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Response of Broiler Chickens to Diets Containing Different Levels of Natural Bioactive Mixture Composed of Lemon, Onion and Garlic Juice

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Abstract : This work was conducted to study the effect of inclusion natural bioactive mixture composed of lemon, onion and garlic juice (LOG) at portions (0.125: 1.00: 1.00/ liter clean water) on growth performance and economic evaluation of broiler chicken. A total of 208 one-day-old straight run chicks were housed in batteries and distributed to 16 replicates, with 4 treatments. The experimental rations were classified as control (T_1) and three different levels of LOG 10, 20 and 30 ml LOG/ kg feed (T_2, T_3 and T_4), respectively. Starter ration contained 23.2% CP and 3045 Kcal ME/Kg diet, grower ration contained 22% CP and 3164 Kcal ME/Kg diet and finisher ration contained 20% CP and 3220 Kcal ME/Kg. The results showed that LOG is a good quality source of essential and non essential amino acids and a good source of macro and micro elements. Inclusion natural bioactive mixture (LOG) in broiler chick diets had no significant ($P>0.05$) effect on final weight, total body weight gain, total feed intake and feed conversion. Mortality rate was decreased with increasing level of inclusion LOG in the rations (5.77, 5.77, 3.48 and 1.92% for T_1, T_2, T_3 and T_4), respectively. Marketing weight, net revenue and relative economic efficiency for T_2 and T_3 were improved compared to control one (T_1). Although feed cost (LE) per (Kg live body weight) was slightly increased with adding LOG in broiler chick rations at 10 or 20 ml/ kg feed relative economic efficiency was slightly improved by 100.7 and 101.1 % for T_2 and T_3 compared to control (T_1). The present results mentioned that, under conditions similar to those available in this study, it can be conclude that, natural bioactive mixture composed of lemon, onion and garlic juice (LOG) can be used to improve the utilization of broiler chick ration, health and their gains. Also, it must be noted that the suitable level of adding LOG in broiler chick rations up to 20 ml LOG/ kg feed with no adverse effect on growth performance.

Keywords: Natural bioactive mixture, broiler chickens, performance, economic evaluation.

Introduction

Today, herbs, spices and medicinal plants have received an increasing attention as possible growth promoter's and additives references. There is an evidence suggests that some of these components have different active substances[1]. Also, they can have many benefits for the health of broilers and function such as antioxidation ability[2], antimicrobial activity[3] and enhancing digestion by stimulating endogenous enzymes[4].

Feeding is the major component of total costs of poultry venture as 80% of the total expenditure is on procurement of feed[5]. Feed additives are a group of nutrient and non-nutrient compounds which helps in improving the efficiency of feed utilization and thus reducing the high cost of feed[6].

In many countries, the routine use of antibiotics in poultry diets have been banned and thus, some endeavors are made to develop new in-feed antibiotics substitutes for reducing and treating infectious diseases in poultry industry. The herb and botanicals are increasingly being used in animal feeds, in place of antibiotics, as possible alternative means to prevent infectious diseases and modulate the immune responses[7].

Onion "*Allium ceps L*" and garlic "*Allium sativum L*" are cultivated widely in Egypt and used by Egyptian farmers since long time ago in poultry diets[8]; have protective effect against many diseases. Moreover, both have valuable nutrients such as vitamins, minerals, essential amino acids and essential fatty acids[9]. Natural foods are generally believed to be safer, healthier and less hazardous than foods containing artificial additives. Both onion and garlic are used as phytogenic feed additive alternative to chemical growth promoters.

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[10, 11].

Most of the plant parts contain compounds with proven anti-bacterial, antiviral, anti-parasitic, anti-fungal properties and have anti-hypertensive, hypoglycemic, antithrombotic, antihyperlipidemic, anti-inflammatory and anti-oxidant activity[12].

Meanwhile, [13]noticed the beneficial influence of onion bulbs on growth performance of broiler chickens. Also, [14, 15, 16]reported that the beneficial influence of onion extracts on the growth performance in meat type broiler chickens.

[17, 18]noted that fresh onion stimulates blood circulation, improve immune response and have anti-bacterial effects due to its contents of pungent substances.

[19]established that garlic can improve productive performance of broiler chicks. Meanwhile garlic has been used for about 50 years as antibiotic growth promoters and to enhance growth performance in poultry as noticed by [20, 21, 22].

Also, garlic has been reported to possess useful pharmacological substances[23]. Freshly crushed garlic contains allicin, alliin, ajoene, diallylsulfide, dithiin, S-allylcysteine. Garlic as natural feed additives in poultry nutrition may be of great benefit and value especially for broiler growers. This is due to their anti-bacterial, anti-inflammatory, antiseptic, anti-parasitic and immunomodulatory properties of garlic[24].

Positive effect of garlic in broiler due to the bioactive compounds present in garlic such as alliin, diallyl sulphide and allicin[25], which posses' anti-microbial activity[26] that could be responsible for the growth promoting effect of garlic.

Finally, garlic is used as flavoring agent in different dishes and medicament, anti-oxidant, anti-hypertensive, anti-ageing, hypo-lipidaemic, anti-platelet and detoxifies the heavy metal [27, 28]. Due to its antimicrobial properties, garlic is the highly studied medicinal plant used as growth promoter in broiler chickens as noted by [24].

The active anti-oxidant compounds in lemon are flavonoids, isoflavones, flavones, anthocyanins, coumarins, lignans, catechins and isocatechins, also some compounds found in natural foods such as vitamins C [29, 30, 31].

Lemon (*Citrus Limon L.*) peel contains phenolic compounds, such as flavonoids (flavanones, flavonols, flavones), phenolic acids (ferulic, p-coumaric and sinapic acids), as well as vitamin C (ascorbic acid)[32, 33], which have been linked to anti-microbial[34], anti-cancer[35] and anti-oxidant properties[36, 37]. Phenolic compounds are the most abundant secondary metabolites synthesized by plants through the shikimate pathway[38] as a response to external stresses, such as ultraviolet radiation, wounding, aggression by pathogens, parasites and predators; in addition, they contribute to the color of plants[39, 40].

So, this work was carried out to investigate the effect of adding natural bioactive mixture composed of (lemon, onion and garlic) juice (LOG) at different levels on growth performance of broiler chickens and economical evaluation.

Materials and Methods

This experiment was carried out at Regional Centre for Food and Feed in cooperation work with Animal Production Department, National Research Centre. Total number of 208 one-day-old straight run broiler chicks was housed in batteries and were randomly divided into four groups (each of 52 chicks). Each group divided into four replicates (each of 13 chicks) and chicks raised for 42 days.

Feed and water were provided *ad libitum*. Diets were formulated in Regional Center for Food and Feed. The diets which used were formulated to be isonitrogenous, isocaloric and mycotoxins-free as well as free from any medication as growth promoter or antibiotics and meet the nutrient requirements of the broiler chicks during starter, grower and finisher periods according to the National Research Council [41].

The four experimental treatments were classified as follows:

Group 1 Fed basal diet without any supplementation and assigned as control group (T_1).
Group 2 Fed basal diet contained 10 ml of LOG/ kg feed (T_2).
Group 3 Fed basal diet contained 20 ml of LOG/ kg feed (T_3).
Group 4 Fed basal diet contained 30 ml of LOG/ kg feed (T_4).

All birds were fed a starter ration from one to 14 days of age containing 23.2% CP and 3045 Kcal ME/Kg diet. From 15 to 28 days of age, the birds were switched to grower ration containing 22% CP and 3164 Kcal ME/Kg diet. While, during 29 to 42 d of age, they were fed finisher ration containing 20% CP and 3220 Kcal ME/Kg diet as described in (Table 1).

The temperature was set at 32 ºC on the first day, gradually reduced to 24 ºC by the end of the third week, and until the end of experiment. The light was provided 24 hrs daily throughout the experiment. All experimented birds were vaccinated against different diseases according to the vaccination programs adopted in most Egyptian chicken broiler farmers.

Table (1): Formula and calculated values (%) of different experimental rations.

Ingredients	Starter ration	Grower ration	Finisher ration
Yellow corn	55.81	55.50	62.00
Soybean meal (46% CP)	30.00	31.00	24.00
Corn gluten meal	7.50	5.00	6.20
Vegetable oil	2.30	4.63	4.07
Di-calcium phosphate	1.68	1.84	1.70
Limestone	1.28	0.69	0.70
Vitamins & Mineral Mixtures*	0.40	0.40	0.40
Sodium chloride	0.40	0.40	0.40
L-lysine-HCl	0.42	0.31	0.33
DL-Methionine	0.13	0.15	0.12
Choline chloride	0.08	0.08	0.08
Total	100	100	100
*Calculated values (%)**			
Crude protein (CP)	23.20	22.00	20.00
Metabolizable energy (ME), kcal/ kg	3045	3164	3220
Lysine	1.36	1.30	1.13
Methionine	0.53	0.52	0.47
Methionine+Cystine	0.98	0.94	0.85
Calcium	0.96	0.90	0.85
Available phosphorus	0.45	0.48	0.44

*Each kg of Vitamins & Mineral Mixtures contained 12000 I.U Vit. (A); 2000 I.U Vit. (D_3); 10 mg Vit. (E); 2 mg Vit. (K_3); 1 mg Vit. (B_1); 5 mg Vit. (B_2); 1.5 mgVit. (B_6); 10 µg Vit. (B_{12}); 50g Biotin; 10 mg Pantothenic acid; 30 mg Niacin; 1 mg Folic acid; 60 mg Manganese; 50 mg Zinc; 30 mg Iron; 10 mg Copper; 1 mg Iodine; 0.1 mg Selenium and 0.1 mg Cobalt.

* Values (%) were calculated according to chemical composition of poultry feed stuffs[41].

Chicken performance response variables were determined according to[42]; weekly individually body weight, weight gain and feed consumption (g/bird/day) were recorded. Also feed conversion expressed as (g feed/g live body weight gain) was calculated. Dead birds were also, recorded.

Economical efficiency traits were calculated according to[42] in relation to prices of ingredients and chicks live body weight in local market at the time of the study as following:

Net revenue= Total revenue – Total feed cost.

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

Amino acids composition of LOG was estimated according to the method described by[43] using HPLC and the modification of PICO-TAG methods.

Minerals content of LOG were determined by digested a part of sample in 10 ml of nitric acid overnight on a steam bath and subsequently digested with 70% perchloric acid. Calcium, Mg, K, Na, Zn, Cu and Fe were analyzed by atomic absorption spectrophotometry using standard procedures of the[44].

Data collected of feed intake, live body weight and feed conversion were subjected to statistical analysis as one way analysis of variance according to[45]. Meanwhile[46] 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 = overall mean.
T_i = effect of tested diet levels for i = 1–4, 1 = (basal diet contained 0% LOG), 2 = basal diet plus 10 ml LOG/ kg feed, 3 = basal diet plus 20 ml LOG/ kg feed and 4 = basal diet plus 30 ml LOG/ kg feed.
e_{ij} = the experimental error.

Results and Discussion

Data presented in Table (1) showed that experimental rations were formulated to be isonitrogenous and isocaloric and to cover the requirements of broiler chickens at different stages of ages as recommended by[41].

Amino acids profile and mineral elements determined of LOG

Amino acid composition (%) of LOG illustrated in (Table 2) showed that LOG protein contained suitable portions of essential amino acids (arginin, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, theronine and valine); the corresponding values were 1.73, 0.54, 0.73, 1.26, 0.96, 0.32, 0.69, 0.72 and 0.94%.

On the other hand non essential amino acids noticed that LOG contained suitable portions of aspartic, serine, cystine, glutamic, glycine, alanine, tyrosine and proline. The corresponding values were 2.17, 0.74, 0.41, 1.82, 0.81, 0.74, 0.96 and 0.57%, respectively. The present result cleared that LOG is good quality source of essential and non essential amino acids.

Table (2): Amino acids profile and mineral elements determined of LOG.

Amino acids profile		**Mineral elements determined**	
1- Essential amino acids	**%**	***1- Macro elements***	***PPM***
Arginine	1.73		
Histidine	0.54		
Isoleucine	0.73	Calcium (Ca)	386.13
Leucine	1.26	Magnesium (Mg)	98.65
Lysine	0.96	Potassium (K)	75.13
Methionine	0.32	Sodium (Na)	208.85
Phenylalanine	0.69		
Theronine	0.72		
Valine	0.94		
2- Non essential amino acids	%	*2- Micro elements*	*PPM*
Aspartic	2.17		
Serine	0.74		
Cystine	0.41	Zinc (Zn)	11.00
Glutamic	1.82	Cupper (Cu)	2.47
Glycine	0.81	Iron (Fe)	41.78
Alanine	0.74		
Tyrosine	0.96		
Proline	0.57		

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

Also, minerals content of LOG presented in (Table 2) showed that, LOG contained important macro and micro mineral elements. The LOG contained the most determined minerals at adequate concentration and the predominant minerals were found to be Ca, Mg, K and Na at levels of 386.13, 98.65, 75.13 and 208.85 PPM, respectively.

In addition, the LOG contained a considerable content of Zn, Cu and Fe at levels of 11.00, 2.47 and 41.78 PPM, respectively. So, in generally, the present results can be mentioned that LOG was characterized with their richness with the most determined nutritious minerals and they are considered a good source of macro and micro elements. Therefore, they should be utilized in food fortification.

Growth performance

Data of growth performance is illustrated in Table (3) showed that inclusion natural bioactive mixture (LOG) in broiler chick diets had no significant (P>0.05) effect on final weight, total body weight gain and total feed intake during the three different periods of feeding. However incorporation 10 ml LOG / kg feed (T_2) recorded the best feed conversion (1.31) during starter period, while, T_4 recoded the lowest feed conversion (1.61) during grower period.

Mean while T_3 recoded the best values of feed conversion (1.79 and 1.63) during both finisher and over the entire period, respectively. The present results in agreement with those established by [47, 48] who noted that dietary garlic supplementation did not significantly (P>0.05) influence the performance of broiler.

Also, [49]noticed that adding 8% garlic in broiler chickens rations did not have significant (P>0.05) difference on the growth performance.

In addition, [50]concluded that inclusion 0.2% or 0.4% garlic powder in Cobb-500 chicken diets had no significant effects on broilers performance.

Also, [16]found that feeding white mini broilers chickens diet containing 0.3% or 0.5% onion extract had no significant effect on final body weight and weight gain.

There were no significant (P>0.05) among chickens groups that fed rations contained garlic essential oil [51] or garlic powder [52, 53] in performance.

In contrast, [54]noted that broiler chickens received 1 or 2 percent onion extract in drink water had higher daily weight gain compared to control group during grower and total period (P<0.05). Also, they found that broiler chickens received 1 percent onion extract in drink water had lower feed conversion during total period (P<0.05).

Also, [14]found that dietary supplementation of fresh onions bulb at 30 g/ kg diet in Ross 308 broiler chick caused significant (P<0.05) increasing in final body weight of broilers at 42nd days of age compared to the other treatments (0 or 10 g onions/ kg diet). Also, they noticed that birds fed 30 g onion/kg diet had the highest feed intake all periods.

In addition, [22]noticed that feeding Cobb broiler chicks diets contained 3% garlic powder significantly (P<0.05) increased feed intake, body weight gain and achieved the best efficiency of feed utilization. Also, [55]noted that Hubbard broiler chicks fed 3% garlic powder had significantly (P<0.05) heaviest body weight gain, highest feed intake and best feed conversion ratio compared to the others (0, 2 and 4% garlic). In additional [56]found that administration of ginger and garlic to broiler chickens increased their performance.

Table (3): Effect of dietary treatments on growth performance of experimental groups.

Item		Experimental groups				SEM
		T_1 Basal ration	T_2 10 ml LOG / kg feed	T_3 20 ml LOG / kg feed	T_4 30 ml LOG / kg feed	
Number of chickens		52	52	52	52	---
Starter period (0-14 days)	IW, g	549	544	549	545	1.34
	FW, g	4087	4171	4075	4195	60.88
	TBWG, g	3538	3627	3526	3650	61.37
	Total feed intake, g	4729	4766	4744	4960	70.17
	Feed conversion (g. intake/ g. gain)	1.34	1.31	1.35	1.36	0.16
Grower period (15-28 days)	IW, g	4087	4171	4075	4195	60.88
	FW, g	14561	14895	14585	14625	145.7
	TBWG, g	10474	10724	10510	10430	599.9
	Total feed intake, g	16329	16793	16458	16775	176.3
	Feed conversion (g. intake/ g. gain)	1.56^{a}	1.57^{ab}	1.57^{ab}	1.61^{b}	0.008
Finisher period (29-42 days)	IW, g	14561	14895	14585	14625	145.7
	FW, g	24118	24621	24593	23582	275.3
	TBWG, g	9557	9726	10008	8957	194.7
	Total feed intake, g	17638	17997	17887	18259	204.6
	Feed conversion (g. intake/ g. gain)	1.85^{a}	1.85^{a}	1.79^{a}	2.04^{b}	0.035
Over entire period (0- 42 days)	IW, g	549	544	549	545	1.34
	FW, g	24118	24621	24593	23582	275.3
	TBWG, g	23569	24077	24044	23037	275.6
	Total feed intake, g	38698	39556	39091	39995	387.2
	Feed conversion (g. intake/ g. gain)	1.64^{a}	1.64^{a}	1.63^{a}	1.74^{b}	0.013

a and b: Means in the same row having different superscripts differ significantly (P<0.05).
SEM: standard error of the mean.
IW= initial weight FW= Final weight TBWG= Total body weight gain
LOG: Natural bioactive mixture composed of lemon, onion and garlic juice at portions (0.125: 1.00: 1.00 / liter clean water.

Meanwhile, [57]concluded that supplementation thyme and garlic as feed additives at 1% improved productive performance of Ross 308 broiler chicks; they also noted that this combination can be used as alternative of anti-biotic. On the other hand, [58]found that Anak broilers fed diet containing 0.75% garlic had

significantly higher daily gain in comparison with the other levels (0, 0.25, 0.50 and 0.75 % garlic). Also, [59]noted that when Hubbard chick received diets containing 100, 150 or 200g garlic powder/ tone had a highly significant effect on broilers' performance ($P<0.0001$) and it was improved live body weights and increased feed conversation rate however, it decreased cumulative feed intake. Meanwhile, [60]noted that broiler chickens fed 14g garlic powder had the better feed conversion (2.17) than those fed ginger (2.42) or control (2.53).

Also, [61, 62, 63]found that the dietary garlic powder improved significantly weight gain of broiler chicks. And that may be due to allicin active ingredients in garlic which promotes the performance of intestinal flora, thereby improving digestion and enhancing the utilization of energy.

Mortality rate

Mortality rate of broiler chicks illustrated in Table (4) cleared that inclusion LOG at 0, 10 or 20 ml/ kg feed in broiler chick rations during starter period had no effect on mortality rate (1.92% for T_1, T_2 and T_3) meanwhile, adding 30 ml/ kg feed not caused any death (0% mortility).

In grower period dietary treatment had no effect on mortality rate that was equal (0%) for all treatmens.

Meanwhil, during finisher period noticed that T_1 and T_2 recorded the same mortality percentages (3.85%) however, T_3 and T_4 decreased mortality rate to (1.92%).

Over the entire period mortality rate was decreased with increasing the level of LOG that added to broiler chick rations. The corresponding value of mortality rate was 5.77, 5.77, 3.48 and 1.92% for T_1, T_2, T_3 and T_4, respectively.

Table (4): Effect of dietary treatments on mortality rate of experimental groups.

Item	Total No.	T_1 Basal ration		T_2 10 ml LOG / kg feed		T_3 20 ml LOG / kg feed		T_4 30 ml LOG / kg feed	
		Death							
		No.	%	No.	%	No.	%	No.	%
Starter period (0-14 days)	52	1	1.92	1	1.92	1	1.92	-	0.00
Grower period (15-28 days)	52	-	0.00	-	0.00	-	0.00	-	0.00
Finisher period (29-42 days)	52	2	3.85	2	3.85	1	1.92	1	1.92
Over entire period (0- 42 days)	52	3	5.77	3	5.77	2	3.84	1	1.92

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

The present results in agreement with those found by[47] who noticed that mortality percent was decreased with incorporation garlic in broiler chickens. Also, [59]reported that feeding Hubbard chick diets containing 100, 150 and 200g garlic powder/ tone decreased mortality rate. In addition to, [64]concluded that supplementation broiler chick rations with raw garlic were decreased the percent of mortality by 1.67 to 3.33%. This might due to reduction of *E. coli* and *Clostridium* sp. in intestinal content. Meanwhile, [65]observed that the 80% concentration for garlic in broiler chick rations had inhibition effects on the *E. coli*, *Salmonella* and *Staphylococcus*. This tended to decrease mortality rate because it was cleaned biological surface for all birds and decreased microbial count in intestine. Also, [66]showed that the 10% concentration of aqueous extracts of garlic and onion had antifungal activity.

In addition, [67]noted that added 0.1% extract of garlic in the drinking water caused decreasing in mortality rate of broiler chickens compared to the control group (0.50% vs. 1.25%). However, [51, 55, 63]noted that no mortalities were recorded among the different treatment broiler chicks groups that fed diets contained garlic or garlic essential oil throughout the experimental period; this may be due to the hygienic situation of the

experiment. They were also, mentioned that only one bird from each treatment was died, which can not be related in any way to the experimental treatment.

Economic evaluation

Inclusion LOG in broiler chick rations caused slightly increasing in price of one kg feed by 0.57% for T_2, 1.14% for T_3 and 1.71% for T_4 compared to the control ration (Table 5).

Meanwhile, total feeding costs was increased with adding LOG for different tested rations by 2.76% for T_2, 2.17% for T_3 and 5.02% for T_4 in comparison with the control one (T_1).

On the other hand, marketing weight, net revenue and relative economic efficiency for T_2 and T_3 were improved in comparison with control ration (T_1). Although feed cost (LE) per (kg live body weight) was slightly increased with adding LOG in chick rations, also, relative economic efficiency was slightly improved by 100.7 and 101.1 % for T_2 and T_3 compared to control (T_1) when assuming that relative economic efficiency of control diet equals 100%. However, adding 30 ml LOG/ kg feed (T_4) decreased the relative economic efficiency by 9.6% in comparison with the control (T_1).

These results are in agreement with those found by [55] who reported that the highest profitability ratio (1.30) was recorded by the diet with 3% garlic powder as compared to other experimental diets. Also, [58]found that birds fed diet containing 0.75% garlic had significantly higher value of feed cost/kg gain.

Table (5): Effect of dietary treatments on economic evaluation of the experimental groups

Item	Experimental groups			
	T_1 Basal ration	**T_2 10 ml LOG / kg feed**	**T_3 20 ml LOG / kg feed**	**T_4 30 ml LOG / kg feed**
No. of chicks	13	13	13	13
Live body weight (LBW), kg	24.118	24.621	24.593	23.582
Feed consumed, kg	38.698	39.556	39.091	39.955
price of one kg feed, (LE)[1]	2.625	2.640	2.655	2.670
Total feed cost, (LE)	101.6	104.4	103.8	106.7
Total cost, (LE)[2]	166.6	169.4	168.8	171.7
Total revenue, (LE)[3]	361.8	369.3	368.9	353.7
Net revenue, (LE)	195.2	199.9	200.1	182.0
Economic effficiency[4]	1.172	1.180	1.185	1.060
Relative economic efficiency[5]	100	100.7	101.1	90.4
Feed cost / kg LBW (LE)[6]	4.21	4.24	4.22	4.52

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

[1] Based on price of year 2016

[2] Include feed cost + fixed cost (price of chicks, workers, medications, vaccines, sanitation, electricity…etc (5 LE).

[3]Live body weight * price of one kg at selling which was 15 LE.

[4] Net revenue per unit of total cost[68].

[6] Feed cost / kg LBW = Feed intake * price of kg feed / live body weight.

LE: Egyptian pound (local coin) equals 0.11 USS approximately.

In addition to, [60]noted that broiler chickens received 14g of garlic powder per kg feed had the highest revenue and net return, and also gave the least cost benefit ratio compared to control one.

On the other hand, [69]noted that 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. Also, they noted that relative economic efficiency was improved by 150%, 233%, 300% and150% more when rabbits fed diets contained 5, 10, 15 and 20 ml LOG/ kg feed, respectively. Meanwhile, [70]noticed that growing buffalo calves that received 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%.

Conclusion

Under conditions similar to those in the present study, it can be mentioned that, natural bioactive mixture composed of lemon, onion and garlic juice (LOG) depressed mortality rate and improved economic efficiency and can be used safely in broiler chick rations up to 20 ml LOG/ kg feed with no adverse effect on growth performance.

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