<0.05$) reduced triglycerides, but non-significantly albumin and creatinine. Biogen (T_3 and T_4) improved the relative economic efficiency by 28.39 and 23.50%.In conclusion, 0.75 g biogen/Kg diet improved productive and reproductive performance of does and bucks and enhanced blood constituents as well as economic efficiency.

Keywords: Biogen, blood, economic efficiency, rabbits, productive and physiological traits, semen.

INTRODUCTION

In the recent decades, with increasing human food demands scientists manufactured commercial products namely probiotics (microorganisms) to use it as growth promotors as alternatives to antibiotics in animal feeds that caused harmful effects on human health (Sissons, 1989 and Jin *et al.*, 1997). Biogen is one form of the commercial products with various contents depending on yeasts, hydrolytic enzymes, saccharides and some useful bacterial strains. Biogen efficacy in improving the feed utilization either by broilers and layers found to affect growth performance, nutrients digestibility coefficients, carcass traits, some blood components and economic evaluation of growing New Zealand White (NZW) rabbits (Bedford and Morgan, 1996). El-Adawy *et al.* (2002) recorded better feed conversion ratio (FCR) with biogen addition in growing rabbit diets. Similarly, Zanaty (2002) found that biogen addition at level of 1g/kg diets of growing NZW rabbits showed significantly high final live body weight (LBW), daily body weight gain (DBWG) while daily feed consumption (DFC) was decreased, while FCR was improved. Abdel-Azeem *et al.* (2007) reported that adding biogen at level of 2.5g/kg to rabbit diets improved significantly LBW, DBWG, FCR and performance index (PI).

Hollister *et al.* (1990) emphasized that the growth promoting effect of biogen may be possibly reffered to the selected strains of microorganism that given orally to alter the intestine flora with the resultant improvement in gain and feed efficiency. Moreover, the mode of action of biogen may be related to the reduction in viscosity of intestinal contents and improving nutrient absorption.

In addition, Zeedan *et al.* (2014) reported that supplementing dairy Damascus goats' rations with biogen improved the digestibility of all nutrients within late pregnancy and lactation periods. Also, milk yield and composition increased and kids born and weaning weights were increased as well beside better-feed conversion and economic efficiency.

It is evident from the literature (Licois *et al.*, 2000 and Bovera *et al*., 2010) that an intensive production system of rabbits causes many physiological and environmental stresses in terms of enteric pathogens which have negative effects on growth performance, feed efficiency and rabbit health status especially during weaning period. Supplementation of probiotics in forms of beneficial normal flora, such as yeasts, Bacillus subtilis and Lactobacillus acidophilus in order to improve gut environment appeared to be possible alternative could improve gut-microbial population and digestion resulting in increasing feed

* **Corresponding author.**
E-mail address: deep121eg@yahoo.com
DOI: 10.21608/jappmu.2021.182674

efficiency, growth performance and microbial population thus reducing such mentioned disorders.

The present study aimed at investigating the effect of using biogen as feed additive of V-line rabbit diets on their productive and physiological performance as well as its economic efficiency.

MATERIAL AND METHODS

This study was conducted at El-Serw Research Station, Animal and Poultry Production Research Institute, Agriculture Research Center, Ministry of Agriculture, Egypt. Sixteen V-line rabbit does (10 months does with average live body weight 3325.5 ± 122 g and Twelve bucks of 11 months' age weighed 3440 ± 268 g on average) were randomly assigned to four dietary experimental groups (Four does + Three bucks/each treatment) based on body weight with almost similar mean body weight. Rabbits lasted for 110 days (Two parities) and were weighed weekly. Each doe was kept separately in well ventilated individual wired-cages (50 x 50 x 35 cm), where drinking water was available via stainless-steel nipple all the time.

The experimental diets:

Four treatment diets were formulated and fed *ad libitum* according to the NRC (1977) requirements, where T_1; Rabbits fed basal diet (Control), T_2: Basal diet plus 0.5 g biogen/kg diet, T_3: Basal diet plus 0.75 g biogen/kg diet and T_4: Basal diet plus 1 g biogen/kg diet. Feed ingredients and calculated chemical composition (according to feed constituents tables for rabbit feedstuffs used by De Blas and Mateos (2010) of diets are presented in Table (1).

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 bran	28.00
Di-calcium phosphate	1.60
Limestone	0.95
Sodium chloride	0.30
Mineral-vitamin premix(1)	0.30
Total	100
Calculated Analysis:	
Crude protein (%)	17.08
DE (Kcal / kg)	2416
ME (Kcal / kg)(2)	2119
Crude fiber (%)	12.55
Ether extract (%)	2.20
Calcium (%)	1.20
T. Phosphorus (%)	0.76
Methionine (%)	0.23
Lysine (%)	0.86
Price (EGP/kg)(3)	5.00

(1) One kilogram of mineral–vitamin premix provided: Vitamin A, 150,000 UI; Vitamin E, 100 mg; Vitamin K_3, 21 mg; Vitamin B_1, 10 mg; Vitamin B_2, 40 mg; Vitamin B_6, 15 mg; Pantothenic acid, 100 mg; Vitamin B_{12}, 0.1 mg; Niacin, 200 mg; Folic acid, 10 mg; Biotin, 0.5 mg; Choline chloride, 5000 mg; Fe, 0.3 mg; Mn, 600 mg; Cu, 50 mg; Co, 2 mg; Se, 1 mg and Zn, 450 mg.

(2) ME (Kcal/Kg diet) estimated as 0.95 DE according to Santoma *et al.* (1989).

(3) Price of one Kg diet according to the local market prices during the expermintation (Egyptian pound, EGP/Kg).

The biogen used in the present study contained cell walls of *S. cerevisiae* yeast, β-glucan-mannan oligo saccharide (500 g), *Bacillus subtilus* (200 g), lactic acid (50 g), colloidal silica (50 g) and calcium carbonate as carrier till one Kg which manufactured by General Pharma Group.

Reproductive traits of does:

Number of services per conception (NSC) for dams for the two parities was recorded, while litter size (LS) and litter weights (LW) were recorded at birth and weaning (35 days of age). Mean bunny weight (MBW) was measured at birth and weaning and thereafter daily weight gain (DWG) was calculated for the whole period from birth till weaning. Mortality ratio (MR%) was calculated for does in each treatment during two parities.

Reproductive traits of bucks:

All bucks were fed the same tested diets and used for mating were trained for artificial collection of semen by the use of artificial vagina. Reaction time was recorded in seconds using a stop watch. Semen parameters studied were ejaculate volume (ml), sperm concentration (x 10^6/ml), motility (%), abnormality (%) and mortality (%) according to Smith and Mayer (1955).

Hematological parameters and serum metabolites:

At the end of study (110 days of age), three samples were taken marginal ear vein of does randomly from each treatment, kept at room temperature then the tubes were centrifuged at 3500 rpm for 20 minutes to separate clear serum. Afterwards, blood serum was used to determine serum total protein, albumin, globulin by difference (total protein – albumin), triglycerides, total cholesterol and creatinine by using commercial kits (Diamond Diagnostics, Halliston, MA, USA). Another blood samples were taken from the same animals in vial tubes containing EDTA as anticoagulant (three rabbits per treatment) to determine some hematological traits which included RBCx10^{12} according to Hawkeye and Dennett (1989), HCT (%), Hemoglobin (g/dl) according to Tietz (1982), WBC x 10^3 according to Hawkeye and Dennett (1989), Lymphocytes%, (%), Monocytes (%), Eosinophils (%), Neutrophils (%) according to Moore *et al.* (2015).

Economic Efficiency:

For economic efficiency evaluation of using the input–output analyses (Zeweil (1996) depending upon the local market prices during the experimental time for calculating the return. The following equations were applied:

Total feed cost (EGP) = Total feed intake (Kg) x price/kg feed (EGP).

Total return (EGP) = Total weight rabbits (kg) x price/kg live body weight (EGP)

Net return (EGP) = Total return (EGP) - Total feed cost (EGP)

Economic Efficiency (E.E) = Net return (EGP) / Total feed cost (EGP)

Statistical analysis:

Data was statistically analyzed by using computer program of SAS (2002) using the general linear models (GLM). Significance among treatment means were tested at ($P<0.05$) using Duncan's New Multiple Rang Test (Duncan, 1955).

RESULTS AND DISCUSSION

Productive and reproductive traits of does:

From the data in Table (2), the addition of either 0.75 or 1 g biogen to the does diet during the first parity showed better results of NSC, average LS at weaning, average LW, average BW and average DG at birth and

weaning. On the other hand, the groups received 0.5 and 0.75 g biogen in their diets recorded the highest MR% compared to the control and those fed 1g biogen/kg diet. In the second parity, biogen addition to basal diet significantly (P<0.05) decreased NSC and improved average LS at weaning, average LW, average BW and average DG at birth and weaning. Meanwhile, MR% in the second parity was higher in the control and 0.5 g biogen groups, but it decreased in groups fed diets contained 0.75 and 1 g biogen in their diets.

As for parturition interval (days) it seems from Table (2) that the addition of biogen to does diets non-significantly decreased than the control, but the lowest value obtained in group received 0.5 g biogen compared to the control and other two groups of biogen diets. In the mean time, total feed intake / parity showed generally significant (P<0.05) increase in biogen groups than the control group.

The reduction in number trend of services per conception obtained herein came on line with findings of Attia *et al.* (2015) when they used bee pollen and/or propolis, inulin and/or mannan-oligosaccharides in rabbit does diets, since they reported fewer services per conception and greater fertility rate. Similarly, Rizk *et al.* (2019) recorded fertility increasing of hens' egg with using probiotics (contains lactic acid bacteria (*Lactobacillus lactis*) 2.5x 10^8 CFU, *Bacillus subtilis* 1.8x 10^9 CFU and calcium carbonate up to 1 gram as carrier) in their diets. Belhassen *et al.* (2016) found that fertility rate of rabbit does was higher (P<0.05) in rabbits fed with yeast supplemented diet than the control during the second parity.

The improvement in litter size, litter weight, bunny weight and daily gain in groups of 0.75 and 1 g/kg feed found in the present work are supported with the results of Attia *et al.* (2015) when used bee pollen with propolis that resulted in significant increased litter size, body weight of litter, number of kits born alive and weight of kits at 28 days of age. While Belhassen *et al.* (2016) recorded that weight and litter size at birth and at weaning as well as litter weight gain during lactation of cross-bred rabbit does (New Zealand×California) group fed 1 g yeast/Kg feed (6.5×10^9 CFU/kg feed) were similar to that of the control during the reproductive cycles. Moreover, Abo Ghanima *et al.* (2020) found that oral administration of β-glucan (0.25 and 0.5 ml per one-liter of drinking water) significantly improved body weight gain in NZW and Animal Production Research Institute (APRI) rabbits' breeds. Habeeb *et al.* (2013) found that goats fed diets contained 30 or 80 ppm Zn with biogen produced better litter size at birth, number of kids per doe and litter weight at birth. Similar positive effects of using yeast in diets of ewes were found by Abdel-Rahman *et al.* (2012) and Mousa *et al.* (2012) on litter weight at birth and weight gain of their offspring. Also, Faten Abou Ammou *et al.* (2013), indicated that addition of yeast culture (2.5g/h/d or 5g/h/d) to Damascus goats ration increased birth and weaning weights and total and daily gain of kids born.

Table 2. Effect of different levels of dietary biogen on some reproductive traits of V-line rabbits during two parities.

Treatments / Traits	T_1	T_2	T_3	T_4	SEM	Sign. Level
At the first parity:						
Average number of services/conception	2.00^b	3.00^a	1.75^c	2.50^{ab}	0.24	0.03
Average litter size (No.): At birth	7.25	7.00	8.00	7.50	0.18	NS
At weaning	7.00^{ab}	6.50^b	7.20^a	7.20^a	0.14	0.05
Average litter weight (g): At birth	394.7^b	409.7^{ab}	482.0^a	463.6^a	18.14	0.02
At weaning	4742.5^{ab}	4420.0^b	5189.8^a	5405.0^a	191.71	0.05
Average bunny weight (g): At birth	54.44^b	58.53^{ab}	60.25^a	61.81^a	1.37	0.05
At weaning	677.5^b	680.9^{ab}	720.8^a	750.7^a	15.11	0.04
Average daily gain (g) (0-35 days)	17.8^b	17.8^b	18.9^a	19.7^a	0.40	0.05
Average mortality (%)	3.00^b	7.00^a	10.00^a	4.00^{ab}	1.37	0.02
At the second parity:						
Average number of services/conception	2.00^a	1.25^b	1.25^b	1.50^{ab}	0.15	0.05
Average litter size (No.): At birth	7.75	8.75	8.50	8.25	0.18	NS
At weaning	6.50^b	7.50^a	8.00^a	7.50^a	0.27	0.05
Average litter weight (g): At birth	426.25^b	514.67^a	541.02^a	533.11^a	22.88	0.05
At weaning	4228.9^b	5069.4^b	6000.6^a	5851.3^a	353.07	0.05
Average bunny weight (g): At birth	55.00^b	58.82^a	63.65^a	64.62^a	1.94	0.05
At weaning	650.60^b	675.92^{ab}	750.08^a	780.17^a	26.40	0.04
Average daily gain (g) (0-35 days)	17.0^b	17.6^b	19.6^a	20.4^a	0.70	0.05
Average mortality (%)	16.12^a	14.28^a	5.88^b	9.09^{ab}	2.04	0.04
Parturition interval (days)	51.25^a	44.50^b	47.25^{ab}	48.00^{ab}	1.20	0.05
Total feed intake / parity (Kg)	19.80^b	20.70^{ab}	21.30^a	21.65^a	0.35	0.05

SEM = standard error of mean; Sign. Level = Significance level.

$^{a, b, c}$ Means in the same row having different superscripts are significantly different.

The increased mortality % in T_2 and T_3, which enhanced with the highest level of biogen (T_4), in the first parity can be attributed to litter size and birth weight of bunny as some of the main factors affecting kits' pre-weaning mortality (Assan, 2018). It seemed that biogen exhepited its obvous positive effect in declining average mortality % in groups received 0.75 and 1 g/Kg diet during the second parity. The reverse picture denoted by Belhassen *et al.* (2016) who stated that viability rate of kits at birth in the first parity during the first 21 days was significantly (P<0.05) better in supplemented group, while such difference was not observed during the second parity. On the other hand, on chicks Rizk *et al.* (2019) noticed that total embryonic mortality (%) did not significantly changed between probiotic dietary treatments

groups and the control one. On line with the obtained MR% the findings of Bovera *et al.* (2010) who reported that mannan oligosaccharides (MOS) at the rate of 1.0 g/kg in the diets of rabbits could reduce rabbit mortality, since they recorded the highest (P<0.05) total mortality rate for rabbits fed antibiotics than for those fed 0.5, 1.0 and 1.5 g MOS/Kg diet (34.2% *Vs.* 17.7, 7.75 and 17.1%). In this regard, it is of interest to mention that the fluctuation in mortality rate are related to the sanitary status of the farm and feed additives can have a little or no effects in improving rabbit performance (Bovera *et al.*, 2012).

Parturition interval tended to be shorter in the treated groups than the control ones without significant differences. This came on line with non-affected length of gestation of cross-bred rabbit does when adding yeast to their diets (Belhassen *et al.*, 2016).

With regard to the increased feed intake recorded with adding biogen to rabbit diets in the present work it is coincided with the results of Abaza *et al.* (2006) who reported that the addition of probiotics significantly (P≤0.05) increased feed intake. Abdel-Azeem *et al.* (2007) found that daily feed intake increased with higher levels of poultry litter (PL) in the diet of rabbits and attributed this to the higher crude fiber content of PL. Moreover, Mostafa *et al.* (2014) using probiotics (AVI- BAC and BGY) post-partum on cows and Nde *et al*. (2014) with Celmanax® (yeast culture product) addition to diets of sheep. Rizk *et al.* (2019) observed that feed consumption significantly increased for chicks fed diet supplemented with 0.3 and 0.5 g probiotic/kg than the control group at the whole period (1-20 wks. of age). On the other hand, Abdalla *et al.* (2004) indicated that biogen supplementation (2.0 g/kg diet) to duck diets had insignificant effect on its feed intake compared to those fed diet with garlic supplementation. Kout El-Kloub (2006) and Mona *et al.* (2003) reported that feed consumption of laying hens was not affected by probiotics addition to their diets. Attia *et al.* (2015) found that feed intake was highest in the control group; and Bee pollen (BP) plus Propolis (Pro) group consumed less feed than BP, Pro and mannan-oligosaccharides (MOS) groups (P<0.01) without significant differences among BP plus Pro, inulin (In) and In plus MOS groups. Abo Ghanima *et al.* (2020) recorded that oral administration of β-glucan in drinking water reduced total feed consumption.

Reproductive traits of bucks:

Data in Table (3) indicated generally that biogen addition to the diets of bucks significantly (P<0.05) improved ejaculate volume, motility %, live sperm %, total mass and concertation of its semen. While, the dietary treatments significantly (P<0.05) reduced abnormal sperm and dead sperm percentages.

In this concern, the enhancement effect of such feed additives may be due to its active components, e.g. antioxidant factors and/or supplying sufficient nutrient elements (Sˇaric´ *et al.*, 2009) which accordingly affect fertility (Leja *et al.*, 2007 and Xu *et al.*, 2009).

Table 3. Effect of different levels of dietary biogen on semen quality parameters of V-line rabbits bucks.

Treatments / Traits	T_1	T_2	T_3	T_4	SEM	Sign. Level
Ejaculate volume (ml)	0.75^{c}	0.80^{bc}	0.85^{ab}	0.90^{a}	0.02	0.05
Motility (%)	63.53^{c}	70.30^{b}	71.76^{b}	77.66^{a}	1.26	0.05
Abnormal sperm (%)	14.77^{a}	12.80^{b}	11.66^{b}	9.15^{c}	1.97	0.04
Live sperm (%)	76.20^{c}	77.26^{c}	83.30^{b}	87.33^{a}	0.72	0.05
Dead sperm (%)	23.80^{a}	22.73^{a}	16.70^{b}	12.66^{c}	0.67	0.05
Total mass	3.00^{b}	3.66^{ab}	3.66^{ab}	4.33^{a}	0.25	0.03
Concentration (x 10^6/ml)	170.16^{c}	171.23^{c}	182.50^{b}	199.26^{a}	2.90	0.05

SEM = standard error of mean; Sign. Level = Significance level.

$^{a, b, c}$ Means in the same row having different superscripts are significantly different.

Attia *et al.* (2009) concluded that feeding rabbit bucks diets contained bee pollen at the rate of 200 mg/kg body weight significantly (P<0.01) improved semen quality and increased its fertility percentage. Gabbar *et al.* (2019) found that supplementation of thyme aqueous extracts significantly increased the semen quality of rabbits. In addition, semen volume, sperm motility, sperm concentration, and sperm livability significantly increased (p < 0.05) in rabbits received aqueous thyme extract with 50 mg/kg compared to the control (Kandeil *et al.*, 2019). Ahmed *et al.* (2020) stated that the levels of thyme essential oil up to 180 mg/kg as alternative to antibiotics in California male rabbits' diets can play a major role in enhancing its semen quality.

El-Shamaa (2002) found that crossbred ram lambs (1/2 Romanov x 1/2 Rahmani) fed yeast culture (YC) at the rate of 0.05 and 0.025% of live body weight produced higher percentages of motile and live spermatozoa, sperm cell concentration and survival rate of spermatozoa, but lower values of sperm abnormalities than the control.

Hematological parameters and serum metabolites:

As for hematological traits, it is clear from the data explored in Table (4) that biogen addition to V-line rabbit does during the whole experimental period expressed significant (P<0.05) changes by increasing hemoglobin (Hgb), white blood cells (WBCs), monocytes % and eosinophils % compared to the control. While red blood cells (RBCs), hematocrit %, lymphocytes % and neutrophils were not significantly differed among the four experimental groups. The obtained values of RBCs, Hgb, WBCs and lymphocytes % were in the range published by Moore *et al.* (2015). While the obtained values of neutrophils, eosinophils and monocytes in the present study were lower than the last authors published range.

Benson and Paul-Murphy (1999) reported that rabbits with an infectious disease do not have a higher WBC count, but have a changes from lymphocyte-predominant to neutrophil-predominant counts. Rabbits with acute infections sometimes have a normal differential count, but a decrease in total WBC count. This may explain the increased WBCs values accompanied to the similar and close values of both lymphocytes % and neutrophils % to that of the control. Taking into consideration sampling time effect on WBC types, since Washington and Van Hoosier (2012) decided that the

number of lymphocytes is higher in the early morning and became lowest in the late afternoon and evening.

Çetin *et al.* (2010) showed increased total leucocyte count and neutrophils percentage and decreased lymphocyte percentage in rats treated with proptamphos plus propolis. Khalil and El-Sheikh (2010) found that propolis (0.1 and 0.2%) significantly decreased urea and creatinine, while significantly increased total protein of rats' blood. Similarly, Shahba (2011) noticed that mannan-oligosaccharides supplementation increased significantly rabbit blood neutrophils.

On the other hand, Jasprica *et al.* (2007) found that administration of propolis in human did not significantly changed blood cells, hemoglobin concentration and hematocrit.

Table 4. Effect of different levels of dietary Biogen on some hematological parameters and serum metabolites of V-line rabbits.

Treatments / Parameters	T_1	T_2	T_3	T_4	SEM	Sign. level
Hematological traits:						
Red Blood Cells ($\times10^6$/µl)	5.32	5.47	6.02	5.62	0.24	NS
Hematocrit (%)	30.47	31.82	32.65	33.97	1.56	NS
Hemoglobin (g/dL)	11.45^b	12.15^a	12.30^a	12.60^a	0.20	0.05
White Blood Cells ($\times10^3$/ µl)	6.05^b	6.35^{ab}	6.45^{ab}	7.12^a	0.30	0.04
Lymphocytes (%)	39.00	39.50	42.00	44.00	1.50	NS
Monocytes (%)	1.50^b	3.00^{ab}	2.50^{ab}	5.25^a	0.72	0.04
Eosinophils (%)	0.25^b	0.50^b	0.75^b	2.00^a	0.11	0.05
Neutrophils (%)	54.00	55.50	54.50	55.50	1.35	NS
Serum metabolites:						
Total protein (g/dL)	3.93^b	3.70^b	4.16^b	6.50^a	0.38	0.05
Albumin (g/dL)	2.63	2.46	2.53	2.86	0.38	NS
Globulin (g/dL)	1.30^b	1.23^b	1.63^b	3.63^a	0.19	0.05
Triglycerides (mg/dL)	56.00^a	54.80^a	52.00^a	49.66^b	1.30	0.05
Total cholesterol (mg/dL)	45.33^c	51.66^b	53.33^b	57.66^a	1.26	0.04
Creatinine (mg/dL)	1.30	1.16	1.13	1.06	0.07	NS

SEM = standard error of mean; Sign. Level = Significance level.
[a, b, c] Means in the same row having different superscripts are significantly different.

In the mean time, dietary treatment of biogen at the rate of 1 g/Kg feed significantly (P<0.05) increased serum total protein, globulin and total cholesterol and reduced triglycerides. Serum albumin and creatinine content reduced non-significantly with the tested dietary treatments compared to the control.

On line with the obtained results in the present work, Zeedan *et al.* (2014) who concluded that biogen-zinc improved the biochemical parameters of blood (total protein, globulin, total cholesterol and triglycerides) during late pregnancy and lactation periods of Damascus goats. Abdel-Azeem *et al.* (2007) noticed that adding biogen rabbit diets was significantly (P≤0.05 or 0.01) lowered serum globulin and total cholesterol, while serum total protein and albumin were not influenced when rabbits received diets supplemented with biogen (2.5g/kg feed).

Attia *et al.* (2015) mentioned that different additives or prebiotics induced the highest (P<0.01) serum total protein, albumin and globulin in rabbits' blood. While the control group had the highest value of cholesterol followed by the supplemented groups. Abo-Ghanima *et al.* (2020) concluded that blood total protein and globulin in blood of NZW and APRI rabbits increased with β-glucan supplementation in their diets.

On the other hand, Zanaty (2002) found that biogen in diets (1 g/Kg diet) decreased serum total cholesterol in rabbits' blood. Attia *et al.* (2015) recorded higher serum creatinine in all probiotic supplemented groups compared to the control. Moreover, Haiam *et al.* (2007) found that the addition of biogen, zinc bacitracin or their mixture to the diets of laying hens significantly (P≤0.05) decreased serum triglyceride and cholesterol but significantly (P≤0.05) increased serum total protein compared with the control group.

Economic Efficiency:

Data in Table (5) for evaluating the economic efficiency of using the tested levels of biogen in V-line rabbit diets showed that the groups received biogen at the rate of 0.75 and 1 g/Kg diet recorded the highest (P<0.05) average feed intake/parity, but in the same time it produced higher (P<0.05) yield (average weight rabbits, kg/parity). Accordingly, total and net return/parity were superior in the dietary treatment groups than the control. It is obvious that adding biogen to V-line dams' diets at the rate of 0.75 or 1g/Kg feed improved the relative economic efficiency of does by 28.39 and 23.50% than those without biogen additive in the diet (control).

The obtained results are in harmony with findings of Attia *et. al.* (2014) who found that inulin reduced economic efficiency and, the relative economic efficiency, while bee pollen and MOS, administered alone, were able to improve the relative economical efficiency. They attributed this to the significant increase in total cost of feeding rabbits which maximized with inulin. Moreover, Attia *et al.* (2015) concluded that MOS and bee pollen with or without propolis are able to improve the economic efficiency of rabbit does in comparison to the un-supplemented group.

Soliman (2003) found that enclusion of live yeast as a probiotic in laying hen diets gave the best economic efficiency values. Also, Haiam *et al.* (2007) concluded that adding biogen (0.05%) or zinc bacitracin to experimental diets of hens improved both economic efficiency and relative economic efficiency compared to the control group.

Table 5. Economic efficiency of adding biogen to V-line rabbits' diet during (average of the two parities).

Treatments / Parameters	T_1	T_2	T_3	T_4	SEM	Sign. level
Average feed intake (kg/parity)	19.80^{b}	20.70^{ab}	21.30^{a}	21.65^{a}	0.35	0.05
Average weight rabbits (kg/parity)	4.49^{b}	4.75^{ab}	5.60^{a}	5.63^{a}	0.18	0.05
Price / Kg feed (EGP)	5.00	5.10	5.15	5.20	0.04	-
Total feed cost / parity (EGP)	99.00	105.57	109.69	112.58	2.55	NS
Price / Kg live body weight (EGP)	40	40	40	40	0	-
Total return / parity (EGP)	179.60^{b}	190.00^{ab}	224.00^{a}	225.20^{a}	7.16	0.03
Net return / parity (EGP)(1)	80.60^{bc}	84.43^{b}	114.31^{a}	112.62^{a}	5.50	0.05
Economic Efficiency (EE)(2)	0.81^{ab}	0.80^{b}	1.04^{a}	1.00^{a}	0.05	0.05
Relative Economic Efficiency (REE)(3)	100^{b}	0.98^{c}	128.39^{a}	123.50^{a}	25.75	0.05

SEM = standard error of mean; Sign. Level = Significance level. EGP = Egyptian pound.

[a, b, c] Means in the same row having different superscripts are significantly different.

(1) Net return (EGP) = Total return (EGP) - total feed cost (EGP)

(2) Economic Efficiency (E.E) = Net return (EGP) / total feed cost (EGP)

(3) Relative Economic Efficiency (REE) = (E.E / E.E of control) x 100.

CONCLUSION

From the above mentioned results it can be concluded that adding 0.75 g/Kg feed in rabbit rations will be of positive impact on productive and reproductive performance of both does and bucks. Health indicators in terms of blood constituents as well as economic efficiency will improve as well.

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تأثير استخدام البيوجين كإضافة غذائية على الأداء الإنتاجي والتناسلي للأرانب

هاني نبيل فهيم[١] ، محمد محمد الديب[٢] ، منى أحمد رجب[١] و سهير عبد النبي شاذلي[٣]

[١] قسم بحوث تربية الأرانب والرومي والطيور المائية ، معهد بحوث الإنتاج الحيواني والدواجن ، مركز البحوث الزراعية ، وزارة الزراعة ، الدقي ، الجيزة ، مصر.

[٢] قسم بحوث تغذية الحيوان ، معهد بحوث الإنتاج الحيواني والدواجن ، مركز البحوث الزراعية ، وزارة الزراعة ، الدقي ، الجيزة ، مصر.

[٣] قسم بحوث رعايه الدواجن ، معهد بحوث الإنتاج الحيواني والدواجن ، مركز البحوث الزراعية ، وزارة الزراعة ، الدقي ، الجيزة ، مصر.

أجريت هذه الدراسة للتعرف على وتقييم تأثير استخدام البيوجين كإضافات علفية لعلائق الأرانب الفي لاين على أدائها الإنتاجي والفسيولوجي وكذلك كفاءتها الاقتصادية. استخدم فيها ثمانية وعشرون أرنبًا في-لاين (١٦ إناث عمر ١٠ شهور بمتوسط ٣٣٢٥ ± ١٢٢,٢٧ جم و ١٢ ذكر عمر ١١ شهراً بمتوسط ٣٤٤٠ ± ٢٦٨,٧٣ جم وزن جسم حي) تم توزيعها عشوائيًا على أربع مجموعات تجريبية غذائية (٤ أنثى + ٣ ذكور/ كل معاملة) غذيت حتى الشبع هي: T_1 عليقة المقارنة بدون أية إضافات ، T_2 ، T_3، T_4 : العليقة الأساسية مضاف إليها ٠,٥ و ٠,٧٥ و ١,٠ جرام بيوجين / كجم عليقة. أدت إضافة ٠,٧٥ أو ١,٠ جم بيوجين إلى عليقة أمهات الأرانب إلى خفض عدد التلقيحات اللازمة للإخصاب (NSC) ، متوسط حجم البطن (LS) عند الفطام ، متوسط وزن البطن (LW) ، متوسط وزن الخلفة (BW) ، ومتوسط الزيادة اليومية في الوزن (DG) عند الولادة والفطام. كما خفضت نفس المعاملات الغذائية معدل النفوق بشكل عام عن مجموعة الكونترول (T_1) و T_2. كما انخفضت الفترة بين الولادتين بشكل غير معنوي عن مجموعة الكونترول مع إضافة البيوجين إلى الوجبات الغذائية ، وكانت أقصرها في المجموعة الثانية (T_2). أظهرت كمية الغذاء المأكول/ بطن بشكل عام زيادة معنوية ($P<0.05$) في مجموعات البيوجين عن مجموعة الكونترول. وبشكل عام ، أدت الإضافة في غذاء الذكور إلى تحسين جودة السائل المنوي بشكل ملحوظ ($P<0.05$). تسببت إضافة البيوجين بشكل كبير ($P<0.05$) في زيادة الهيموجلوبين (Hgb) وكرات الدم البيضاء (WBCs) و ٪ لخلايا monocytes و eosinophils مقارنة بالكنترول. بينما لم تختلف اختلافا معنويا كرات الدم الحمراء ، الهيماتوكريت٪ ، الخلايا الليمفاوية٪ ، بين المجموعات التجريبية الأربعة. أدت الإضافات إلى زيادة معنوية ($P<0.05$) في البروتين الكلي والجلوبيولين والكوليسترول الكلي في الدم وخفضت نسبة الدهون الثلاثية. كما انخفض محتوى الألبيومين في الدم والكرياتينين بشكل غير ملحوظ في المجموعات الغذائية المختبرة مقارنةً بمجموعة الكنترول. من الواضح أن إضافة البيوجين بمعدل ٠,٧٥ و ١,٠ جم / كجم عليقة قد أدت إلى تحسين قياسات الدم والكفاءة الاقتصادية النسبية للأمهات بنسبة ٢٨,٣٩ و ٢٣,٥٠٪ عن تلك التي لا تحتوي على إضافات البيوجين في عليقتها (الكنترول).نستنتج من ذلك أن إضافة ٠,٧٥ جم / كجم من العلف في عليقة الأرانب كان مفيدًا لتحسين الأداء الإنتاجي والفسيولوجي لكل من الأمهات والذكور وقد عزز بشكل إيجابي مقاييس الدم بالإضافة إلى الكفاءة الاقتصادية.