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Natural Bioactive Mixture Composed of Lemon, Onion and Garlic Juice for Feeding Rabbits

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Abstract: Forty five growing rabbits aged 5 weeks (564±5.81 g) used in a feeding trial for period lasted 56 days. Experimental rabbits randomly allotted into 5 equal groups to established the impact of adding natural bioactive mixture composed of (juice of lemon, onion and garlic) (LOG) at portions (1.00: 1.00: 0.125/ liter clean water), respectively, to rabbit rations on their performance, nutrient digestibility coefficients and economic evaluation. The 1st group rabbits expressed as (control) and received basal ration while rabbits in 2nd, 3rd, 4th and 5th groups were received the basal ration supplemented with mixture juice of (LOG) at levels (5, 10, 15 and 20 ml/ kg ration). The percentages of crude protein ranged from 18.11% to 18.33%, while digestible energy ranged from 2512 to 2539 (kcal/ kg DM) among five tested rations. Adding natural bioactive mixture juice (LOG) at different levels significantly improved ($P<0.05$) nutrient digestibility (except CP, cellulose and TDN value) in comparison with the control one. However, there were no significant effect ($P>0.05$) between different levels of supplementation. The best nutrient digestibility (except DM and EE) and DCP were observed with adding 15 ml LOG/ kg ration (R_4). Dietary treatments had no significant effect on DM intake. DM intake ranged from 106 to 112 g/head/day. Rabbits fed 5 ml LOG/ kg DM containing ration recorded the highest DM intake. Treatments had no significant effect ($P>0.05$) on crude protein, digestible crude protein, gross energy and digestible energy intakes. However adding 10 ml LOG/kg ration (R_3) significantly increased total digestible nutrient intake in comparison with the control one (R_1). The present results showed that average daily gain was improved by 20%, 29%, 36.1% and 19.3% for (R_2, R_3, R_4 and R_5, respectively) in comparison with the control group (R_1). On the other hand, feed conversion improved ($P<0.05$) in comparison with the control one. Inclusion LOG at different levels increased both net revenue and relative economic efficiency compared to control one. Net revenue was improved by 176%, 278%, 343% and 178% for rabbits received 5, 10, 15 and 20 ml LOG/ kg feed, respectively compared to the control group. While, relative economic efficiency was improved by 150%, 233%, 300% and 150% more than the control that assuming that equal 100%. It could be indicated that inclusion natural bioactive juice LOG in rabbit rations at level 15 ml LOG/ kg feed causes the best results in terms of growth performance with a positive effect on digestion coefficients and realize high net revenue.

Keywords: Bioactive mixture, rabbits, performance**,** nutrient digestibility, nutritive values, economic evaluation.

Introduction

During the recent years, noticed that using bioactive feed additives become important materials used to improve the efficiency of feed utilization and growth performance of different animals[1, 2].

Addition natural additives such as onion and garlic to food will increase the antioxidant content and may have potential as a natural antioxidant and thus inhibit unwanted oxidation processes [3].

Supplementation garlic to food encouraged stimulation of immune function, enhanced foreign compound detoxification and resistance various stresses[4]. [5]reported that onion bulbs possess numerous organic sulphur compounds including Trans-S-(1-propenyl) cysteine sulfoxide, S-methyl-cysteine sulfoxide, spropylcycteine sulfoxides and cycloallicin, flavinoids, phenolic acids, sterols including cholesterol, stigma sterol, b-sitosterol, saponins, sugars and a trace of volatile oil compounds mainly of sulphur compounds. On the other hand, [6] recorded that most of the plant parts contain compounds with proven antibacterial, antiviral, antiparasitic, antifungal properties have antihypertensive, hypoglycemic, antithrombotic, antihyperlipidemic, anti inflammatory and antioxidant activity.

Garlic rich in sulphur compound such as cysteine sulfoxides [7]. Also, it contained steroidal glycosides [8], lectins [9], prostaglandins, fructan, pectin, essential oil, adenosine, vitamins B_1, B_2, B_6, C and E, biotin, nicotinic acid, fatty acids, glycolipids, phospholipids, anthocyanins, flavonoids, phenolics and amino acids [10, 11]. [12] stated that lemon is a good source of potassium (145 mg per 100 g fruit), bioflavonoids, and vitamin C (40 to 50 mg per 100 g), this equal twice time as much as oranges. [1] found that feeding suckling buffalo calves diets containing bioactive mixture composed of lemon, onion and garlic juice (LOG) at 2.5, 5 and 7.5% improved their performance; nutrient digestibility (OM, CP, CF, EE and NFE) and decreased feed costing, consequently improved economic evaluation in comparison with the control one.

More sources of medicinal plants have impact stimulation on digestive enzyme and it improves the utilization of digestive products throughout increasing liver function [13, 14, 15]. So, this work aimed to using bioactive natural mixture composed of lemon, onion and garlic juice (LOG) to study its effects on feed intake, gain, feed conversion, digestibility, and economic evaluation of growing New Zealand White rabbits.

Materials and Methods

The present study was carried out at El-Nubaria Experimental and Production Station at El-Imam Malik Village, which belongs to the Animal Production Department, National Research Centre, 33 El-Bohouth Street, Dokki, Giza, Egypt, in cooperation with Regional Centre for Food and Feed, Agriculture Research Centre, Ministry of Agriculture, Giza, Egypt. This work designed to study the influence of supplementation rations with bioactive natural additive that composed of (juice of lemon, onion and garlic) (LOG) at portions (1.00: 1.00: 0.125/ liter clean water) at different levels on growth performance, digestibility, and economic evaluation of growing New Zealand White rabbits.

Experimental animals and feeds

Forty five growing New Zealand White (NZW) rabbits aged 5 weeks with an average weight 564 ± 5.81 g were reared under the same managerial and hygienic conditions. Rabbits were randomly divided into 5 equal groups, 9 rabbits for each in 3 replicates and assigned for control ration and 4 experimental rations. The 1^{st} group expressed as (control) and received basal ration while rabbits in 2^{nd}, 3^{rd}, 4^{th} and 5^{th} groups were received the basal ration supplemented with bioactive mixture juice of (LOG) at levels (5, 10, 15 and 20 ml/ kg DM intake) (V/W), respectively. The juice was prepared and sprayed on basal diet as described by [1]**.** The formula of experimental rations is presented in (Table 1).

Table (1): Formula of experimental rations (kg/Ton).

Ingredients	Experimental rations				
	R_1 Basal diet	**R_2 5 ml LOG**	**R_3 10 ml LOG**	**R_4 15 ml LOG**	**R_5 20 ml LOG**
Clover hay	320				
Yellow corn	140				
Barley	70				
Soybean meal (44% CP)	160	Basal diet	Basal diet	Basal diet	Basal diet
Wheat barn	260	+	+	+	+
Molasses	25	5 ml	10 ml	15 ml	20 ml
Di-Ca- phosphate	15	LOG /kg	LOG /kg	LOG /kg	LOG /kg DM
DL. Methionine	3	DM intake	DM intake	DM intake	intake
Sodium chloride	4				
Vit-Min-Premix*	3				
Price L.E / Ton	2100	2140	2180	2220	2260

*Each kg vitamins and minerals premix contains: Vit. A 2.00000 IU, 10.000 mg, B 1400 mg, B_2 1200 mg, B_6 400 mg, B_{12} .2 mg, K 3400 mg, D_3 200000 IU, choline chloride 240 mg, pantothenic acid 400mg, niacin 1000 mg, folic acid 1000 mg, biotin 40 mg, manganese 1700 mg, zinc 14000 mg, iron 1500 mg, copper 500 mg, selenium 20 mg, iodine 40 mg and magnesium 8000 mg.

LOG: Natural bioactive mixture juice composed of lemon, onion and garlic juice at portions (1.00: 1.00: 0.125/ liter clean water).

Meanwhile, chemical analysis and cell wall constituents of feed ingredients and experimental rations are presented in (Table 2). The experimental rations have been formulated to cover the nutrient requirements of growing rabbits according to [16] as presented in Table (2).

Rabbits were housed in galvanized wire batteries. Stainless steel nipples for drinking and feeders were supplied for each cage. Diets (on pellets form) and fresh water were available all times *ad lib* throughout feeding trial that lasted 56 days. Live body weight of rabbits and feed consumption were weekly recorded. Feed conversion ratio was calculated as g of [Dry matter intake (DMI), g total digestible nutrient intake (TDNI), g crude protein intake (CPI), g digestible crude protein (DCPI), kcal of gross energy intake (GEI) and kcal of digestible energy intake (DEI)/ g gain].

Digestibility trials

At the last week of experimental period, digestibility trials were carried out over a period of 7 days. All rabbits from each group were used in digestibility trials. Feces were daily collected quantitatively during the collection period before feeding at 8:30 a.m. Feed intake of experimental rations and weight of feces were daily recorded. Representative samples of 10% of total fresh weight of feces was sprayed with solution of 10% sulfuric acid and 10% formaldehyde and oven dried at 60°C for 48 hrs and composite samples of dried feces were ground and stored for later chemical analysis. The nutritive values expressed as total digestible nutrients (TDN) and digestible crude protein (DCP) of tested rations was calculated according to [17].

Analytical procedures

Chemical analysis of ingredients, experimental rations, feces and urine were analyzed according to [18]. Cell wall constituents {Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL)} were also determined in the ingredients and experimental rations according to [19]. Hemicellulose was calculated as the difference between NDF and ADF, while cellulose was calculated as the difference between ADF and ADL.

Gross energy (kcal/kg DM) was calculated according to [20], where each g CP = 5.65 kcal, g EE = 9.40 kcal and g (CF & NFE) = 4.15 kcal.

Digestible energy (kcal/kg DM) was calculated according to [21] using the following equation: DE = 4.36 – 0.049 x NDF

A non fibrous carbohydrate (NFC) was calculated according to [22] using the following equation: NFC = 100 – {CP + EE + Ash + NDF}.

Economic evaluation

Economical efficiency of experimental diets was calculated according to the local market price of ingredients and rabbit live body weight as following:

Net revenue= Total revenue – Total feed cost.

Economical efficiency (%) = Net revenue / Total feed cost %.

Statistical analysis

Collected data of nutrient digestibility coefficients, nutritive values, feed intake, daily gain and feed conversion were subjected to statistical analysis as one way analysis of variance using the general linear model procedure of [23]. While, [24] was used to separate means when the dietary treatment effect was significant according to the following model:

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

Where: Y_{ij} = observation, μ = the overall mean, T_i = the effect of treatment levels for i =1 to 5 and e_{ij} = the experimental error.

Results and Discussion

Chemical analysis

All experimental rations were iso-caloric and iso-nitrogenous approximately (Table 2). The chemical analysis of different experimental rations were in the same range approximately for OM, CP, CF, EE, NFE and ash contents.

Table (2): Chemical analysis of the rations.

Item	Experimental rations				
	R_1 control	**R_2 5 ml LOG**	**R_3 10 ml LOG**	**R_4 15 ml LOG**	**R_5 20 ml LOG**
1- Chemical analysis of the experimental rations					
Moisture	8.20	8.30	8.35	8.40	8.50
On DM basis					
Organic matter (OM)	90.40	90.47	90.50	90.56	90.60
Crude protein (CP)	18.11	18.20	18.26	18.30	18.33
Crude fiber (CF)	13.00	13.30	13.50	13.60	13.80
Ether extract (EE)	2.72	2.81	2.84	2.86	2.90
Nitrogen-free extract (NFE)	56.57	56.16	55.90	55.80	55.57
Ash	9.60	9.53	9.50	9.44	9.40
Gross energy (kcal/ kg DM)[1]	4166	4175	4179	4183	4187
Digestible energy (DE), kcal/ kg DM[2]	2525	2512	2534	2539	2515
Non fibrous carbohydrates (NFC)[3]	32.13	31.75	32.14	32.23	31.71
Cell wall constituents					
NDF	37.44	37.71	37.26	37.17	37.66
ADF	25.49	26.74	26.24	26.10	26.24
ADL	10.15	9.68	8.73	9.37	9.66
Hemicellulose[4]	11.95	10.97	11.02	11.07	11.42
Cellulose[5]	15.34	17.06	17.51	16.73	16.58

[1]Gross energy (Blaxter, 1968) [(20)].
[2]Digestible energy (Cheeke, 1987) [(21)]
[3]Non fibrous carbohydrates (Calsamiglia et al. , 1995) [(22)].
[4]Hemicellulose = NDF – ADF
[5]Cellulose = ADF – ADL.

LOG: Natural bioactive mixture juice composed of lemon, onion and garlic juice at portions (1.00: 1.00: 0.125/ liter clean water).

The percentages of organic matter ranged from 90.40 to 90.60%, crude protein ranged from 18.11% to 18.33%, ether extract ranged between 2.72% to 2.90%, crude fiber ranged from 13.00 to 13.80%, nitrogen-free extract content was ranged from 55.57 to 56.57% and ash ranged from 9.40 to 9.60% for the different experimental rations. On the other hand, percentages of neutral detergent fiber (NDF) were in the same range (between 37.17 to 37.71%) for the five experimental rations. The percentages of different cell wall constituents (NDF, ADF, ADL, hemicellulose and cellulose) contents were also in the range for the five experimental rations. Both gross energy (GE) and digestible energy (DE) ranged from 4166 to 4187 and 2512 to 2539 (kcal/ kg DM) for GE and DE, respectively. Meanwhile, percentages of non fibrous carbohydrates ranged between 31.71 to 32.23% for the five tested rations. The variation in chemical composition and contents of cell wall constituents may be related to differ in source of roughage incorporated in rations formulation.

Nutrients digestibility and nutritive values

The present results of (Table 3) indicated that adding natural bioactive mixture juice (LOG) at different levels significantly improved (P<0.05) DM, OM, CF, EE, NFE, NDF and hemicellulose digestibilities and TDN value in comparison with the control one. However, there were no significant effect (P>0.05) between different levels of supplementation.

Table (3): Nutrients digestibility and nutritive values of the rations.

Item	Experimental rations					SEM
	R_1 control	R_2 5 ml LOG	R_3 10 ml LOG	R_4 15 ml LOG	R_5 20 m LOG l	
Digestion coefficients:						
Dry matter (DM)	72.30^{b}	77.89^{a}	77.94^{a}	78.42^{a}	78.61^{a}	0.83
Organic matter (OM)	59.04^{b}	67.76^{a}	69.09^{a}	68.52^{a}	66.69^{a}	1.06
Crude protein (CP)	71.60^{b}	78.68^{ab}	78.78^{ab}	80.05^{a}	79.45^{a}	1.25
Crude fiber (CF)	19.63^{b}	43.17^{a}	46.44^{a}	43.23^{a}	43.00^{a}	2.75
Ether extract (EE)	91.50^{b}	97.35^{a}	97.38^{a}	95.15^{a}	95.22^{a}	0.67
Nitrogen-free extract (NFE)	62.52^{b}	68.57^{a}	69.95^{a}	69.54^{a}	66.87^{a}	0.87
NDF	34.78^{b}	44.73^{a}	47.24^{a}	52.00^{a}	46.55^{a}	1.78
ADF	30.65^{c}	31.28^{c}	36.99^{bc}	48.49^{a}	41.44^{ab}	2.02
Hemicellulose	41.81^{b}	56.51^{a}	60.64^{a}	62.17^{a}	55.39^{a}	2.17
Cellulose	28.92^{b}	42.35^{ab}	43.82^{ab}	58.04^{a}	43.38^{ab}	3.24
Nutritive values:						
Total digestible nutrient (TDN)	56.49^{b}	64.73^{a}	65.98^{a}	65.45^{a}	63.87^{a}	1.00
Digestible crude protein (DCP)	12.97^{b}	14.32^{ab}	14.39^{ab}	14.65^{a}	14.56^{a}	0.24

a, b and c: Means in the same row having different superscripts differ significantly (P<0.05).
SEM: Standard error of mean.

LOG: Natural bioactive mixture juice composed of lemon, onion and garlic juice at portions (1.00: 1.00: 0.125/ liter clean water).

Treatments had no significant effect (P>0.05) on CP digestibility. The best nutrient digestibility (except DM and EE) and DCP were observed with adding 15 ml LOG/ kg ration (R_4). These results are in harmony agreement with [1] who**,** noted that feeding suckling buffalo calves diets containing bioactive mixture composed of lemon, onion and garlic juice (LOG) at 2.5, 5 and 7.5% improved their nutrient digestibility of (OM, CP, CF, EE and NFE). On the other hand, [2] mentioned that digestibility of all nutrients as well as DCP values were significantly (P<0.05) enhanced by adding 2.5% natural bioactive mixture composed of lemon, onion and garlic for growing calves compared to zero, 5 and 7.5%. However, TDN value did not significant affected by any level of supplementation.

Also, the present results are also in agreement with those noted by [25, 26, 27, 28, 29, 30]. Meanwhile**,** [28, 31] reported that improvement that happened in the digestibility of different nutrients is probably related to improving the gross activity of microorganisms, increased immunity alternation in numbers and species of microorganisms in the digestive tract on inclusion vegetable and fruits increase in cellulolytic bacteria,

increased volatile fatty acids (VFA's) concentration and the animal rations and higher DM, TDN intake and more higher gain rate.

Growth performance of the experimental groups

The present results (Table 4) revealed that adding bioactive mixture juice LOG had no significant effect on DM intake, however adding 10 ml LOG/kg ration (R_3) significantly increased total digestible nutrient intake in comparison with the control one (R_1). These results might explain that adding bioactive mixture (LOG) at different experimental levels had no adverse effect on rabbit's palatability. DM intake ranged from 106 to 112 g/head/day. Rabbits fed 5 ml LOG/ kg DM containing ration recorded the highest DM intake. Treatments had no significant effect (P>0.05) on crude protein, digestible crude protein, gross energy and digestible energy intakes. These results are in harmony with[2].

Table (4): Growth performance of the experimental groups.

Item	Experimental rations					SEM
	R_1 control	R_2 5 ml LOG	R_3 10 ml LOG	R_4 15 ml LOG	R_5 20 ml LOG	
Live body weight (LBW)						
No. of animals	9	9	9	9	9	-
Initial weight (g)	564	560	565	562	569	5.81
Final weight (FW, g)	1298^{b}	1441^{ab}	1512^{a}	1561^{a}	1445^{ab}	29.35
Total body weight gain (TBWG, g)	734^{b}	881^{ab}	947^{a}	999^{a}	876^{ab}	28.97
Experimental duration, days	56 days					
Average daily gain (ADG, g/day)	13.11^{b}	15.73^{ab}	16.91^{a}	17.84^{a}	15.64^{ab}	0.51
Feed intake of:						
Dry matter (DMI), g	109	112	110	109	106	2.65
Total digestible nutrient (TDNI), g	62^{b}	72^{ab}	73^{a}	71^{ab}	68^{ab}	1.70
Crude protein (CPI), g	19.7	20.4	20.1	19.9	19.4	0.48
Digestible crude protein (DCPI), g	14.1	16.0	15.8	16.0	15.4	0.39
Gross energy (GEI), kcal	454	468	460	456	444	9.05
Digestible energy (DEI), kcal	275	281	279	277	267	3.28
Feed conversion (g intake /g gain) of						
Dry matter (DM)	8.31^{b}	7.12^{a}	6.51^{a}	6.11^{a}	6.78^{a}	0.21
Total digestible nutrient (TDN)	4.73^{b}	4.58^{ab}	4.32^{ab}	3.98^{a}	4.35^{ab}	0.11
Crude protein (CP)	1.50^{b}	1.30^{ab}	1.19^{a}	1.12^{a}	1.24^{a}	0.03
Digestible crude protein (DCP)	1.08^{b}	1.02^{ab}	0.93^{ab}	0.90^{a}	0.98^{ab}	0.03
Gross energy (GE), kcal / g.gain	34.63^{b}	29.75^{a}	27.20^{a}	25.56^{a}	28.39^{a}	0.86
Digestible energy (DE), kcal / g.gain	20.98^{c}	17.86^{b}	18.86^{b}	15.53^{a}	17.07^{b}	0.48

a, b and c: Means in the same row having different superscripts differ significantly (P<0.05).
SEM: Standard error of mean.

LOG: Natural bioactive mixture juice composed of lemon, onion and garlic juice at portions (1.00: 1.00: 0.125/ liter clean water).

Adding bioactive mixture juice LOG improved final weight, total body weight gain and average daily gain. Rations (R_3 and R_4) significantly increased (P<0.05) average daily gain compared to the control group; however, there were no significant effect between R_3 and R_4 groups.

Average daily gain was improved by 20%, 29%, 36.1% and 19.3% for (R_2, R_3, R_4 and R_5, respectively) in comparison with the control group (R_1). These results are in agreement with those obtained by [2] who found that average daily gain was increased by 4.8% in growing buffalo calves fed diet contained 2.5% of the same bioactive mixture components. Meanwhile, they noticed that ADG was significantly (P<0.05) declined with increasing levels of addition from LOG mixture at 5 and 7.5% in comparison with 2.5% LOG and insignificantly compared to the calves in control group. Also, the present results in agreement with those reported by [26, 27,29,1].

Onion and garlic caused an improvement in growth this reason related to increase the inflow of glucose into tissues and thyroid like activity [32]. In addition to, improvement of live body weight gain by feeding animals on onion and/or garlic may be due to their contents of sulphar compounds that are considered as active antimicrobial agents and improve immunity [33, 34].

Also the present results (Table 4) illustrated that adding bioactive mixture juice (LOG) significantly ($P<0.05$) improved feed conversion which expressed as (g intake /g gain) of DM, TDN, CP and DCP and also, for feed conversion that expressed as (kcal intake /g gain) of GE and DE compared to the control group. These results might be due to the effective to improve immunity and decrease debility incidence, which agree with the findings of [35, 36,37,2] who reported that nutrition plays important role in diminishing growth rate. While, [11] found that dry matter intake, Final weight, weight gain and feed conversion were slightly improved in calves fed garlic as natural feed additive. [1] fed suckling buffalo calves diets supplemented with 2.5, 5 and 7.5% bioactive natural mixture composed of lemon, onion and garlic juice (LOG) and they noted that feed conversion expressed as kg DM, TDN and DCP/ kg gain improved by 31.05, 36.64 and 21.75%, respectively compared to control one.

Economic evaluation of the experimental rations

The profitability of using rations containing bioactive natural mixture composed of lemon, onion and garlic juice (LOG) presented in (Table 5). Costing of one kg feed increased by 1.90%, 3.81%, 5.71% and 7.62%, respectively for tested rations that contained 5, 10, 15 and 20% LOG/ kg feed compared to the control ration (0% LOG).

Table (5): Economic evaluation of experimental rations.

Item	Experimental rations				
	R_1 control	**R_2 5 ml LOG**	**R_3 10 ml LOG**	**R_4 15 ml LOG**	**R_5 20 ml LOG**
Live body weight (LBW), kg	1.298	1.441	1.512	1.561	1.445
Total feed consumed for each rabbit, kg	6.664	6.832	6.720	6.664	6.496
Costing of one kg feed, (LE)[1]	2.10	2.14	2.18	2.22	2.26
Total feed cost, (LE)	13.99	14.62	14.65	14.79	14.68
Feed cost / kg LBW (LE)[2]	10.78	10.15	9.69	9.47	10.16
Managerial cost / Rabbit, (LE)[3]	3	3	3	3	3
Total cost, (LE)[4]	31.99	32.62	32.65	32.79	32.68
Total revenue, (LE)[5]	33.75	37.47	39.31	40.59	37.57
Net revenue, (LE)	1.76	4.85	6.66	7.80	4.89
Economic efficiency[6]	0.06	0.15	0.20	0.24	0.15
Relative economic efficiency[7]	100	250	333	400	250

[1] Based on prices of year 2016.
[2] Feed cost/kg LBW = feed intake * price of kg / live weight.
[3] Include management, labors and veterinary care.
[4] Include the feed cost of experimental rabbit which was LE 15/ rabbit + management.
[5] Body weight x price of one kg at selling which was LE 26.
[6] Net revenue per unit of total cost (Khial, 1997) [(41)].
[7] Assuming that the relative economic efficiency of control diet equals 100 %.
LE = Egyptian pound equals 0.13 US$ approximately.

LOG: Natural bioactive mixture juice composed of lemon, onion and garlic juice at portions (1.00: 1.00: 0.125/ liter clean water).

With incorporation LOG in rabbit rations at different levels both net revenue and relative economic efficiency were increased in comparison with the control one. Net revenue was improved by 176%, 278%, 343% and 178% for rabbits received 5, 10, 15 and 20 ml LOG/ kg feed, respectively compared to the control group. While, relative economic efficiency was improved by 150%, 233%, 300% and 150% more than the control that assuming that equal 100%.

Feed cost/ kg live body weight gain were decreased by 5.84%, 10.11%, 12.15% and 5.75% for rabbits received rations contained 5, 10, 15 and 20 ml LOG/ kg feed, respectively compared to the control group (Table 5).

These results were in agreement with those obtained by [38, 39, 40] who noted that the feed cost was increased as the level of supplementation incorporation increased in rabbit rations. Also, they noted that there was significant effect for treatment ($P<0.05$) on the cost of feed per kg. On the other hand, [2] reported that growing buffalo calves that fed diet supplemented with 5% natural additive composed of (lemon, onion and garlic) juice (LOG) recorded the most efficient one. While the highest relative economic efficiency was observed when experimental group calves received diet containing 2.5% natural additive compared to those calves fed the control one by 3.55%. Also, the present results are in agreement with [35, 37, 28].

Conclusion

Under the conditions of this study it could be mentioned that adding natural bioactive mixture composed of lemon, onion and garlic juice (LOG) to growing rabbit rations gave the best results in terms of growth performance, digestion coefficients, feed conversion and relative economic efficiency. So, it could be mentioned that the best level of adding LOG in rabbit rations was 15 ml LOG/ kg feed.

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