



Effect of Dietary Growth Promoters on Performance and Carcass Traits of Growing Rabbits

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Abstract

The objective of this study was to investigate the effects of dietary turmeric powder, ginger powder, fenugreek seeds powder, dried lemon powder on performance, carcass traits of growing rabbits. A total of 30, New Zealand White rabbits (NZW) at 5 weeks of age were randomly assigned to five treatments with three replicates. The dietary treatments consisted of 5 groups as follows; the basal diet as control, phytogenic additives groups were supplemented with 0.5% turmeric powder, 0.5% ginger, 1.0% fenugreek seeds and 1.0% dried lemon added to the basal diet. Body weight gain, feed consumption and feed conversion were calculated during the experimental periods. At the end of the experimental period (12 weeks of age) three rabbits from each treatment were sacrificed for studying carcass traits. The data revealed that, rabbits fed dietary curcuma recorded faintly ($P \geq 0.05$) improvement in body weight compared with other dietary groups. The greatest numerically ($P \geq 0.05$) body gain during entire experimental period (6- 12 weeks of age) was for rabbits fed dietary dried lemon compared with all dietary groups. No significant differences ($P \geq 0.05$) in feed intake and feed conversion were detected among all dietary treatments. Rabbits fed dietary lemon recorded slightly increased ($P \geq 0.05$) in absolute live body weight, carcass weight and giblets weight compared with other dietary treatments. However, rabbits fed dietary ginger recorded slightly increased ($P \geq 0.05$) in dressing percentage. It could be concluded that using the previous additions at the mentioned levels, may improve performance and carcass traits in rabbits.

Keywords: Rabbits; Growth Promoters; Performance

Introduction

To improve the utilization of rabbit diets nutrients, supplementation of growth promoters from different sources used [1,2]. The growth promoters like chemical products, herbal plants, essential oils, antibiotics, enzymes etc. play an active role in the experimental and commercial production of large and small animals [3,4]. Recently, many countries tend to prevent the application of antibiotics for their side effects on both animal and human.

The ban on nutritive antibiotic use in the world and the augmented awareness of the consumers triggered a need for natural and safe feed additives to achieve better production results of farm animals therefore, nowadays growth promoters from herbal sources (phytogenic extracts) are used very commonly [5]. Herbs such as Turmeric (*Curcuma longa*), ginger (*Zingiber officinale*), fenugreek (*Trigonella foenum-graecum L.*) and dried lemon (citrus limon) are phytogenic additives, possible alternatives, reported in poultry production which include a group of natural feed additives; derived from herbs, spices or other plants or their extracts in the form of essential oils [6].

Al-Sultan [7] found that turmeric meal up to 5.0 g/kg increased body weight in broiler chicks. Also, Al-Jaleel [8] revealed that, the inclusion of curcuma at the levels of 0.50% in the diets improved body weight compared with other dietary groups when birds fed dietary 0, 0.25, 0.50, 1, 1.5% *Curcuma longa*. Imasuen., *et al.* [9] showed that, feed consumption in growing rabbits was higher for those fed diets contain 15% and 20% ginger waste meal (GWM), respectively compared to the group fed diet without GWM. However, Chaudry., *et al.* [10] found that, addition 5% citrus pulp into broiler diets did not have significant effects on feed consumption. Zeweil., *et al.* (2015) observed that, feed conversion was improved in rabbits fed dietary fenugreek as feed additives at 0.6% level as compared to the control group. Alagawany., *et al.* [11] reported that, diets supplemented with 4 and 6 g turmeric /kg diet, linearly decreased dressing percentage ($P=0.037$) of growing rabbits.

The aim of this study was to evaluate the effect of adding some natural feed additives i.e. turmeric, ginger, fenugreek and dried Lemon to rabbit diets at the levels of 0.5, 0.5, 1.0, and 1.0% respectively, on productive performance, and some carcass traits.

Materials and Methods

Experimental animals

The present study was carried out at the farm of Animal and Poultry Production, Faculty of Agriculture, Minia University, Egypt during the period from March, 8 to April, 28, 2017. A total number of 30 males, 5 weeks old growing New Zealand white rabbits were used to study. Rabbits distributed into (5 treatments x 3 replicates x 2 rabbit = 30 rabbits). All rabbits were housed in open house. The rabbits were allocated in a cage with slatted floor of iron. The dimensions of the cage were (45 × 45 × 38cm) for length, width and high, respectively. Feed and water given to the rabbits *ad-libitum* during the experimental periods.

Experimental diets

Growing rabbits were distributed to same five dietary treatment groups. The first group fed control diet formulated to contain adequate levels of nutrients for growing New Zealand White rabbits as recommended by the National Research Council, [12]. The formulation and chemical composition of control diet is shown in m 2. Chemical analysis of ingredients and diets was determined according to AOAC [13]. Four additional dietary treatment groups were formulated to contain control diet incorporated with feed supplementation according to the source of addition such as 0.5% curcuma, 0.5% ginger, 1.0% fenugreek and 1.0% dried lemon respectively.

Growth parameters

Live body weight and body weight gain

The live body weight of each replicate (2 rabbit) recorded to the nearest gram each 2 week through the experimental period from 6 to 12 weeks of age. Body weight gain/rabbit/period was calculated. The average live weight gain was calculated by subtracting the average initial live weight of a certain period from the average final live weight of the same period.

Feed consumption

Rabbits in each replicate (2 rabbits) were provided with certain amount of feed for each 2 weeks. The remainder and scattered of feed for each replicate were recorded after each period (two weeks). Then the feed consumption was calculated by subtracting the remainder and scattered of feed at the end of the same period from the certain amount of feed at the first of each period. The feed intake of each rabbit was calculated by divided the feed intake of each replicate by 2.

Feed Conversion:

Feed conversion was calculated as the amount of feed required production an unit of body weight gain (g, feed/ g, gain) as the following equation:

$$\text{Feed conversion} = \frac{\text{Average of feed intake / rabbit / period}}{\text{Average of body gain / rabbit / period}}$$

Figure

Carcass traits

At the end of the experimental period (12 weeks of age) three rabbits were randomly chosen from each treatment. All rabbits were individually weighted and slaughtered after approximately 12 hours of fasting, when complete bleeding was a chived, slaughter weight was recorded. After skinning the carcass was opened dawn and all entails were removed and empty carcass, heart, liver, kidneys, head without skin and abdominal fat were separate and weighted, each of them was proportionated to the live pre slaughtering weight.

Statistical analysis

Data were summarized using Microsoft® Excel 2010 (10.2614.2625) Microsoft Egypt, mssupport@brands.com. The general liner model (GLM) was applied to test the differences among the five experimental groups. P-values less than 0.05 were considered to be statistically significant SAS Institute [14]. The statistical analysis was calculated using the following equation:

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

Where:

Y_{ij} = Experiment observations. μ = the overall mean.

T_i = the effect of dietary treatment. $i = T_1, \dots, T_5$.

E_{ij} = the experimental error.

Duncan's test was used to examine the significance degrees among means [15].

Results and Discussion

Body weight

Data presented in Table 2 showed the averages of body weight at 6, 8, 10 and 12 weeks of age of growing rabbits fed dietary supplementation such as: 0.5% curcuma, 0.5% ginger, 1.0% fenugreek and 1.0 dried lemon.

The results showed that, body weight of growing rabbits had no significant ($P > 0.05$) difference among all dietary treatments. Even though, growing rabbits fed dietary curcuma recorded little increase ($P > 0.05$) in body weight at all growing ages. At the end

Ingredients	%
Ground yellow corn	54.0
Soya bean meal	20.3
Wheat bran	5.0
Lime stone	0.3
Berseem hay	18.8
Dicalcium phosphate	1.0
Salt	0.3
Premix	0.3
Total	100
	Calculated analyses%
Crude protein,	17.4
ME (Kcal/ kg)	2561.7
Crude fiber,	7.8
Calcium,	0.68
Available phosphorus,	0.33
Methionine+ cysteine,	0.57
Lysine,	0.85

Table 1: The composition and chemical analysis of control diet of growing New Zealand White rabbits.

Treatment	Body weight (g) at			
	6 week	8 week	10 week	12 week
Control	1130.83	1565.00	1916.67 ^{ab}	2184.16
Curcuma,0.5%	1402.50	1837.50	2185.00 ^a	2432.50
Ginger, 0.5%	1287.50	1615.83	1963.33 ^{ab}	2250.83
Fenugreek, 1%	1327.17	1524.17	1819.17 ^b	2129.17
Lemon, 1%	1307.50	1723.33	2125.83 ^{ab}	2430.00
±SE	79.33	96.04	100.29	97.07
Sig.	NS	NS	NS	NS

Table 2: Effect of natural feed additives on body weight of rabbits at different ages.

SE: standard error (±). NS: Not significant (P>0.05).

of growing experiment (12 weeks of age), rabbits fed dietary curcuma recorded faintly (P>0.05) improvement in body weight followed by rabbits fed dietary dried lemon compared with other dietary groups.

The slightly improvement in body weight as a result of adding supplementation of turmeric to growing rabbit diet at level 0.5 g/kg may be due to optimum antioxidant activity of turmeric at the level of 0.5% that stimulate protein synthesis by enzymatic system. Furthermore, turmeric could control and limit the growth and colonization of numerous pathogenic and non-pathogenic species

of bacteria in the rabbit's gut resulting in balanced gut microbial ecosystem that leads to better feed utilization reflected by live body weight and weight gain [7,16].

The previous results are in harmony with the finding of Peiretti, *et al.* [17] using curcuma, Habibi, *et al.* [18] using ginger, Alagawany, *et al.* [11] using turmeric, Basir and Toghiani [19] using dried lemon pulp, Gumus, *et al.* [20] using turmeric and Lu, *et al.* [21] using dried citrus pulp, they did not show any significant differences in body weight between the groups fed different feed supplementation.

Al-Sultan [7] observed that supplementation of turmeric meal up to 5.0 g/kg increased body weight. Similarly, Al-Jaleel [8] studied the effect of feeding broiler chicks dietary 0, 0.25, 0.50, 1, 1.5% Curcuma longa on performance. They revealed that, the inclusion of curcuma at the levels of 0.50% in the diets improved body weight compared with other dietary groups.

Body weight gain (g)

Treatment	Body weight gain (g/period)		
	6-8 week	6-10 week	6-12 week
Control	434.17 ^a	785.83 ^{ab}	1053.33 ^a
Curcuma, 0.5%	435.0 ^a	782.50 ^{ab}	1030.0 ^a
Ginger, 0.5%	328.33 ^a	675.83 ^b	963.33 ^a
Fenugreek, 1%	197.00 ^b	492.0 ^c	802.0 ^b
Lemon, 1%	415.83 ^a	818.33 ^a	1122.50 ^a
±SE	38.30	36.27	47.78
Sig.	*	*	*

Table 3: Effect of natural feed additives on body weight gain of growing rabbits at different age intervals.

^{a-c}Values within the same column have different superscripts are significantly different (p≤0.05). SE: standard error (±). (*):- significant (P≤ 0.05).

The results revealed that there are significant differences (P≤0.05) in body weight gain between dietary treatments during all experimental periods. In general, it could be noticed that, adding tested feed supplementation to growing NWZ rabbits diet improved (P≤0.05) body weight gain during all experimental periods except rabbits fed dietary fenugreek seeds. In general, during 6 to 8 weeks of age rabbits fed dietary curcuma presented the best (P≤0.05) body weight gain compared with other groups. While, the greatest numerically (P≤0.05) body gain during 6 to 10 weeks of age and the entire experimental period (6- 12 weeks of age) was for rabbits fed dietary dried lemon compared with all dietary groups.

The improvement of rabbits performance due to dietary herbs proposed to sustain both good health and welfare of poultry, improve their performance and enhancing their gut health and pro-

ductivity [22]. Turmeric (*Curcuma longa*), ginger, fenugreek and dried lemon are phytochemical additives, possible alternatives, reported in poultry production which include a group of natural feed additives; derived from herbs, spices or other plants or their extracts in the form of essential oils [4]. Turmeric powder is a rich source of beneficial phenolic compounds: the curcuminoids, where three main curcuminoids, curcumin, demethoxycurcumin and bisdemethoxycurcumin [23] have been isolated from turmeric. Supplementation of turmeric powder at 0.20 and 0.40 g/kg to the commercial diet for rabbits positively affected the body weight gain in rabbit does [2].

The previous results are in harmony with the finding of Chaudry, *et al.* [10] using citrus peel, Al-Homidan [24] using ginger, Kumar, *et al.* [25] using curcuma, Durrani, *et al.* [26] using curcuma, Nobakht [27] using dried lemon pulp, Imasuen, *et al.* [9] using ginger and Földešiová, *et al.* [2] using curcuma. They show significant differences in body weight gain between the groups fed different feed supplementation.

On the other hand, Emadi and Kermanshahi [28] using turmeric, Peiretti, *et al.* [17] using turmeric, Yaghobfar, *et al.* [29] using turmeric, Akbarian, *et al.* [30] using turmeric, Alagawany, *et al.* [11] using turmeric, Basir and Toghyani [19] using dried lemon pulp, Lu, *et al.* [21] using dried citrus pulp and Mancini, *et al.* [31] using ginger. They did not show significant differences in average daily weight gain between the groups fed different feed supplementation.

Feed consumption (g)

Averages of feed consumption of growing rabbits at 6-8, 6-10 and 6-12 weeks of age intervals are presented in Table 4.

Treatment	Feed consumption (g)		
	6-8 week	6-10 week	6-12 week
Control	1950.83	3405.0	5091.67
Curcuma, 0.5%	2048.33	3570.83	5187.50
Ginger, 0.5%	1923.33	3644.17	5319.17
Fenugreek, 1%	1266.67	3318.33	4961.67
Lemon, 1%	2125.83	3595.83	5229.17
±SE	349.27	460.50	566.84
Sig.	NS	NS	NS

Table 4: Effect of natural feed additives on feed consumption of growing rabbits at different age intervals.

SE: standard error (±). NS: Not significant (P>0.05).

The results showed that, growing rabbits fed dietary feed supplementation such as: 0.5% curcuma, 0.5% ginger, 1.0% fenugreek and 1.0 dried lemon showed no significant (P>0.05) difference in feed consumption among dietary treatments at all experimental

periods. Even though, during 6 to 8 weeks of age rabbits fed dietary lemon recorded numerically increased (P>0.05) in feed consumption followed by rabbits fed dietary curcuma. However, rabbits fed dietary ginger recorded numerically increased (P>0.05) in feed consumption during the periods 6 to 10 and 6 to 12 weeks of age followed by rabbits fed dietary dried lemon compared with other dietary treatments.

The slightly enhancing in feed intake of rabbits fed diet incorporated with feed additives may be due to the improvement of taste or feed palatability of diet concerning to the feed additives [32]. Moreover, the improvement in feed consumption as a result of using feed supplementation as growth promoters may be due to that, structural properties, such as the presence of the functional groups [33] and aromaticity [34] which a critical role in improving feed consumption.

The previous results are in line of findings of Chaudry, *et al.* [10] found that, addition 5% citrus pulp into broiler diets did not have significant effects on feed consumption. Also, Mancini, *et al.* [31] showed no significant differences in average daily feed intake between the experimental groups as a result of feeding rabbit groups diet contain 0.0, 4.0, 8.0g of ginger powder.

On the other hand, Imasuen, *et al.* [9] showed that, feed consumption in growing rabbits was higher for those fed diets contain 15% and 20% ginger waste meal (GWM), respectively compared to the group fed diet without GWM.

Feed conversion ratio (g feed/g weight gain)

Data of feed conversion for New Zealand White growing rabbits at 6-8, 6-10 and 6-12 weeks of age intervals fed different sources of feed supplementation are presented in Table 5.

Treatment	Feed conversion (feed/g weight gain)		
	6-8 week	6-10 week	6-12 week
Control	4.47	4.3 ^b	4.8
Curcuma, 0.5%	4.83	4.6 ^{ab}	5.06
Ginger, 0.5%	5.97	5.4 ^{ab}	5.63
Fenugreek, 1%	6.53	6.7 ^a	6.18
Lemon, 1%	5.34	4.4 ^{ab}	4.67
±SE	1.0	0.69	0.69
Sig.	NS	NS	NS

Table 5: Effect of natural feed additives on feed conversion of growing rabbits at different age intervals.

SE: standard error (±). NS: Not significant (P>0.05).

The results indicated that there were no significant (P>0.05) differences in feed conversion among all dietary treatments of rabbits fed dietary supplementation such as: 0.5% curcuma, 0.5% ginger, 1.0% fenugreek and 1.0 dried lemon during all periods of the

experiment. It could be noticed that the best numerically ($P>0.05$) feed conversion ratio was calculated for rabbits fed dietary control and lemon (T1 and T5) during the periods 6-10 and 6-12 weeks of age. However, the poorest numerically ($P>0.05$) feed conversion ratio was calculated for rabbits fed dietary fenugreek during all experimental periods compared with other dietary supplementations.

The numerically positive effect of feed conversion for rabbit fed dietary lemon may be due that citrus have over 60 flavonoids [35] and these compounds can be digested in the small intestine (Walsh, *et al.* 2009); therefore, the level of these flavonoids can significantly increase in blood serum. Flavonoids have antioxidant, anti-inflammatory, antibacterial and immune-stimulating effects [36].

Weerasingha and Atapattu [37] fed broiler chicks on diet contain 0, 1, 2, 3, 4, 5% fenugreek powder as feed supplementation, from day 21-38. They found that, birds fed dietary 1% fenugreek powder improved the feed conversion ratio (FCR) by 13.8%, compared to birds in the control group. Also, Zeweil, *et al.* (2015) observed that, adding fenugreek as feed additives at 0.6% level to rabbit diets significantly improved feed conversion ratio as compared to the control group.

Lu, *et al.* [21] revealed that, there were no statistically significant differences in terms of feed conversion ratio, after the groups were fed according to the diets as 0 (control group), 7%, 14% and 21% dried citrus pulp in the diet of growing rabbits.

Carcass characteristics

Absolute weights of carcass parts

Averages of some carcass characteristics of growing rabbits fed diets supplemented with natural feed additives are presented in Table 6.

Treatment IVE	Live body weight (g)	Carcass Weight (g)	Giblets weight (g)	Abdominal fat (g)
Control	2131.67	1250.67	202.33	10.00
Curcuma, 0.5%	2381.67	1404.67	223.00	12.33
Ginger, 0.5%	2343.33	1417.67	219.33	14.67
Fenugreek, 1%	2276.67	1324.67	214.67	10.33
Lemon, 1%	2425.00	1445.33	230.33	9.66
±SE	85.94	62.70	8.31	3.08
Sig.	NS	NS	NS	NS

Table 6: Effect of natural feed additives on some carcass characteristics.

SE: standard error (\pm). NS: Not significant ($P>0.05$).

These results showed that, growing rabbits fed dietary supplementation such as: 0.5% curcuma, 0.5% ginger, 1.0% fenugreek and 1.0 dried lemon had no significant ($P>0.05$) difference among all dietary treatments in all carcass traits studied. Even though, rabbits fed dietary lemon recorded slightly increased ($P>0.05$) in absolute live body weight, carcass weight and giblets weight compared with other dietary treatments. However, rabbits fed dietary ginger recorded the greatest numerically abdominal fat weight.

The previous results are in synchronization with the finding of Onu [38] stated that, the addition of ginger (0.25%) in the basal diet of broiler chicks did not affect on carcass characteristics. Also, Peiretti, *et al.* [17] concluded that edible organs of growing rabbits did not affect ($P >0.05$) by dietary contained 3 g curcuma/kg diet compare to the control diet. Moreover, Alagawany, *et al.* [11] found that, dietary supplementation of turmeric did not have linear or quadratic effects on carcass weight of growing rabbits at 13 weeks of age.

On the other hand, Alagawany, *et al.* [11] reported that, increasing the dietary turmeric level to 6 g/kg diet significantly increased relative heart weight (linearly and quadratically, $P=0.021$ and < 0.001 , respectively), carcass weight (quadratically, $P=0.017$) of growing rabbits. Also, Lu, *et al.* [21] found that, adding 21% dried citrus pulp in the diet of growing rabbits increased hot carcass weight and liver weight.

Carcass proportion

Averages of some carcass proportions of New Zealand White rabbits fed dietary supplementations such as 0.5% curcuma, 0.5% ginger, 1.0% fenugreek and 1.0 dried lemon are presented in Table 7.

Treatment	Dressing %	Giblet %	Abdominal fat %
Control	58.67	9.02	0.53
Curcuma, 0.5%	58.87	8.85	0.54
Ginger, 0.5%	60.50	8.74	0.53
Fenugreek, 1%	58.23	8.97	0.56
Lemon, 1%	59.58	9.09	0.55
±SE	1.09	0.16	0.04
Sig.	NS	NS	NS

Table 7: Effect of natural feed additives on some carcass proportions.

SE: standard error (\pm). NS: Not significant ($P>0.05$).

The data exhibited that, there were no significant ($P>0.05$) difference among all dietary treatments on the proportions of some carcass traits i.e. dressing, giblets and abdominal fat. It could be detected that rabbits fed dietary ginger recorded slightly increased ($P>0.05$) in dressing percentage followed by others fed dietary dried lemon compared with other dietary treatments. However the best giblets percentages were recorded for rabbits fed dietary

dried lemon. Moreover, the slightly increased ($P>0.05$) abdominal fat% was recorded for rabbits fed dietary fenugreek.

The insignificant effect of dietary treatments on the proportions of carcass trait was harmony with the absolute weights of these traits. El-Deek, *et al.* [39] found that, the dressing percentage did not differ between control and ginger treated broilers up to sixth week of age.

On the other hand, Imasuen, *et al.* [9] showed that, growing rabbits fed dietary 10%, 15% and 20% level of ginger waste male supplementation having the highest value of the dressing percentage compare to the control diet. Also, Alagawany, *et al.* [11] reported that, diets supplemented with 4 and 6 g turmeric /kg diet, linearly decreased dressing percentage ($P=0.037$) of growing rabbits.

Conclusion

From the present study, It could be concluded that supplemented growing rabbit diet with 0.5% turmeric powder, 0.5% ginger, 1.0% fenugreek seeds and 1.0% dried lemon as growth promoters may improve performance and some carcass traits of rabbits. The best addition was 1.0% dried lemon compared with other additions.

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