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Effect of Adding Sodium Nitrate without or with some Feed Additives in Growing Rabbit Diets on:
1. Growth Performance and Economic Efficiency

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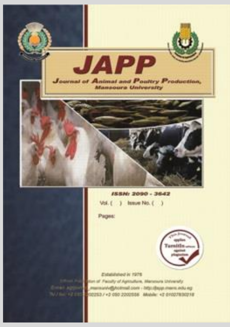

ABSTRACT

Ninety, 7 weeks of age weaning New Zealand White (NZW) rabbits with similar average live body weight (745 g) were used in this study. Rabbits were randomly distributed into 10 equal groups (each group contains 9 animals) and housed in separate cages (3 rabbits in each). The experimental groups were fed randomly on one of the 10 formulated experimental diets used. Sodium nitrate addition for these diets was at two levels. The first level was 0.0 % of the total mixed diet for diet 1 (R1), diet 2 (R2), diet 3 (R3), diet 4 (R4) and diet 5 (R5), while the second level was 2 % of the total mixed diet for diet 6 (R6), diet 7 (R7), diet 8 (R8), diet 9 (R9) and diet 10 (R10). The diets R1 and R6 were without feed additives, while the four feed additives which were used, sodium sulphate, bentonite (clay), yeast and prebiotic for diets R2, R3, R4 and R5 respectively and also, in corresponding diets R7, R8, R9 and R10, respectively.The main results showed that live body weight (LBW) was higher with feeding on R1, R4. R5, R9 and R10 than feeding on the other experimental diets. The average daily gain from 7 to 14 weeks were higher when feeding on the control without $NaNO_3$ (R_1) or when added yeast or prebiotic as shown in R_4 or R_5 respectively, and with adding $NaNO_3$ with yeast or prebiotic R_9 or $R_{10,}$ respectively than the others.The average feed conversion ratio (FCR) from 7 to 14 weeks was the highest when feeding on R_2, R_3, R_4, R_6, R_7, R_8 and R_9, while the lowest ratio values were with feeding on R_1 and R_{10}. The relative economic efficiency was decreased with feeding on the experimental diets than feeding on R_1 diet. The highest value of LBW was recorded with diets R1, R4, R5, R9 and R10. However, more research works are required to clarifying the effects of these additives on economic efficiency in different experimental conditions with high levels of sodium nitrate than used herein.

Keywords: performance, feed utilization, economic efficiency.

INTRODUCTION

Livestock products explanation for concerning 30% of the worldwide assessment of agriculture and 19% of the assessment of food production, and offer 34% of protein and 16% of the energy obsessive in the lumen diet. Assembly the command consumes more meat, milk, eggs and more. Livestock products depend to a great extent on the accessibility of standard supplies of suitable, cost-effective as well as safe animal feed.

The amount of fertilizer available N does not improve much when the animal excretes more N. This because excess N is primarily exceeded in the urine, not in faces. It would seem that a practical option to improve N management in tropical areas to improve its utilization by livestock. In order words, to obtain more marketable product from the available feed inputs.

Although, nitrates (NO_3) are not incredibly toxic to animals, nitrites (NO_2) are toxic. Nitrate poisonous for monogastric animals is a large amount less anxious than ruminants for the reason that of this dissimilarity in the conversion site. However, if the intake of nitrite is faster than its collapse to NH_3, the accumulation of nitrite will begin to rumble, Yaremcio (1991). Nitrite is rapidly absorbed into the blood system by converting hemoglobin to methemoglobin. Red blood cells that contain methemoglobin cannot transport oxygen and the animal dies from suffocation. Toxicity is related to the total amount of feed consumed and how quickly it is ingested, but in general, if the feed contains more than 6000 parts per millions of nitrates, it should be considered toxic, Yaremcio (1991).

Eating small amounts of high nitrate feed increases the total amount of nitrate that can be consumed daily by livestock without adverse effects and helps livestock to adapt to high nitrate feed (Rasby *et al.*, 2014).

There is research on anaerobic systems other than rumen indicating that the accumulation of nitrates is powerfully influenced through the population density of specialized microbes with the aim of reduce nitrates to nitrites and oxidize sulphide to sulphate as they increase nitrites to ammonia.

As animal grow, they tend to deposit fat, protein and water at similar rates at the same percent of mature body weight with higher protein accumulation at lower weights and then a tapering off in protein rate as the animal reaches chemical maturity. When nutrients are limited, the animal cannot sustain its normal growth pattern and must slow down its weight gain or even loss weight if the restriction is severe enough (Ruiz *et al*. 2002).

Economy or profitability is a major factor when deciding whether an additive should be used. Feed additives are not necessary for higher production and economic success

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(Hutjens, 1991). The productive response of animals depends on eating, digesting and metabolizing the foods. Eating dry matter is essential in animal nutrition, because the amount of nutrients that an animal receives for production, health, and reproduction depends on it (Neto *et al.*, 2010). Through accurate estimates of dry matter intake, more efficient diets can be formulated that fully meet the animal's nutritional requirements, avoiding the increase or absence of specific nutrients.

The NH_3 rumen bacteria are used more to collect sulfur (S) holding amino acids in the rumen as soon as the S awareness increases. Sheep were supplemented to give high levels of NH_3 in rumen with balanced minerals and without protozoan in rumen; it was found that the growth efficiency of microbes approached 100% of the optimum theory of anaerobic systems. Provisions of bentonite will benefit ruminants increasing productivity on green pasture or in any stage of growth provided the rumen has been given a complete array of nutrients.

A number of benefits have been reported to swallow probiotics Vaughan *et al.* 1999. In feed regulation, probiotics are included in the group of feed additives for stabilizing the microbial communities of the digestive tract in monogastric animals and ruminants. In a finer sense, the term probiotics is restricted to products which consist of single or a little well - defined sprains of microorganisms (Russell, 2002). The use of prebiotics in association with useful probiotics may be a worthwhile approach, as the prebiotics preferentially stimulate some probiotic strains.

The current study was conducted to study the possibility of feeding diets with or without sodium nitrate by adding sodium sulfate, clay, yeast and prebiotics to improve rabbit performance.

MATERIALS AND METHODS

The experimental work of the present study was carried out at the Poultry Research Unit, Agricultural Research and Experimental Center, Faculty of Agriculture, Mansoura University.

Experimental animals and management:

Ninety, 7 weeks' old weaning New Zealand White (NZW) rabbits with average live body weight (LBW) 745 g were used in this study. Rabbits were randomly distributed into 10 equal experimental groups; each contained three equal replications. Each replicate group (3 rabbits) was housed in a separate cage with the following dimensions (50×50×45 cm) for length, width and height, respectively. Rabbits were fed their respective experimental diets from 7 to 14 weeks of age. Feed and water were offered *ad libitum* throughout the experimental period. The values of live body weight and feed intake were recorded on a replicate group basis and thus daily weight gain and feed conversion were also calculated.

Feed additives:

The present study was conducted to assess the effect of inclusion the basal diet with / without sodium nitrate. The experimental basal diets were added with sodium sulphate or clay or yeast culture or prebiotic. Sodium sulphate was obtained from "Mansoura chemical branch" El-Gamhoria company at the Chest Hospital in Mansoura. The clay or "bentonite" was obtained from Sinai Manganese Company, Cairo Egypt. Bentonite contained the following oxides, SiO_2 49-55 %; AL_2O_3 20-24 %; Fe_2O_3 2.6-6 %; CaO 0.2-6 %; Na_2O 1.1-24 %; Mg 0.5-2 % and K_2O 1.2-1.4 %.

Yeast culture is "Progut – a new generation" yeast product. The prebiotic is a buffered blend of specific acids on a unique mineral carrier system combined with a fructo – oligosaccharide (FOS) to promote a healthy gut microflora, which 2 Kg were added to ton feed of the basal diet at feeding time.

Experimental diets and design:

The Experimental diets were formulated to provide adequate energy and protein for growing rabbits. Ten experimental diets were formulated to be more than 16 % protein according to the (NRC, 1977) recommendations. The constituents of the experimental basal diet were as shown:

Table 1. Ingredients of the experimental basal diets.

Feed ingredients	Basal diet
Alfalfa hay	32.00
Yellow corn	10.00
Barley	13.00
Wheat bran	20.00
Soybean meal	13.00
Mint	6.15
Aniseed	1.00
Molasses	2.00
Limestone	1.00
Dicalcium phosphate	1.00
Sodium chloride	0.40
Vit. Min. premix*	0.30
Coccdan	0.05
Methionine	0.10

*** Premix: Each 2 kg of the premix contained Vit A, 10.000000 IU; Vit D_3, 2000000 IU, Vit E, 10000 mg; Zinc, 3000 mg, Manganese, 2000 mg; Iron, 4000 mg; Copper, 1000 mg; Iodine, 100 mg; Selenium, 10 mg; Cobalt, 10 mg; Sodium, 23000 mg; and Magnesium, 2000 mg; $CaCo_3$: added to 2.0 kg.**

Growth performance parameters:

Live body weights of the experimental rabbits were individually recorded the start of the experiment and on a weekly basis thereafter, estimated to the nearest five grams in the early morning before receiving any feed or water. Body weight gain and feed conversion ratio were also calculated on a replicate group basis. Mortality of rabbits was also monitored and recorded daily.

At the end of the experimental period, three rabbits from each experimental treatment were randomly chosen and slaughtered to study carcass characteristics. Rabbits were fasted for approximately 18 hours before slaughtering, individually weighed and slaughtered according to the rules of Islamic religion. Slaughter data were immediately recorded for the individual rabbits. Skinning was carried out by removing the skin including tail and legs. Carcasses were eviscerated and the different organs (e.g. Liver, heart, kidneys, viscera and lungs) were removed and immediately weighed to the nearest gram. Absolute weights of dressed carcass and organs and dressing-out percentage were estimated.

Economic efficiency:

The local price of daily body weight gain and daily feed cost was calculated depending on the prevailing prices being: Price of kg body weight = 50.00 EGP; Kg $NaNO_3$= 5 EGP; Kg clay= 2.5 EGP; Kg yeast= 85 EGP; Kg prebiotic = 420 EGP; Kg feed (R1) = 4.8 EGP ; Kg feed (R2)= 4.8 EGP; Kg (R3)= 4.9 EGP; Kg (R4)= 5.0 EGP; Kg (R5)= 5.6 EGP; Kg (R6)= 4.9 EGP; Kg feed (R7)= 4.9 EGP; Kg feed (R8)= 5.0 EGP; Kg feed (R9)= 5.1 EGP; Kg feed (R10)= 5.7 EGP

- **Total feed cost = Average feed intake (kg) × price per (kg) feed.**
- **Weight gain price =Average weight gain (kg)× price per kg live body weight.**
- **Profit (EGP) = Price of weight gain – Price of feed cost.**

Table 2. Chemical composition of the experimental diets.

Items	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
$NaNO_3$			0.0					2%		
Addtives	Non	Na_2SO_4	Clay	Yeast	Prebiotic	Non	Na_2SO_4	Clay	Yeast	Prebiotic
DM	88.9	89.86	89.85	90.00	90.06	90.53	91.10	89.11	91.12	91.06
Composition of DM%:										
OM	90.10	89.01	88.11	88.80	90.06	88.10	84.79	88.56	88.99	87.88
CP	19.46	19.69	19.80	19.23	19.58	18.38	19.87	18.98	18.34	18.90
CF	12.77	18.42	15.10	15.93	18.38	16.11	16.78	18.02	17.01	18.05
EE	4.83	1.24	1.76	1.77	2.33	2.15	1.82	2.52	2.12	2.68
NFE	53.05	49.67	51.45	51.87	49.78	51.46	46.31	49.04	51.53	48.24
Ash	9.90	10.99	11.89	11.20	9.94	11.90	15.21	11.44	11.01	12.12
Fiber fractions %:										
NDF	28.41	32.74	29.43	31.36	30.60	31.95	29.74	30.96	31.63	30.89
ADF	17.60	20.15	18.58	19.12	18.91	19.22	18.09	19.21	20.03	19.27
Hemicellulose	10.81	12.59	10.85	12.23	11.69	12.73	11.65	11.75	10.60	11.62
ADL	4.84	5.46	5.34	5.19	5.19	5.45	7.49	5.85	5.71	5.71
Cellulose	12.77	14.69	13.23	13.93	13.72	13.77	10.60	13.37	14.32	13.56
NFC*	37.40	35.34	37.13	36.44	37.55	35.62	33.36	36.10	36.91	35.41
NFC/NDF	1.31	1.07	1.26	1.16	1.22	1.11	1.12	1.16	1.16	1.14

*** Non fibrous carbohydrates% = OM% - (CP%+NDF%+EE%), Calsamiglia *et al.*, 1995.**

Statistical analysis:

Statistical analysis of data was carried out using the General Linear Model Program of SAS (2000). Differences among means of treatments were identified by Duncan's Multiple Range Test (Duncan, 1955). The obtained data for productive traits of different groups of rabbits were subjected to factorial analysis of variance according to the following mathematical model:

$$Y_{ijk} = \mu + T_i + L_j + TL_{ij} + e_{ijk}$$

Where; Y_{ijk} = Observation of the tested factor, μ = Overall mean, T_i = the effect of sodium nitrate level, L_j = the effect of feed additives, TL_{ij} = the interaction between sodium nitrate level and feed additives and e_{ijk} = experimental random error.

RESULTS AND DISCUSSION

The effect of feeding diets without or with sodium nitrate and without or with sodium sulphate or clay or yeast or prebiotic on live body weights from 7 to 14 weeks are presented in Table (3). The effect of feed diets which contained prebiotic, was significantly ($P < 0.05$) higher in live body weight (LBW) of rabbits at 10 week of age up to 13 weeks than diets with the other feed additives, but there was no significant effect at 14 weeks with added prebiotic or the control diet on LBW.

The feed additives showed that significant effect on live body weight (LBW) of growing rabbits throughout the whole experimental period from 7 to 14 weeks of age with diets without feed additive or with added yeast or prebiotic (1140.83 g, 1109.17 g and 1146.17 g, respectively) than feeding diets with added sodium sulphate or clay (1028.33 g and 1055.17g, respectively) but without significant difference.

The interaction between NaNO3 treatment and feed additives did not significantly affect live body weight of growing rabbits throughout the experimental period from 7 to 14 weeks of age as shown in Table (4). The live body weight was higher with feeding on R1, R4. R5, R9 and R10 (1199, 1104.0, 1149, 1114 and 1142 g, respectively) than other experimental diets.

Table 3. Effect of feeding experimental diets without or with $NaNO_3$ and without or with feed additives on live body weight (g) from 7 to 14 weeks of feeding.

Items	$NaNO_3$		± SEM	Additives					± SEM
	0 %	0.2 %		Non	Na_2SO_4	Clay	Yeast	Prebiotic	
Wk 7	744.73	746.33	8.733	741.17	736.33	736.00	751.17	763.00	13.809
Wk 8	864.80	869.40	8.852	866.17	852.00	852.50	863.50	901.33	13.996
Wk 9	1040.00	1032.73	8.233	1045.67	1027.50	1019.33	1039.33	1050.00	13.018
Wk 10	1201.93	1198.47	8.001	1202.33^{b}	1174.67^{b}	1175.00^{b}	1204.17^{b}	1244.83^{a}	12.65
Wk 11	1377.53	1378.00	9.58	1391.33^{b}	1344.67^{bc}	1329.50^{c}	1367.33^{bc}	1456.00^{a}	15.147
Wk 12	1528.8	1549.53	9.87	1548.00^{b}	1495.50^{c}	1485.17^{c}	1531.50^{bc}	1635.67^{a}	15.606
Wk 13	1671.47	1677.00	11.402	1687.00^{b}	1650.00^{bc}	1626.50^{c}	1657.67^{bc}	1750.00^{a}	18.028
Wk 14	1852.47	1830.47	12.22	1882.00^{a}	1764.67^{b}	1791.17^{b}	1860.33^{a}	1909.17^{a}	19.322
Average WK (7-14)	1107.73	1084.13	11.575	1140.83^{a}	1028.33^{b}	1055.17^{b}	1109.17^{a}	1146.17^{a}	18.301

a, b, c : Means within the same raw with different superscripts are significantly different ($P < 0.05$). SEM = standard error of means.

Table 4. The interaction between feeding experimental diets without or with $NaNO_3$ and without or with feed additives on live body weight (g) from 7 to 14 weeks of feeding.

Items	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	± SEM
Additives	Non	Na_2SO_4	Clay	Yeast	Prebiotic	Non	Na_2SO_4	Clay	Yeast	Prebiotic	
$NaNO_3$			0.0					0.2			
Wk 7	728.67	731.00	744.67	769.00	750.33	753.67	741.67	727.33	733.33	775.67	19.53
Wk 8	862.67	844.67	857.33	886.00	873.33	869.67	859.33	847.67	841.00	929.33	19.79
Wk 9	1055.67	1030.00	1007.67	1065.67	1041.00	1035.67	1025.00	1031.00	1013.00	1059.00	18.41
Wk 10	1204.67	1191.00	1162.00	1228.33	1223.67	1200.00	1158.33	1188.00	1180.00	1266.00	17.89
Wk 11	1400.00	1354.00	1307.67	1405.00	1421.00	1382.67	1335.33	1351.33	1329.67	1491.00	21.42
Wk 12	1559.00	1500.33	1457.00	1562.33	1565.33	1537.00	1490.67	1513.33	1500.67	1706.00	22.07
Wk 13	1695.67	1696.00	1595.67	1677.67	1692.33	1678.33	1604.00	1657.33	1637.67	1807.67	25.495
Wk 14	1928.00	1802.67	1758.33	1873.33	1900.00	1836.00	1726.67	1824.00	1847.33	1918.33	27.326
Average WK (7-14)	1199.33	1071.67	1013.67	1104.33	1149.67	1082.33	985.00	1096.67	1114.00	1142.67	25.882

SEM = standard error of means.

When nutrients are in a form highly fermentable diet (good quality diet) could be resulted in maximal growth rates (Ruiz *et al*., 2002). In monogastrine, it is composed mainly of anaerobic species (Clostridia, Bifidobacteria, Lactobacilli, Bacteriodes, Eubacteria) which produce lactic acid and other short – chain fatty acids (Harmsen *et al*., 2002). In this respect, (Huis in't Veld *et al*., 1994) showed that the full potential of therapeutic manipulation of the enteric flora with prebiotic may not be optimally realized until understanding of the normal flora is complete.

The average daily gain was higher ($p < 0.05$) (24.50 g/d) with added $NaNO_3$ than without it (21.61 g/d) from 11 to 12 wk. of age, but the average daily gain was higher ($p < 0.05$) (25.86 g/d) without added $NaNO_3$ than with $NaNO_3$ (21.92 g/d) from 13 – 14 wk. of age. There was no significant difference on average daily gain of the whole period from 7 to 14 wks. between feeding without or with $NaNO_3$ (22.61 and 22.13 g/d, respectively) as shown in Tablet, (5).

The average daily gain was higher ($p < 0.05$) with added prebiotic from 9 – 10 wk. of age than feeding the control or added Na_2SO_4 or clay or yeast to the diets and the average daily gain was higher ($p < 0.05$) with feeding the control or added prebiotic from 10 – 11 wk. of age than added clay or yeast. The average of the daily gain of the whole period from 7 – 14 wk. was higher ($p < 0.05$) with feeding the control diet (23.28 g/d) or added prebiotic (23.39 g/d) or added yeast (22.64 g/d) than added Na_2SO_4 or clay (20.99 and 21.53 g/d respectively).

Table 5. Effect of feeding experimental diets without or with $NaNO_3$ and without or with feed additives on average daily gain (g/h/d).

Items	$NaNO_3$		± SEM	Addtives					± SEM
	0 %	0.2 %		Non	Na_2SO_4	Clay	Yeast	Prebiotic	
Wk (7 – 8)	17.15	17.58	0.571	17.86	16.52	16.64	16.05	19.76	0.903
Wk (8 – 9)	25.03	23.33	0.742	25.64	25.07	23.83	25.12	21.24	1.174
Wk (9 – 10)	23.13	23.68	0.769	22.38^{b}	21.02^{b}	22.24^{b}	23.55^{b}	27.83^{a}	1.216
Wk (10 – 11)	25.09	25.65	0.723	27.00^{ab}	24.29^{bc}	22.07^{c}	23.31^{c}	30.17^{a}	1.142
Wk (11 – 12)	21.61^{b}	24.50^{a}	0.771	22.38	21.55	22.24	23.45	25.67	1.219
Wk (12 – 13)	20.38	18.21	0.742	19.86^{abc}	22.07^{a}	20.19^{ab}	18.02^{bc}	16.33^{c}	1.173
Wk (13-14)	25.86^{a}	21.92^{b}	1.110	27.86^{ab}	16.38^{c}	23.52^{ab}	28.95^{a}	22.74^{b}	1.755
Average WK (7-14)	22.61	22.13	0.236	23.28^{a}	20.99^{b}	21.53^{b}	22.64^{a}	23.39^{a}	0.373

a, b, c : Means within the same raw with different superscripts are significantly different ($P < 0.05$). SEM = standard error of means.

The interaction among the experimental diets without or with $NaNO_3$ and without or with feed additives on the average daily gain (g/h/d) are shown in Table (6). There was no significant effect when feeding the experimental diets on the average daily gain. The average daily gain from 7 to 14 weeks were higher when feeding on the control without $NaNO_3$ (R_1) (24.48 g/h/d) or added yeast or prebiotic as shown with R_4 or R_5 (22.54 and 23.46 g/h/d, respectively) and with feeding on $NaNO_3$ with added yeast or prebiotic (R_9 or R_{10}) (22.73 and 23.32 g/h/d, respectively) than the others R_2 or R_3 or R_6 or R_7 and R_8 diets, (21.87, 20.69, 22.09, 20.10 and 22.38 g/h/d, respectively).

Schiere (2004) reported that growth rates of around 15 – 20 grams per day are common in the tropics even though it is possible to obtain 30 – 40 grams per day on very good food. The new Zealand white rabbit was bred selectively in large meat production units (Lebas and Colin, 1992).

Weight gain and the growth rate of the main tissues depend on the breeds biological characteristics and on production factors such as feeding (Santagreu, 1992). N balance, clearly demonstrating that was efficiently used as a fermentable nitrogen source for microbial growth in the rumen (Marais, 1998). Growth rates or N balance were the same in goat fed the same basal diet but including 1% of body weight as tree foliage when nitrate was the major fermentable N source.

Table 6. The interaction among feeding experimental diets without or with $NaNO_3$ and without or with feed additives on average daily gain (g/h/d).

Items	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	± SEM
Additives	Non	Na_2SO_4	Clay	Yeast	Prebiotic	Non	Na_2SO_4	Clay	Yeast	Prebiotic	
NaNO3			0.0					0.2			
Wk (7 – 8)	19.14	16.24	16.09	16.71	17.57	16.57	16.81	17.19	15.38	21.95	1.28
Wk (8 – 9)	27.57	26.48	21.48	25.67	23.95	23.71	23.67	26.19	24.57	18.52	1.66
Wk (9 – 10)	21.29	23.00	22.05	23.24	26.10	23.48	19.05	22.43	23.86	29.57	1.72
Wk (10 – 11)	27.90	23.29	20.81	25.24	28.19	26.1	25.29	23.33	21.38	32.14	1.62
Wk (11 – 12)	22.71	20.9	21.33	22.48	20.62	22.05	22.19	23.14	24.43	30.71	1.72
Wk (12 – 13)	19.52	27.95	19.81	16.48	18.14	20.19	16.19	20.57	19.57	14.52	1.659
Wk (13-14)	33.19	15.24	23.24	27.95	29.67	22.52	17.52	23.81	29.95	15.81	2.483
Average WK (7-14)	24.48	21.87	20.69	22.54	23.46	22.09	20.10	22.38	22.73	23.32	0.528

SEM = standard error of means.

As shown in Table (7), there were significant effect on DMI with feeding on the diet without $NaNO_3$ at 9, 11 and 14 weeks than feeding diet with $NaNO_3$. The average DMI of the whole period from 7 to 14 wks. was not significantly differed when feeding without or with $NaNO_3$ (92.76 and 91.32 g/h/d, respectively). The diets which were fed without feed additives or added yeast or prebiotic were higher ($p < 0.05$) in DMI (79.21, 79.59 and 79.67 g/h/d, respectively) than added Na_2SO_4 or clay (75.38 and 75.89 g/h/d respectively) at 9 wk. of age. There was no significant effect during the whole period from 7 to 14 weeks with feeding diets without feed additives or with added Na_2SO_4 or clay or yeast or prebiotic (93.4, 90.0,91.35, 92.58 and 92.87 g/h/d, respectively).

The interaction among feeding the experimental diets in Table (8), showed that there was no significant effect from 7 to 14 weeks on DMI. The average DMI from 7 to 14 weeks of age when feeding the experimental diets was ranged from 89.96 g/h/d with feeding on R_7 to 93.55 g/h/d with feeding on R_6.

Feeding clays also causes morphological changes in the intestinal mucosa such as an increase in villus height and an increase in the villus height to crypt depth ratio. These changes increase the surface area of the gastrointestinal tract thus increasing nutrient digestibility (Subramaniam and Kim, 2015). Fiber is required to achieve a high rate of passage of feed through the gut and to optimize caecal fermentation, although an excess of dietary fiber limits energy intake and growth performance (De Blas *et al.*, 1999).

Table 7. Effect of feeding experimental diets without or with $NaNO_3$ and without or with feed additives on average dry matter intake (g/h/d).

Items	NaNO3		± SEM	Addtives					± SEM
	0 %	0.2 %		Non	Na_2SO_4	Clay	Yeast	Prebiotic	
Wk 7	58.70	59.24	0.696	59.15	59.62	58.76	59.33	58.00	1.101
Wk 8	69.77	69.11	0.707	69.12	69.37	68.18	70.33	70.20	1.118
Wk 9	79.25[a]	76.42[b]	0.569	79.21[a]	75.38[b]	75.59[b]	79.34[a]	79.67[a]	0.899
Wk 10	87.66	86.49	0.566	89.44[a]	85.04[b]	85.91[b]	87.82[ab]	87.14[ab]	0.894
Wk 11	99.90[a]	97.45[b]	0.675	102.11[a]	95.90[c]	96.63[bc]	99.04[abc]	99.68[ab]	1.067
Wk 12	97.74	97.37	0.662	99.45[a]	93.92[b]	99.27[a]	96.50[ab]	98.61[a]	1.047
Wk 13	118.47	117.42	0.735	119.81	115.49	117.52	118.02	118.88	1.162
Wk 14	130.58[a]	127.03[b]	0.846	128.90	125.23	128.91	130.23	130.76	1.338
Average WK (7-14)	92.76	91.32	0.57	93.40	90.00	91.35	92.58	92.87	0.901

a, b, c : Means within the same raw with different superscripts are significantly different ($P < 0.05$). SEM = standard error of means.

Table 8. The interaction between feeding experimental diets without or with $NaNO_3$ and without or with feed additives on average dry matter intake (g/h/d).

Items	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	
Additives	Non	Na_2SO_4	Clay	Yeast	Prebiotic	Non	Na_2SO_4	Clay	Yeast	Prebiotic	± SEM
$NaNO_3$			0.0					0.2			
Wk 7	58.00	59.9	59.33	60.00	56.27	60.29	59.33	58.19	58.67	59.72	1.56
Wk 8	68.67	70.07	68.55	70.87	70.69	69.57	68.68	67.81	69.8	69.70	1.58
Wk 9	78.67	79.00	79.00	79.67	79.93	79.74	71.75	72.17	79.01	79.42	1.27
Wk 10	89.00	89.00	88.67	85.97	85.66	89.89	81.08	83.16	89.68	88.62	1.26
Wk 11	104.67	98.33	98.67	98.35	99.47	99.55	93.47	94.59	99.72	99.89	1.51
Wk 12	99.00	99.00	98.67	93.74	98.28	99.90	88.84	99.88	99.26	98.95	1.48
Wk 13	118.80	118.67	119.00	117.43	118.46	120.83	112.31	116.04	118.62	119.3	1.644
Wk 14	129.17	129.59	130.00	131.14	133.00	128.64	120.87	127.81	129.31	128.53	1.892
Average WK (7-14)	93.25	92.95	92.74	92.15	92.72	93.55	87.04	89.96	93.01	93.02	1.274

SEM = standard error of means.

In a large number of studies going back to the early part of the 20th century it has been demonstrated that nitrate is relatively innocuous and the upper limit of NO_3 intake is about 1g/Kg live weight in animals not accustomed to receiving nitrate in their diet (Booth and McDonald, 1982). (Lebas and Colin, 1992), reported that if the breeder uses balanced concentration, the average daily consumption will be 100 to 130 g/h/d for medium size animal.

There was no significant effect on the average of the whole period of the feed conversion (FC) when feeding the basal diet without or with $NaNO_3$ (4.12 and 4.14 g DMI/g DG, respectively). Table (9) shows, also the effect of the feed additives on the FC. The FC was higher ($p < 0.05$) without or with added Na_2SO_4 or clay or yeast than added prebiotic at 9 to 10 weeks of age, and FC, decreased ($p < 0.05$) with added prebiotic than the others at 10 to 11 weeks.

The average conversion ratio from 7 to 14 weeks was the highest when feeding on R_2, R_3, R_4, R_6, R_7, R_8 and R_9 diets (4.25, 4.49, 4.09, 4.25, 4.33, 4.02 and 4.09 g DMI/g DG, respectively), while the lowest values were recorded with feeding on R_1 and R_{10} (3.81 and 3.99 g DMI/g DG, respective) as shown in Table (10).

The average feed conversion ratio (FCR) of 3.60, 3.82 and 3.63 in France, Italy and Spain, respectively (Maertens, 2009). However, all these studies stress the big differences between farms (from less than 3.0 till over 4.5). young and quick growing animals have a much more favorable FCR in early fattening stage than near slaughter weight. In good conditions, the rabbits will gain 30 to 40 g/day, if the breeder offer balanced concentrations, the average daily consumption will be 100 to 130 for medium size animal, which means on intake of 3 to 3.5 Kg feed will produce 1 Kg gain LBW (Lebas and Colin, 1992).

Table 9. Effect of feeding experimental diets without or with $NaNO_3$ and without or with feed additives on feed conversation (dry matter intake g / g daily gain).

Items	NaNO3		± SEM	Addtives					± SEM
	0 %	0.2 %		Non	Na_2SO_4	Clay	Yeast	Prebiotic	
Wk (7 – 8)	4.14	4.01	0.136	3.92	4.20	4.16	4.44	3.68	0.216
Wk (8 – 9)	3.24	3.35	0.117	3.14	3.02	3.31	3.16	3.86	0.185
Wk (9 – 10)	3.87	3.73	0.127	4.02[a]	4.08[a]	3.99[a]	3.75[a]	3.16[b]	0.200
Wk (10 – 11)	4.05	3.89	0.097	3.83[b]	3.99[ab]	4.41[a]	4.30[ab]	3.34[c]	0.154
Wk (11 – 12)	4.58[a]	4.07[b]	0.144	4.45	4.46	4.51	4.13	4.08	0.228
Wk (12 – 13)	6.11	6.66	0.25	6.17[b]	5.64[b]	5.85[b]	6.76[ab]	7.48[a]	0.395
Wk (13-14)	5.51[b]	6.13[a]	0.169	4.94[cd]	7.73[a]	5.53[c]	4.56[d]	6.34[b]	0.267
Average WK (7-14)	4.12	4.14	0.047	4.03[bc]	4.29[a]	4.26[ab]	4.09[abc]	3.97[c]	0.074

a, b, c : Means within the same raw with different superscripts are significantly different ($P < 0.05$). SEM = standard error of means.

As shown in Table (11), there was significant effect ($p < 0.05$) on the liver or giblets weight when added Na_2SO_4, clay, yeast or prebiotic which were higher ($p < 0.05$) than feeds without any additives. Also the same trend was observed on heart weight, but without significant difference between feeding diets without additives or with added clay. The average dressing % results, showed that there was no significant difference among the feeds without additives or added Na_2SO_4, clay, yeast or prebiotic (57, 57, 56, 57, or 56% respectively). Table (12), showed that there were no significant difference among the experimental diets on the carcass characteristics of growing rabbits. The average dressing % was ranged from 56 to 58%.

Table 10. The interaction between feeding experimental diets without or with $NaNO_3$ and without or with feed additives on feed conversation (dry matter intake g / g daily gain).

Items	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	
Additives	Non	Na_2SO_4	Clay	Yeast	Prebiotic	Non	Na_2SO_4	Clay	Yeast	Prebiotic	± SEM
$NaNO_3$			0.0					0.2			
Wk (7 – 8)	3.63	4.32	4.27	4.32	4.18	4.20	4.09	4.04	4.56	3.18	0.305
Wk (8 – 9)	2.86	2.99	3.84	3.11	3.41	3.40	3.05	2.78	3.22	4.30	0.262
Wk (9 – 10)	4.19	3.88	4.24	3.73	3.31	3.84	4.28	3.76	3.78	3.01	0.283
Wk (10 – 11)	3.78	4.24	4.76	3.91	3.56	3.88	3.73	4.06	4.69	3.13	0.218
Wk (11 – 12)	4.36	4.79	4.67	4.18	4.89	4.53	4.13	4.36	4.076	3.26	0.322
Wk (12 – 13)	6.35	4.25	6.01	7.25	6.66	5.99	7.04	5.69	6.26	8.29	0.559
Wk (13-14)	4.13	8.53	5.67	4.73	4.49	5.74	6.93	5.39	4.39	8.19	0.378
Average WK (7-14)	3.81	4.25	4.49	4.09	3.96	4.25	4.33	4.02	4.09	3.99	0.104

SEM = standard error of means.

Table 11. Effect of feeding experimental diets without or with $NaNO_3$ and without or with feed additives on some Carcass characteristics of growing rabbits.

Items	$NaNO_3$		± SEM	Addtives					± SEM
	0 %	0.2 %		Non	Na_2SO_4	Clay	Yeast	Prebiotic	
live body weight	2079.67^{a}	1922.00^{b}	32.603	1889.17	2060.00	1936.67	2060.00	2058.33	51.55
Slaughter (g)	2020.53^{a}	1861.67^{b}	31.135	1830.83	2000.00	1878.33	1995.50	2000.83	49.228
Blood (g)	58.47	59.67	2.778	56.83	60.00	58.33	62.67	57.50	4.392
Skin (g)	353.27	328.33	19.696	334.17	371.67	334.17	346.67	317.33	31.142
Lung (g)	30.53^{b}	34.80^{a}	1.388	25.00^{c}	32.67^{b}	30.33^{bc}	31.67^{bc}	43.67^{a}	2.195
Viscera (g)	336.33^{a}	299.00^{b}	6.754	310.00	315.00	308.33	328.33	326.67	10.678
Liver (g)	156.13	150.40	3.547	108.00^{b}	166.00^{a}	172.67^{a}	157.67^{a}	162.00^{a}	5.608^{a}
Heart (g)	16.07	14.93	1.023	11.500^{b}	17.667^{a}	13.667^{ab}	18.000^{a}	16.67^{a}	1.618
Kidneys (g)	33.93	34.93	1.566	29.50	38.67	34.00	33.33	36.67	2.475
Giblets weight*	206.13	199.87	3.528	149.00^{b}	222.00^{a}	220.33^{a}	209.00^{a}	214.67^{a}	5.578
Hot carcass (g)	1169.67^{a}	1091.67^{b}	20.198	1075.83	1167.5	1080	1177.50	1152.50	31.935
Dressing**	0.56	0.57	0.004	0.57	0.57	0.56	0.57	0.56	0.006

a, b, c : Means within the same raw with different superscripts are significantly different ($P < 0.05$). SEM = standard error of means.

*** Giblets weight including the weight of liver, heart and kidneys. ** Dressing percentage (D.P.) = carcass weight / Live body weight × 100**

Table 12. The interaction between feeding experimental diets without or with $NaNO_3$ and without or with feed additives on some Carcass characteristics of growing rabbits.

Items	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	
Additives	Non	Na_2SO_4	Clay	Yeast	Prebiotic	Non	Na_2SO_4	Clay	Yeast	Prebiotic	± SEM
$NaNO_3$			0.0					0.2			
live body weight	1905.00	2308.33	1935	2160	2090	1873.33	1811.67	1938.33	1960	2026.67	72.902
Slaughter (g)	1855.00	2246.67	1880.00	2092.67	2028.33	1806.67	1753.33	1876.67	1898.33	1973.33	69.619
Blood (g)	47.00	61.67	55.00	67.00	61.67	66.67	58.33	61.67	58.33	53.33	6.211
Skin (g)	356.67	423.33	340.00	371.67	274.67	311.67	320.00	328.33	321.67	360.00	44.042
Lung (g)	14.67	39.33	32.67	32.00	34.00	35.33	26.00	28.00	31.33	53.33	3.104
Viscera (g)	313.33	376.67	310.00	350	331.67	306.67	253.33	306.67	306.67	321.67	15.102
Liver (g)	74.67	194.67	180.67	159.33	171.33	141.33	137.33	164.67	156.00	152.67	7.931
Heart (g)	7.67	20.67	14.00	22.00	16.00	15.333	14.667	13.333	14.00	17.333	2.288
Kidneys (g)	19.67	44.00	35.33	36.00	34.67	39.33	33.33	32.67	30.67	38.67	3.501
Giblets weight*	102.00	259.33	230.00	217.33	222.00	196.00	184.67	210.67	200.67	207.33	7.889
Hot carcass (g)	1091.67	1283.33	1075.00	1220	1178.33	1060	1051.67	1085	1135	1126.67	45.163
Dressing**	0.57	0.56	0.56	0.56	0.56	0.57	0.58	0.56	0.58	0.56	0.008

SEM = standard error of means. * Giblets weight including the weight of liver, heart and kidneys. ** Dressing percentage (D.P.) = carcass weight / Live body weight × 100

(Abdel-wareth *et al.*, (2014) showed that the growing rabbit performance and carcass characteristics when feeding on standard diet were 56.32, 3.66 and 1.22% for dressing, Liver and Kidney weight, respectively. Slaughter yield improve with age, for a given carcass weight, animals at high growth rate receiving more balanced feed, generally have a better carcass yield (Lebas and Colin, 1992).

The relative economic efficiency from R_1 of the experimental diets was 76.16, 63.73, 77.25, 68.73, 76.77, 58.29, 76.01, 78.04 and 66.37 % for R_2, R_3, R_4, R_5, R_6, R_7, R_8, R_9 and R_{10}, respectively. The highest relative economic efficiency results were with feeding on R_2, R_4, R_6, R_8 and R_9. Feeding on R_3, R_5, and R_{10} were in the intermediate, while feeding on R_7 was the lowest value of economic efficiency as shown in Table (13).

Conclusively, the present study showed that the live body weight was higher with feeding on diet without $NaNO_3$ or without feed additives (R1) or with added yeast (R4) or prebiotic (R5) or with $NaNO_3$ and with added yeast (R9) or prebiotic (R10). The average daily gain was higher with feeding on R1 or R4 or R5 or R10. The conversion ratio was decreased with feeding on R1 and R10. In general feeding on like these feed additives need more research works to adjust the economic efficiency and animal health in general.

Table 13. Effect of feeding experimental diets without or with $NaNO_3$ and without or with feed additives on the economic efficiency of growing rabbits.

Items	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Additives	**Non**	**Na_2SO_4**	**Clay**	**Yeast**	**Prebiotic**	**Non**	**Na_2SO_4**	**Clay**	**Yeast**	**Prebiotic**
$NaNO_3$			**0.0**					**0.2**		
Price (EGP)/ kg fresh of feed	4.8	4.8	4.9	5	5.6	4.9	4.9	5	5.1	5.7
Feed intake /g/h/d	146.23	144.67	144.69	144.44	144.35	143.6	142.7	145.89	142.67	142.76
Total feed cost (EGP) / day	0.402	0.696	0.702	0.724	0.814	0.704	0.701	0.722	0.729	0.819
Average daily gain (g)	24.48	21.87	20.69	22.54	23.46	22.09	20.1	22.38	22.73	23.32
Price of daily gain (EGP)	1.224	1.094	1.035	1.127	1.173	1.105	1.005	1.119	1.137	1.166
Profit (EGP)	0.522	0.398	0.333	0.403	0.359	0.401	0.304	0.397	0.407	0.347
Relative economic efficiency*	100	76.16	63.73	77.25	68.73	76.77	58.29	76.01	78.04	66.37

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تاثير إضافة نترات الصوديوم بدون او مع إضافات علفية فى علائق الأرانب النامية على الاداء الانتاجى والكفاءة الاقتصادية

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تم اختيار 90 ارنب نيوزلاندى عمر (7) سبعه اسابيع حيث تم توزيعها إلى (10) عشره مجاميع متساويه ومتماثله فى الوزن وتم تغذيتها على العلائق التجريبيه . أجريت هذه الدراسة بهدف بحث تأثير أربعة أنواع من الاضافات الغذائية وهى كبريتات صوديوم وطين وخميرة وبريبيوتك فى علائق بدون إضافة نترات صوديوم أو تحتوى على نترات صوديوم . تم تكوين 10 علائق تجريبية فى صورة مكعبات حيث قسمت الى مجموعتين متساويتين فكانت المجموعة الأولى بدون إصافة نترات صوديوم بينما المجموعة الثانية تحتوى على 2% نترات صوديوم وتم استخدام اربعة انواع من الاضافات العلفية وهى كبريتات صوديوم وطين وخميرة وبريبيوتك فى كل من المجموعتين وكانت المجموعة الأولى تمثل R1 , R2 . R3, R4, R5 بينما المجموعة الثانية تمثل R6, R7. R8, R9, R10 وكانت أهم النتايج المتحصل عليها كما يلى: زاد وزن الجسم عند التغذية على العلائق R1 , R4 . R5, R9, R10 زاد معدل النمو اليومى خلال الفترة 7-14 اسبوع عند التغذية على R1 , R4 . R5, R9, R10 تحسن معدل التحول الغذائى عند التغذية على العلائق R1 , R10 انخفضت الكفاءة الأقتصادية عند التغذية على العلائق التجريبية مقارنة بالتغذية على العليقة الكنترول يستنتج من هذه الدراسة ان العلائق التى تحت الدراسة كانت تحتوى على مستويات من النترات لا تؤثر على انتاجية الحيوان وكانت التغذية على علائق R1 , R4 . R5, R9, R10 هى الأفضل من الناحية الانتاجية ولكن يجب الاخذ فى الاعتبار عمل مزيد من الدراسات لضبط استخدام الاضافات العلفية لتحسين الكفاءة الاقتصادية.