Effect of Ginger Roots Meal as Feed Additives in Laying Japanese Quail Diets

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Abstract: A feeding trial was conducted with 210 Japanese quail (140 females and 70 males) at 4 weeks of age were used in an experiment lasted 22 weeks. The present study was designed to investigate the utilization of ginger roots meal (*Zingiber officinale* L) as medicinal plant feed additive in laying Japanese quail diets and its effect on productive and reproductive performance. Experimental Japanese quail (*Coturnix coturnix japonica*) were divided randomly into four equal experimental treatments (35 females in each treatment). The first treatment was fed a basal diet as control, while the other three treatments were fed the basal diet additives with the ginger roots meal (GRM), at levels of 0.25, 0.50 or 0.75 g/kg diet, respectively. The experimental diets were isocaloric (2900 kcal ME/kg), isonitrogenous (20% CP) and isofibrous.

The final live body weight and body weight change increased significantly (P<0.05) with increasing GRM levels. The highest final live body weight and body weight change were recorded by using 0.75 followed by 0.50 g/kg, while those fed control diet recorded the lowest ones. Feed intake (g/day) increased significantly (P<0.05) with increasing CFM levels, however 0.75 g/kg GRM recorded the highest ones, while the control diet recorded the lowest ones. The level of 0.50 g/kg GRM recorded the best (P<0.05) feed conversion ratio (g feed /g egg mass), while the control diet recorded the worst ones. The non-significant (P>0.05) effect of dietary CFM levels on age at sexual maturity and first egg weight, while egg weight, egg number , egg mass, hatchability and fertility percentage recorded a significant difference (P<0.05) as compared to the control treatment. Egg yolk and shell thickness percentage showed a non-significant (P>0.05) albumen and yolk index percentage were decreased (P<0.05) by increasing GRM. Egg shell and egg shape were increased (P<0.05) by increasing GRM as compared to the control treatment. Level of 0.50 g/kg GRM recorded the best net return as well as the highest value of economical efficiency and relative economical efficiency compared with the other treatments.

In conclusions, it could be concluded that using dietary medicinal plant such as ginger roots meal (*Zingiber officinale* L) at 0.50 g/kg of the diet could improve productive, reproductive performance and economical efficiency of laying Japanese quail.

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1. Introduction

Recently, many countries tended to prohibit the using of antibiotics as growth promoters because of their side effect on both birds and human health. A remarkable increase in the use of medicinal plant products has been observed in the past decade. It has been known from ancient times that essential oils from aromatic and medicinal plants possess biological activity, antibacterial, anti-emetics, antifungal and antioxidant. Consequently, such plants have attracted increasing interest as an alternative feeding strategy to replace antibiotic growth promoters .

Spices are very common to be useful as additives in broilers diets (Zhang et al., 2009). Active principles are chemical compounds present in the entire plant or in specific parts of the plant that confers their therapeutic activity or beneficial effects (Martins et al., 2001). The supplementation of spices and herbs could have many benefits to broilers health and performance such as having anti-oxidative potential (Hui, 1996), antimicrobial activity (Dorman and Deans, 2000), enhancing digestion by stimulating endogenous enzymes (Brugalli, 2003).

The natural feed additives as the medicinal plants such as genus, ginger (*Zingiber officinale* L., Family *Zingiberaceae*) roots is one of the most commonly used spices around the world and a traditional medicinal plant that has been widely used in medicines for several thousand years. Ginger roots which are used in the treatment of various diseases in human. It is widely used in many countries as a food condiment and as a medicinal herb (Chrubasik et al., 2005).

The active ingredients of ginger roots and leaves such as zingerone, gingerdiol, zingibrene, gingerols and shogaols produced antioxidant activity (Zancan et al., 2002). The natural antioxidants can protect DNA and other molecules from cell damage induced by oxidation and can improve sperm quality and increase reproductive efficiency of men (Yang et al., 2006 and Khaki et al., 2009).

Ginger roots are commonly used for its anti-oxidant (Sharma and Gupta, 1998; Ghada et al., 2009; Asmah et al., 2010; Debrup et al., 2012 and Arkan et al., 2012); anti-Helicobacter pylori

(Mahady et al., 2003); anxiolytic (Vishwakarma et al., 2002); anti-emetic (Ernst and Pittler, et al., 2000); anti- inflammatory (Grzanna et al., 2005); anti-angiogenesis (Kim et. al., 2005); anti- tumor (Surn et al., 1999); anti-thrombotic(Backon,1986) androgenic (Kamtchouing et al., 2002); hypoglycemic (AL-Amin et al., 2006) and cardiovascular effects (Verma et al., 2004). Its main compounds have shown various pharmacological effects including immunomodulatory, antitumorigenic, antiinflammatory, antiapoptotic, antihyperglycemic, antilipidemic and antiemetic effects (Ali et al., 2008).

The chemical composition and antioxidant activity of ginger roots were minerals namely iron, calcium, phosphorous, zinc, copper, chromium and manganese and vitamin C. also, antioxidant components (polyphenols, flavonoids and total tannin) total polyphenols 840 mg/100 g, Tannin 1.51g/100 g, Flavonoids 2.98g/100 g, total antioxidant activity 73529.4µmol/ g (Shirin and Prakash, 2010). Medicinal plants have been reported to have health benefit properties and their preventive and therapeutic use in poultry is expected to increase in the future and a numerically large group of economically important plants.

Recent research works on medicinal plants (herbal) formulations as feed additives have shown encouraging results as regards weight gain, feed efficiency, lowered mortality and increased livability in poultry birds (Mishra and Singh, 2000; Abaza, 2001 ; Deepak et al., 2002; Abd El-Galil, 2007; Jahan et al., 2008 and Henda, 2014). However, information is lacking on the effect of ginger as a feed additive on laying Japanese quail performance.

So, the main objective of the present work was to establish the utilization of ginger roots meal as herbal feed additives in laying Japanese quail diets and its effect on reproductive performance, egg quality, digestion coefficients and economic efficiency.

2. **Materials and Methods**

The present experiment was carried out at Maryiout Experimental Research Station (South West of Alexandria), which belongs to the Desert Research Center. A total number of 210 Japanese quail (140 females and 70 males) at 4 weeks of age were used in an experiment lasted 22 weeks. Experimental Japanese quail (*Coturnix coturnix japonica*) were kept under similar managerial, hygienic and environmental conditions and were divided randomly into four equal experimental treatments of 35 females in each treatment.

Quail were kept in batteries, which were divided into separate cages, where two females were housed in each cage. The first treatment was fed the basal diet as control diet (0% GRM), while the other three treatments were feed additive the ginger roots (*Zingiber Officinale* L) meal (GRM) which added to the control diet at levels of 0.25, 0.50 or 0.75 g/kg, respectively.

The experimental diets (Table 1) were formulated according to N.R.C (1994) and were iso-nitrogenous (20% crude protein) and iso-caloric (2900 kcal ME/kg). Feed and water were available *ad libitum*. Chemical analyses of the experimental diet were assayed using methods of A.O.A.C (1990).

Table (1): Composition and proximate chemical analysis of basal diet.

Ingredients	%
Yellow corn	59.40
Soybean meal (44% CP)	9.00
Concentrate (44% CP)*	10.00
Corn gluten meal (60% CP)	8.37
corn gluten feed (22% CP)	8.26
Limestone ground	4.55
Vit. and min. premix**	0.30
L-lysine	0.12
Total	**100**
Proximate chemical analysis %	
Crude protein	20.13
Crude fiber	2.96
Ether extract	3.78
Calculated values	
Metabolizable energy (kcal/kg)***	2900
Calcium %	2.50
Available phosphorus %	0.30
Methionine %	0.45
Lysine %	1.00
Methionine + Cystin %	0.88
Price /k diet L.E.****	2.350

* Protein concentrate contained, 44 %Crude protein, 1.02% Crude fiber, 6.23% Ether extract, ME 2457 (kcal/kg), 1.58 % Methionine, 2.13% Methionine & Cystln, 3.05%Lyslne 7.24% Calcium, 3.25 % Available Phosphorus and 1.30 % Nacl.

** Each 1 kg Vitamins and minerals premix contains, Vit. A 120000 IU, Vit. D3 20000 IU, Vit.E, I00 mg, Vit.K, 20mg, Vit. B1, 10 mg, Vit. B2, 50mg, Vit. B6,15 mg, Vit. B12, 100 µg, Pantothenic acid 100 mg, Niacin 300 mg, Folic acid 10mg, Biotin 500 IJg, Iron. 300mg, Manganese 600 mg, Choline chlorite 500 mg,. Iodine 10 mg, Copper 100 mg, Selenium 1 mg, Zinc 500 mg and 1200 mg Antioxidant.

***Calculated according to NRC of poultry (1994).

****Calculated according to price of feed ingredients at the same time (2008) of the experiment. Price of one kg ginger roots meal =10.00 L.E.

The mineral analysis of ginger root meal was performed by using Atomic absorption spectrophotometer (Hitachi Polarized Zeeman; Model no Z-8200) following the conditions described in AOAC (1990). The minerals determined were calcium (Ca), phosphorus (P), zinc (Zn), iron (Fe), magnesium (Mg), copper (Cu), and manganese (Mn),

During the experimental period, individual live body weight and feed intake were determined biweekly. Feed conversion ratio (g feed intake / g egg mass) was calculated and the mortality was recorded every day.

Age at sexual maturity was determined by an average of the first ten eggs for each treatment. Eggs were collected daily and weighed for each group, so egg number, egg mass were calculated during the experimental period. At 15 weeks of age, 20 eggs were randomly taken from each group and were used to evaluate egg quality; yolk. Weight and shell weight were recorded. Shell thickness (without membrane) was measured by micrometer, while albumen weight was calculated by subtracting yolk and shell weight from egg weight, yolk, shell and albumen percentage were calculated as a percentage of egg weight.

Males were housed individually in cages (one quail per cage) and fed the same diets for females. At 15 weeks of age, males (70 males) were transferred to female cages (two females and one male) for twenty minutes for five days, the eggs were then collected and incubated. Hatchability percentage was calculated for each treatment.

At the end of the experimental feeding period, digestion trials were conducted using 20 adult quail males (five quail from each treatment) to determine the digestibility coefficients and the nutritive values of the experimental diets as affected by ginger roots meal levels. Males were housed individually in metabolic cages.

The digestibility trials extended for 9 days of them 5 days as a preliminary period followed by 4 days as collection period. The individual live body weights were recorded during the main collection period to determine any loss or gain in the live body weights. During the main period, excreta were collected daily and weighed dried at 60°C bulked finally ground and stored for chemical analysis. The faecal nitrogen was determined according to Jakobsen et al., (1960). Urinary organic matter was calculated according to Abou-Raya and Galal (1971). Metabolizable energy was calculated according to Titus and Fritz (1971).

The digestion coefficients % of organic matter (OM), crude protein (CP), crude fiber (CF), ether extract (EE) and nitrogen free extract (NFE) of the experimental diets were estimated.

The nutritive values expressed as digestible crude protein (DCP), total digestible nutrients (TDN) and metabolizable energy (ME) were calculated.

Economical efficiency for egg production was calculated from the input / output analysis according to the costs of the experimental diets and selling price of one kg egg. The values of economical efficiency were calculated as the net revenue per unit of total costs.

Statistical analysis was carried out using General Linear Model (GLM) procedures by SAS program (2004) using simple one way analysis of variance according to this model:

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

Where:

Y_{ij} = Represented observation in j^{th} GRM level.

μ = Overall mean.

T_i = Effect of j^{th} GRM level (j =0, 0.25, 0.5or 0.75 g).

e_{ij} = Random error.

Duncan's New Multiple Range Test (Duncan, 1955) separated differences among treatment means.

Results and Discussion

The proximate minerals analysis of ginger roots meal (GRM)

The minerals elemental composition of ginger roots meal sample as depicted in table (2) indicated that ginger is rich with major elements as calcium 2.97mg/100g, phosphorus 8.61mg/100g and magnesium 1.53 mg/100g, whereas, trace (Micro elements) values as iron 85.55 mg/100g, zinc 69.0 mg/100g, copper 9.64 mg/100g and manganese 7.59 mg/100g.

Table (2): Mineral contents (mg / 100 g) contents of ginger roots meal (GRM)

Parameter	mg/100g
Calcium	2.97
Phosphorus	8.61
Magnesium	1.53
Iron	85.55
Zinc	69.01
Copper	9.64
Manganese	7.59

The essential minerals like calcium and phosphorus are important in extra-cellular and intra-cellular body functions and as components responsible for the bulding block of structural component in body. Minerals as iron, even if present in threshold level can act as anti-oxidant and are involved in strengthening the immune system. Whereas, zinc are known to prevent cardiomyopathy, muscle degeneration, growth retardation and bleeding disorder. Therefore , the presence of these minerals in ginger root provides bases for their use in food application, Belitz (2009).

Live body weight and body weight change

Data of live body weight and body weight change during the whole experimental period of quail females as affected by the different levels of GRM are summarized in table (3). The final live body weight and body weight change during the whole experimental period varied significantly ($P<0.05$) among the experimental treatments.

It is worthy noting that final live body weight was improved with increasing the GRM levels in the diet. Birds, gradually fed diets additive with 0.75 g/kg CRM recorded 4.98 % higher than that of the control treatment, while, 0.25 or 0.50 g/kg CRM resulted in 2.12% and 3.54% higher than that of the control treatment, respectively. It is clear that live body weight change during the whole experimental period was increased by increasing GRM levels in the experimental diets. The addition with 0.25, 0.5 or 0.75 g/kg GRM level increased live body weight change by 4.72, 7.91and 10.34% more than that of the control treatment, respectively.

Table (3). The productive performance ($\bar{X}$ ±SE) of laying quail as affected by dietary GRM

Items	Levels of GRM (g/kg)				Sig
	Control (0)	0.25	0.50	0.75	
Initial live body weight (g)	120.55±4.19	119.60±4.32	118.92±5.01	119.33±4.29	ns
Final live body weight (g)	255.30^{b}±3.25	260.71^{ab}±3.71	264.33^{a}±4.43	268.01^{a}±4.60	*
Live body weight change (g)	134.75^{b}±2.11	141.11^{ab}±2.60	145.41^{a}±3.02	148.68^{a}±3.11	*
Age at sexual maturity/bird/day	49.20±0.25	48.77±0.26	48.62±0.30	48.40±0.35	ns
First egg weight (g).	11.50±0.32	11.52±0.40	11.51±0.4.10	11.48±0.43	ns
Egg weight (g)	11.75^{b}±0.08	12.49^{a}±0.05	12.41^{a}±0.03	12.25^{ab}±0.08	*
Egg number/ bird/ day	0.67^{b}±0.02	0.69^{b}±0.05	0.71^{ab}±0.08	0.72^{a}±0.07	*
Egg mass (g)/ bird/day	7.87^{b}±0.10	8.62^{ab}±0.06	8.81^{a}±0.07	8.82^{a}±0.08	*
Feed intake (g)/ bird/day.	29.52^{b}±0.21	29.56^{ab}±0.08	29.85^{a}±0.06	30.25^{a}±0.09	*
Feed conversion ratio.	3.76^{a}±0.04	3.43 ^{ab}±0.03	3.39^{b}±0.05	.3.42^{b}±0.06	*
Morality rate %.	0.00	0.00	0.00	0.00	-
Hatchability %	76.12^{b}±3.22	78.23^{b}±3.01	79.02^{a}±3.13	80.86^{a}±3.68	*
Fertility %	89.61^{b}±3.95	90.85^{ab}±4.04	92.51^{ab}±4.15	94.89^{a}± 5.01	*

a.b: Means within a row with different superscripts are significantly different. Sig.= Significance, *= (P< 0.05) and n.s = not significant.

The increase in body weight change may be due to the increase in feed intake and the improvement in nutrients digestibility of diets and reflection on the positive effect may be attributed to the biological function of medicinal plant components that have been essential for growth (Boulos, 1983; Bradley, 1992 and Leung and Foster, 1996). Zhao et al., (2011) who found that the higher performance of the laying hens may be due to antioxidant, antimicrobial and other activities such as increased blood circulation and secretion of digestive enzymes and reduction in the oxidation of feed. According to Herawati (2010) the improved performance may be attributed to the two types of digestive enzymes in ginger; protease and lipase. Ibrahim et al., (1998), Ademola et al., (2009), Farinu et al., (2004) and Onimisi et al., (2005) who found that ginger supplementation to the diets can increase body weight when supplemented up to 2% level on broiler diets. On the contrary, Al-Homidan (2005) observed that diets containing 20 or 60 g /kg ginger of diet reduced growth rate of starter broilers.

Age at sexual maturity

The non-significant (P>0.05) effect of dietary GRM levels on age sexual maturity as shown in table (3). Level of 0.75 (g/kg) recorded early sexual maturity compared to other experimental treatments.

Weight of first egg

Results of first egg weight recorded a non significant decrease among treatments. It was noticed that there was a decrease in weight of first egg with the increase of GRM in the diets. It is worthy noting that feeding quail on 0.75 (g/kg) GRM recorded the lowest values that may be attributed to early sexual maturity compared to other experimental treatments (Table 3).

Egg weight

Egg weight during the whole experimental period significantly differ (P<0.05) among the experimental treatments. It is worth noting that addition of diet by 0.25, 0.50 or 0.75 g/kg of GRM recorded an increase in egg weight amounted to 5.4, 4.73 or 3.376% compared to the control treatment, respectively. Level of 0.25 g/kg recorded the highest egg weight (12.49 gm) while, the control treatment recorded the lowest egg weight (11.85 gm), compared to other treatments of GRM level as shown in Table 3.

Egg number and egg mass

Results in Table 3 indicate that egg number (EN) and egg mass (Em) during the whole experimental period significantly varied among the experimental treatments. It is worthy noting that egg number was higher in birds receiving 0.50 and 0.75 % CFM compared to other experimental treatments, it is clear that addition of diet by 0.50 or 0.75 g/kg GRM increased egg number by 2.9 or 4.35 % than that of the control treatment, respectively. This may be due to the differences in earlier sexual maturity and attributed to the biological function of medicinal plant components. Khodary et. al., (1996) stated that the efficiency of medicinal plants and some plant seeds as natural tonic, restoratives, antibacterial and anti-parasitic drugs is improving the productive performance in poultry.

Egg mass recorded maximum values 8.82 for 0.75 g/kg of GRM diet, while minimum values recoded for the control treatment. It is worthy noting that feeding quail on 0.25, 0.50 or 0.75 g/kg of GRM resulted in 5.38, 7.70 and 7.82 % higher in egg mass than that of the control treatment, respectively.

The increase in egg mass with the 0.50 or 0.75 g/kg of GRM level was expected in view of the increase in egg number and vice versa with the 0.25 g/kg of GRM level. Zhao et al., (2011) who found that laying hens supplemented with ginger powder had higher egg mass than the control treatment at the levels up to 20 g/kg of diet, this is agreement with Mascolo et al., (1989); Philips et al.,(1993) and Jana et al.,(1999). Ahmed et al., (2014) reported that addition of 2.5 and 5.0 kg/ton of crushed ginger to the broiler breeder (Ross) diets there were significant increases (P<0.05) in egg production (%H.D.), egg weight (g), egg mass (g/day) and significant decrease in the proportion of hatched eggs (%), Bosisio et al., (1992) reported that the anti-oxidant, reducing free radicals damage, increase production and reproduction and improve health.

Feed intake and feed conversion ratio

On the basis of the whole experimental period there was a significant differences (P<0.05) among the experimental treatments for daily feed intake trait are shown in table (3). The experimental treatments exhibited more feed intake compared to the control treatment. It is clear that increasing GRM levels in the experimental diets increased feed intake. The supplementation with 0.25, 0.50 or 0.75 g/kg of GRM increased feed intake by 0.14, 1.12 and 2.47 % more than that of the control treatment, respectively. Natural feed additives had beneficial effect for stimulation and activity of digestive system by improving the palatability and enhancing appetite of poultry, thus increasing the amount of feed consumed (Namur et al., 1988). The results of feed conversion ratio showed improvement in feed efficiency utilization by the GRM level in diet as compared to the control treatment during the experimental period. Quail fed 0.50 g/kg GRM during the experimental period recorded the best feed conversion. The improvement in feed conversion ratio of 0.50 g/kg GRM may be due to its highest egg mass as compared to that of GRM levels. Such improvement may be attributed to the properties of these materials that could act not only as antibacterial, anti-protozoa and anti-fungal but also as anti-oxidants (Bradley, 1992 and Leung and Foster, 1996).

This result could be compared with the work of Ademola et al., (2009) who reported higher feed intake of broilers on diet supplemented with ginger. and Tollba (2003) and Herawati (2010) who scored significantly lower FCR for birds fed diets containing ginger up to 2%.

Mortality

No incidence of mortality occurred during the experimental period as well as no effects of GRM levels supplemented on the experimental diets (Table 3). Eisenberg et al., (1993) indicated that medicinal plant contains natural substances that can promote health and alleviate illness. Ginger has long been used as traditional medicine for alleviating the symptoms of gastrointestinal illnesses (Afzal et al., 2001 and Ali et al., 2008), and anti-microbial (Dorman and Deans, 2000 ;Akoachere et al., 2002 and Dedov et al., 2002) and some pharmacological effects (Penna et al., 2003 and Ali et al., 2008).

Hatchability

Results of hatchability showed a significant (P<0.05) improvement by the GRM levels in diet as compared to the control treatment (Table 3). However, feeding quail on 0.25, 0.50 or 0.75% GRM resulted in 0.19, 1.13and 1.64% higher in hatchability than that of the control treatment, respectively. Level of 0.75 g/kg recorded the highest hatchability compared to other treatments of GRM level which may be due to the increase in fertility, Ahmed et al., (2014) Found that the ginger caused an improvements in fertility and hatchability compared to control, In addition, there were an increasing in chick body weight at hatching as an essential reason to interior physiological improvement because of antioxidant activity of nutritional additives.

Fertility

Results on fertility percentage in the present study recorded a significant difference (P<0.05) among treatments (Table 3). It is worthy noting that feeding quail on 0.75 g/kg GRM level recorded higher values. This may be attributed to an improvement of sperm concentration, sperm motility, total motile sperm, live spermatozoa and semen quality with level of 0.75 g/kg, Yang et al.,(2006) indicated that ginger can be improve sperm quality and increase reproductive efficiency of men. Shanoon (2011) who found that the ginger caused a significant increase (P<0.05) in ejaculate volume, sperm concentration, counts, movements and a significant decrease (P<0.05) in motility and abnormality on male broiler reproductive system. Amr and Hamza (2006) in agreement with these results showed that *Zingiber officinale* increase the sex hormones level.

Egg quality traits

The comparison between diets containing different levels of GRM and egg quality with the control diet illustrated in table (4). There were no significant (P>0.05) differences in yolk, albumen, or shell thickness among the dietary treatments, while, percentage of yolk index was decreased (P<0.05) by increasing GRM as compared to the control treatment. Eggshell and egg shape were significantly (P<0.05) increased by increasing GRM, while, yolk index (P<0.05) decreased by increasing GRM as compared to the control treatment. These results are inagreement with

Nasiroleslami and Torki (2010) who found that the addition of the essential oil of ginger increased egg shell weight and egg shell thickness in laying hens.

Table (4). Egg quality ($\overline{X}$ ±SE) as affected by Ginger roots meal in laying quail diets.

Items	Levels of GRM (g/kg)				Sig.
	Control (0)	0.25	0.50	0.75	
Egg weight (g)	11.91±0.12[b]	12.52±0.11[ab]	12.64±0.18[a]	12.63±0.20[a]	*
Yolk %	31.35±0.16	31.44±0.11	31.49±0.14	31.53±0.15	n.s
Albumen %	55.38±0.07	55.27±0.06	54.69±0.09	54.36±0.08	n.s
Egg shell %	13.27±0.04[b]	13.29±0.06[ab]	13.82±0.07[a]	14.11±0.09[a]	*
yolk index %	48.82±0.11[a]	48.88±0.27[a]	47.64±0.35[ab]	46.79±0.63[b]	*
Egg shape %	77.12±0.04[b]	77.55±0.03[ab]	78.11±0.02[a]	79.05±0.02[a]	*
Shell thickness (mm)	0.244±0.06	0.245±0.05	0.245±0.08	0.246±0.09	n.s

a,b: Means within a row with different superscripts are significantly different. Sig.=Significance, *= (P< 0.05) and n.s = not significant.

Digestibility and nutritive values

Apparent digestion coefficients values of dietary treatments are illustrated in table (5), regarding those of CP, CF, EE and NFE. Such values were significantly (P<0.05) differed among the experimental treatments and the data indicated that, all nutrients digestibility values increased for quail fed GRM diet compared to the control diets.

Similar trend was observed for the nutritive values of the tested diets in terms of DCP %, TDN % and ME (kcal/kg), which significantly (P<0.05) increased with the increasing of GRM up to 0.75 g/kg level. Ginger has been reported to enhance animals' nutrient digestion and absorption because of the positive effects on the gastric secretion, enterokinesia, and digestive enzyme activities (Platel and Srinivasan, 2000). Brugalli (2003) who indicated that, enhancing digestion by stimulating endogenous enzymes.

Table (5) Digestibility coefficients % and nutritive values ($\overline{X}$ ±SE) of the experimental diets as affected by GRM

Items	Levels of GRM (g/kg)				Sig
	Control (0)	0.25	0.50	0.75	
Digestibility coefficients %					
CP	81.12[b] ±1.42	82.13[ab] ±1.29	83.70[a] ±1.20	84.02[a] ±1.11	*
CF	24.11[b] ±1.90	25.32[ab] ±1.75	27.50[a] ±1.63	28.10[a] ±1.81	*
EE	85.21[b]±1.72	86.64[ab] ±1.15	87.02[ab]±1.02	80.01[a] ±1.09	*
NFE	84.11[b]±1.10	85.50[ab] ±0.50	86.01[a]±0.53	88.02[a]±0.65	*
Nutritive values					
DCP%	16.33[b] ±0.03	16.53[ab] ±0.04	16.85[a] ±0.03	16.91[a] ±0.05	*
TDN%	66.21[b] ±1.20	67.27[ab] ±1.14	67.94[a] ±1.03	69.11[a] ±1.12	*
ME (kcal/kg)	2771[b] ±8.22	2815[ab] ±7.50	2843[a] ±7.13	2892[a]±9.05	*

a,b: Means within a row with different superscripts are significantly different., Sig.=Significance, *= (P< 0.05) and n.s = not significant.

According to Caspary (1992) who suggested that long villi increased surface area that is capable of greate absorption of available nutrients by ginger. While greater villus height and more numerous cell mitosis in the intestine are indicators that the function of intestinal villi is activated (Langhout et al., 1999; Yasar and Forbes, 1999). The present results show that villus height, villus area, cell area and cell mitosis in all intestinal segments had higher values in the Ginger groups than in the control group. Incharoen and Yamauchi (2009) showed that the control epithelial cells were flat and the cells of the ginger groups were protuberated into the lumen in each intestinal segment suggest that the cells of the ginger groups might be more hypertrophied than those of the control.

Abd El-Galil (2007), Abd EL-latif et al., (2003) and Henda (2014) who indicated that, addition of medicinal herbal plants had a significant effect on improving digestibility coefficient and nutritive values. (Abd El-Latif et al., 2002) adding herbal medicinal plants to the diet asserted the biological role for herbal medicinal plants in activities of metabolic functions and biosynthesis of hormones.

It is important to note that the results of the digestion trials were coincided generally with the differences in production performance and feed conversion ratio in quail diets in comparison with the control diet.

Economical efficiency

The present results indicated that the diet containing 0.50 g/kg GRM as a feed additive result the best net revenue and economic efficiency compared to the other experimental treatments as shown in Table 6. It was noticed that the control diet have the lowest net revenue and economic efficiency.

Table (6): Economical evaluation of quail as affected by dietary Ginger roots meal

Item	Control	Levels of Ginger roots meal (g/kg)		
		0.25	0.50	0.75
Feed conversion ratio	3.76	3.43	3.39	.3.42
Cost of kg feed (L.E)	2235	2235	2235	2235
Feed cost of kg egg (L.E)	8.404	7.666	7.577	7.644
Selling price of one kg egg (L.E)	15.00	15.00	15.00	15.00
Net revenue (L.E)	6.596	7.334	7.423	7.356
Economic efficiency	78.49	95.67	97.97	96.23
Relative economic efficiency%	100	121.89	124.82	122.60

Moreover the best relative economic efficiency was detected with 0.50 g/kg GRM being 114.02% followed by those fed 0.75 g/kg CFM, respectively when compared with the control treatment.

In conclusions, it could be concluded that using dietary medicinal plant such as GRM at 0.50 g/kg of the diet could improve productive, reproductive performance and economical efficiency of laying Japanese quail.

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