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Ginger supplementation in quail as a nutritional alternative in egg production and quality

Suplementación de jengibre en codornices como alternativa nutricional en la producción y calidad de huevo

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Abstract

In this study, the behavior of ginger flour (*Zingiber officinale*) was evaluated on the productive parameters during the first stage of laying in quail (Coturnix coturnix japonica), it was carried out in five phases distributed in weeks (phase one, 1 and 2, phase two, 3 and 4, phase three, 5 and 6, phase four 7 and 8 and phase five 9 and 10) of posture. The variables to be studied were: feed consumption (g) feed conversion, mortality, (%), percentage of laying (%), egg quality expressed in (egg weight (g) shell thickness (mm), resistance of shell (kgf), yolk coloration. A completely randomized design with four treatments and six repetitions was used, as well as an analysis of variance and Tukey's test at 5%. The treatments used were: T_1, T_2 and T_3 T_0 (control), were applied in doses of ginger flour of: 0%, 0.2%, 0.4% and 0.6% respectively. The statistical differences between T_3 and the control group, determined that the flour favors the consumption of food, especially in the final phases of the study, (T_1, T_2 and T_3) compared to the control group. Feed conversion shows significant differences with T_2 in the intermediate production phases compared to the control. The percentage of laying does not present significant differences, in addition to the quality of the eggs improved notabl e mind. Regarding mortality, there were significant differences especially in T_3 compared to the control since the birds showed resistance to diseases. In relation to profitability, the results of T_3 were superior, with a CRB of 1.19. Concluding that the inclusion of ginger flour improves the productive parameters and the quality of the eggs

Resumen

El presente estudio se valoró el comportamiento de la harina de jengibre *(Zingiber officinale)* sobre los parámetros productivos durante la primera etapa de postura en la codorniz (*Coturnix coturnix japónica*), fue realizado en cinco fases distribuidas en semanas (fase una, 1 y 2, fase dos. 3 y 4, fase tres.5 y 6, fase cuatro 7 y 8 y fase cinco 9 y 10) de postura. Las variables a estudiarse fueron: consumo de alimento (g) conversión alimenticia, mortalidad, (%), porcentaje de postura (%), calidad del huevo expresado en (peso del huevo (g) grosor de la cascara (mm), resistencia de la cascara (kgf), coloración de la yema. Se utilizó un diseño completamente al azar con cuatro tratamientos y seis repeticiones, además de un análisis de varianza y prueba de Tukey al 5%. Los tratamientos empleados fueron: T_1, T_2, T_3 y T_0 (testigo), se aplicaron en dosis de harina de jengibre de: 0 %, 0.2 %, 0.4 % y 0.6 % respectivamente. Las diferencias estadísticas entre T_3 y el grupo testigo, determinadose que la harina favorece el consumo de alimento, sobre todo en las fases finales del estudio, (T_1, T_2 y T_3) frente al grupo testigo. La conversión alimenticia muestra diferencias significativas con T_2 en las fases intermedias de producción frente al testigo. el porcentaje de postura no presenta diferencias significativas, ademas la calidad de los huevos mejoro notablemente. Con respecto a la mortalidad existieron diferencias significativas sobre todo en T_3 conparado con el testigo ya que las aves mostraron resistencia a enfermedades. Con relación a la rentabilidad fueron superiores los resultados de T_3, con una RCB de 1.19. Concluyendo que la inclusión de harina de Jengibre mejora los parámetros productivos y la calidad de los huevos

Introduction

Ecuador is considered a clearly productive country, because it has ideal climatic conditions, being cotorn farming an activity in development at a regional level on the coast and the mountains with greater notoriety, the climatic conditions of these regions allow its development, but its growth is not being taken avantage of, due to cultural factors, lack of information on the product and its benefits[1]. This leads to the search for organic supplements, which in one way or another are part of the elaboration of balanced that perform the same functions as the commonly used inputs, with this looking for products at low prices, and accessible to the consumer[2] one of the most viable alternatives is the use of products and by-products derived from plants for therapeutic use, with favorable results at the productive level in farm animals, after their inclusion in feed and drinking water[3].

Supplementing ginger and bee propolis as growth promoter (GP), antioxidant material in performance traits[4], carcass characteristics, blood parameters, antioxidant status of growing Japanese quail. In growing 7-day-old Japanese quail, a diet formulated based on corn extract and soybean meal added ginger (*Zingiber officinale*) provided a greater number of colony-forming units *Lactobacillus* spp. The intestinal health of birds is achieved when there is a favorable balance in their microbiota, guaranteeing an establishhment and predominance of beneficial bacteria, producing nutritional metabolites, stimulating the production of enzymes for better nutrient digestibility, increasing weight and other zootechnical indices[5].

The quail, a small bird characterized by its great productive capacity, excellent layer, with an average of 23 to 25 eggs per month and 250 to 300 years, with an average weight of 10 to 12 g, 5 to 6 quail eggs are equivalent to a chicken egg, which can weigh up to 15 g[6]. Due to these important characteristics, a balanced diet is sought to cover the demanding rhythm of laying, despite the fact that there is a wide range of concentrated feeds on the market, the producer faces problems by not having food for quail in their laying phases, using balanced feed (BF) for other types of birds, which often do not meet their nutritional requirements, manifesting in low production levels and health problems[7]. Studies on the therapeutic benefits of ginger suggest that, among the main ones, it suppresses gastric contractions and secretions, reduces vomiting, antipyretic, analgesic, hypotensive, reduces intestinal activity, and also has hepatoprotective, hypocholesterolemic, with anti-inflammatory, antipyretic, antimicrobial and hypoglycemic action[8].

The effect of ginger essential oil on growth performance, posture, antioxidant status of egg yolk, cholesterol, and serum metabolites in Japanese quail[9] positively influence egg weight and antioxidant status of the yolk, also significantly reduces the content of serum and egg yolk in cholesterol, without adverse effects on feed intake and weight gain in quail.

The types of phytase (fungal and bacterial) on the productivity and quality of the egg in quail in the laying phase, the use of commercial phytase in an on-top formulation scheme, have a positive action on the

quality of the shell, reducing the can- number of broken eggs and increasing shell thickness[10].

Supplementing ginger and bee propolis as a PG, diets supplemented with ginger, propolis or their combination could be added to the quail ration to improve the feed conversion ratio (FCR), humoral immunity and optimize the lipid profile in the blood serum, improve the antioxidant status, without negative effects on the birds[4]. Phytogenic additives can stimulate a favorable balance of the intestinal microbiota, ensuring the establishment and prevalence of beneficial bacteria, with a greater number of lactic acid producing bacteria being observed in the jejunum of broilers at 42 days of age, when evaluating the effect of different plant extracts in the diets of broilers[5].

The cholesterol quality of edible eggs produced by diets fed with probiotics and/or ginger, inoculated in a quail diet on the serum and cholesterol of the yolk, indicate that with a combination of probiotics with ginger the levels were lower total cholesterol in serum and yolk[11]. The use of three levels of *Z. officinale*, in broiler chickens, in the initial phase, fattening and total phase, obtained better weight gain, FCR and lower mortality compared to the standards established at a general level[12].

The addition in the diet of the essential oil of oregano (*Origanum vulgare*) and dehydrated ginger in weight gain, feed consumption (FC) and FCR in Cobb 500 male chickens refer that the use of dehydrated ginger as GP they do not differ in treatment, probably due to a low health challenge[13]. The evaluation of ginger as a feed additive in broiler diets, increased weight and a lower conversion index[14]. The objective of the study was to evaluate the effect of ginger flour on the productive parameters and egg quality of the quail in the first stage of laying.

Materials and methods

The present test was carried out in the Florida sector, Cevallos canton of the Tungurahua province, Ecuador. 240 five-week-old quails were used, acquired from the AVIPAZ poultry farm, they were housed in metal cages for their feeding, production. The shed was adapted to an ambient temperature of 18-24 ºC, relative humidity between 60 and 65 %, always avoiding sudden changes in temperature. Curtains were used to provide an optimal environment. In addition, it was provided with 4 extra hours of light from 12 p.m. at 10 p.m. which are the hours of greatest posture. The animals were randomly distributed to each treatment under a Completely Random Design (CRD), with 3 treatments (T_1, T_2 and T_3) and a control (T_0), with 6 repetitions. Analysis of variance, ADEVA and the 5 % Tukey test were performed. Each cage had automatic feeder and cup-type drinkers with ad libitum access to water. Food was supplied in the morning and afternoon (07:00 and 17:00 respectively), the experimental diets were carried out according to the requirements for Japanese laying quail[15].

Quails were randomly located, 10 birds in each of the 24 cages, 30 g/food/bird/day were provided[15]. The quails had an adaptability period of two weeks with food including ginger according to treatment. Drinking water was supplied, then 3 % sugar water was supplied for the first three hours, on the first day vitamins and amino acids were added, 2 g of coaxial solution 20 was mixed with 1 L of water and given to the quails. for 3 days. in order to help birds, avoid transport stress. The production data were taken from

the seventh se quail life, concluding the study in week sixteen, the investigation lasted 24 weeks. The study was carried out in five phases distributed in weeks (phase one, week 1 and 2, phase two 3 and 4 weeks), phase three 5 and 6 weeks, phase four 7 and 8 weeks and phase five 9 and 10 weeks) of laying, data were taken such as: FC (g) FCR, (g) mortality, (%), laying percentage (%), egg quality expressed in egg weight (g), shell thickness (mm), shell strength (kgf), yolk color. It was carried out using the direct method (food offered - food rejected), 30 g of food per bird was supplied daily, that is, 300 g per day per cage, the excess food per cage per day was weighed. The FCR was determined by the relationship (food consumed/egg yield). The egg collection was collected daily and the analysis was carried out weekly[16]. The laying percentage (% P) was determined by the relationship (number of eggs laid/day/number of birds/day*100). It was carried out by the direct method, collecting the eggs per cage daily throughout the experiment, the analysis was carried out weekly.

For the egg weight (EW) g, it was performed by the direct method, collecting the eggs per cage daily throughout the experiment and weighed using a digital scale. The quality of the egg was obtained by using the Digital NABBEL DTE 6000 egg quality analyzer, the parameters that were measured were weight (g), shell resistance (kgf), yolk color, shell thickness (mm). Weight (g): For the interpretation of results, measures such as ranges or categories were used: (A, B, AB), and finally the profitability was determined through the net benefits/present value of the investment costs. It was carried out by monitoring the production costs incurred during the research period[7].

Results

Table 1 stage 1, week 1 and 2, the variable FC, a slight preference was achieved, T_1 with 293.63 g, compared to T_0 which is the lowest 288.26 g, FCR, presents the highest value in T_0 with 33.96 % compared to T_3 with 17.84, the position percentage, T_1 reflects the highest value with 49.76 % and T_0 with 41.19 %, these variables do not present significant differences ($p > 0.05$). The quality of the eggs does not present results in this phase, since, for its analysis, it was taken into account to start from week 9 of the birds' life.

Table 2 stage 2, weeks 3 and 4, FC with significant results for the Tukey test at 5% ($p < 0.05$), placing the T_3 treatment with 291.60 g in range A. FCR, presents the highest value in T_1 5.29 % compared to T_3 with 4.89 %, they do not present significant differences ($p > 0.05$). The position percentage, T_3 reflects the highest value registered with 71.43 % and T_1 with 68.33 %, the non-significant differences ($p > 0.05$).

Egg quality, for EW, T_3 stands out with 12.96 g, placing it in a range A when applying the Tukey test at 5 %. In the color of the yolk T_1 is located in the AB range with a color scale of 13.15 and finally in the B range we have T_0 with a color scale of 12.77. kgf stands out in rank A of the Tukey test at 5 % T_3 and T_2 with 0.93 and 0.89 kgf respectively. In the thickness of the shell we have T_3 in the range A of Tukey at 5 % with 0.21 mm.

In stage 3, week 5 and 6, (Table 2), the AC is obtained had significant results for the Tukey test at 5 % ($p < 0.05$), locating in the range A. In the FCR variable, the highest value is presented in T_2 with 9.58% located in Tukey's A range at 5 %. The position percentage, T_3 reflects the highest value registered with 78.57 % and T_1 with 73.33 %, they do not present significant differences ($p > 0.05$).

Table 1 Productive parameters during the first stage of laying with the inclusion of ginger flour at 0.2%, 0.4% and 0.6% in week 1 and 2

	Ginger flour levels (%)					
Variable	**T_0**	**T_1**	**T_2**	**T_3**	**(p)**	**C.V.**
Number of birds	60	60	60	60		
Feed consumption (FC) %	288.26^a	293.63^a	292.33^a	293.07^a	0.0679ns	1.23%
Feed conversion (FCR)	33.96^a	27.51^a	33.27^a	17.84^a	0.5764ns	78.85%
Percentage of posture (%P)	41.19^a	49.76^a	45.24^a	42.86^a	0.2965ns	17.76%

* Significant at 5% **, highly significant at 5%, ns not significant at 5%, CV coefficient of variation, T_O diet with 0% inclusion of ginger flour, T_1 diet with 0.2% inclusion of ginger, T_2 diet with 0.4% ginger inclusion, T_3 diet with 0.6% ginger inclusion.

Table 2 Productive parameters during the first stage, inclusion of ginger flour at 0.2%, 0.4% and 0.6% during stages 2 and 3

Etapas	**Stage 2, 3 a 4 weeks**						**Stage 3, 5 to 6 weeks**					
Variables	**T_0**	**T_1**	**T_2**	**T_3**	**(P)**	**C.V**	**T_0**	**T_1**	**T_2**	**T_3**	**(P)**	**C.V**
No. of birds	60	60	60	60			60	60	60	60		
Feed consumption (%)	281.88^b	288.93^{ab}	288.19^{ab}	291.60^a	0.00149*	1.66%	281.67^b	289.90^a	288.95^a	292.12^a	<0.0001**	0.82%
Feed conversion (FCR)	5.13^a	5.29^a	5.11^a	4.89^a	0.9287ns	20.49%	4.26^b	4.89^b	9.58^a	3.95^b	0.0056*	14.25%
Percentage of posture (% P)	69.29^a	68.33^a	69.76^a	71.43^a	0.8941ns	10.14%	78.10^a	73.33^a	77.14^a	78.57^a	0.6806ns	10.63%
Egg weight (EW)g	11.30^b	11.46^b	11.61^b	12.96^a	<0.0001**	3.86%	11.65^b	11.79^b	12.01^b	13.09^a	0.0001*	3.67%
Yolk color	12.77^b	13.15^{ab}	13.65^a	13.85^a	0.0022*	3.40%	13.48^b	13.56^b	13.64^{ab}	14.21^a	0.0100*	2.66%
Shell resistance (Kgf)	0.80^b	0.81^b	0.89^a	0.93^a	0.0001*	5.41%	0.85^b	0.90^b	0.95^{ab}	1.04^a	0.0005*	6.95%
Shell thickness (mm)	0.17^c	0.18^{bc}	0.19^{ab}	0.21^a	<0.0001**	4.55%	0.19^b	0.20^{ab}	0.23^a	0.22^{ab}	0.0117*	6.10%

* Significant at 5% **, highly significant at 5%, ns not significant at 5%, CV coefficient of variation, T_O diet with 0% inclusion of ginger flour, T_1 diet with 0.2% inclusion of ginger, T_2 diet with 0.4% ginger inclusion, T_3 diet with 0.6% ginger inclusion.

Table 3 Productive parameters during the first stage, inclusion of ginger flour at 0.2%, 0.4% and 0.6% during stages 4 and 5

Etapas	**Stage 4, 7 a 8 weeks**						**Stage 3, 5 to 6 weeks**					
Variables	**T_0**	**T_1**	**T_2**	**T_3**	**(P)**	**C.V**	**T_0**	**T_1**	**T_2**	**T_3**	**(P)**	**C.V**
No. of birds	60	60	60	60			60	60	60	60		
Feed consumption (%)	281.67^b	289.90^a	288.95^a	291.76^a	0.0001*	0.85%	281.67^b	289.90^a	288.95^a	292.12^a	<0.0001**	0.82%
Feed conversion (FCR)	4.42^b	7.52^a	5.40^{ab}	4.09^b	0.0041*	7.28%	4.43^a	6.42^a	5.29^a	4.09^a	0.3937ns	19.19%
Percentage of posture (% P)	78.33^a	70.24^a	73.10^a	77.86^a	0.4665ns	13.56%	77.86^a	70.24^a	73.10^a	77.87^a	0.5091ns	13.78%
Egg weight (EW)g	11.99^b	12.08^b	12.55^{ab}	13.20^a	0.0004*	3.56%	12.09^b	12.47^b	13.23^a	13.39^a	0.0002*	3.68%
Yolk color	13.70^b	13.86^b	14.05^{ab}	14.64^a	0.0023*	2.75%	14.05^b	14.10^b	14.54^{ab}	14.77^a	0.0058*	2.50%
Shell resistance (Kgf)	0.89^c	0.99^b	1.05^{ab}	1.09^a	<0.0001**	5.38%	0.92^b	1.01^{ab}	1.11^a	1.12^a	0.0005*	6.99%
Shell thickness (mm)	0.20^c	0.21^{bc}	0.23^{ab}	0.24^a	<0.0001**	5.26%	0.22^c	0.24^b	0.25^{ab}	0.26^a	<0.0001*	3.45%

* Significant at 5%, ** highly significant at 5%, ns not significant at 5%, CV coefficient of variation, T_O diet with 0% inclusion of ginger flour, T_1 diet with 0.2% inclusion of ginger, T_2 diet with 0.4% ginger inclusion, T_3 diet with 0.6% ginger inclusion.

Table 3 phase 4, FCR we have significant results for the Tukey test at 5 % ($p < 0.05$), placing in the range A, treatments T_3, T_1 and T_2 with 291.76, 289.90 and 288.95 g, respectively. The position percentage, T_3 reflects the highest value registered with 77.86% and T_1 with 70.24%, they do not present significant differences ($p > 0.05$). Regarding the egg quality variables, for the EW variable, T_3 stands out with 13.20 g, placing this treatment in a rank A when applying the Tukey test at 5 %. T_2 with 12.55 g in range AB, T_1 and T_0 in range B, with 12.08 g and 11.99 g respectively.

The color of the yolk, T_3 in range A of the Tukey test at 5 % with 14.64 of color scale, in range AB we have T_2 with 14.05 of color scale, being the highest values. In kgf, T_3 with 1.09 kgf stands out in the A range of the Tukey test at 5 %, in the AB range we have T_2 with 1.05 kgf, T_3 in the A range with 0.24 mm, T_2 in the AB range with 0.23 mm, T_1 in the BC range with 0.21 mm, and finally to T_0 in the C range with 0.20 mm thick.

Table 4 Total mortality rate

	Ginger flour levels (%)					
Variable	**T_0**	**T_1**	**T_2**	**T_3**	**(p)**	**C.V.**
Number of birds	60	60	60	60		
Mortality %	3.61^b	1.39^{ab}	0.83^a	0.28^a	0.0052^*	24.35%

* Significant at 5%, ** highly significant at 5%, ns not significant at 5%, CV coefficient of variation, TO diet with 0% inclusion of ginger flour, T1 diet with 0.2% inclusion of ginger, T2 diet with 0.4% ginger inclusion, T3 diet with 0.6% ginger

Table 5 Calculation of the benefit/cost ratio per treatment

Treatmen	Total income	Total cost update	factor current total	Cost current total	Current total income	RBC
T_0	$ 144.00	$ 140.06	1.03	$ 144.26	$ 148.32	1.03
T_1	$ 150.00	$ 140.61	1.03	$ 144.83	$ 154.50	1.07
T_2	$ 167.00	$ 142.71	1.03	$ 146.99	$ 172.01	1.17
T_3	$ 174.00	$ 146.62	1.03	$ 151.02	$ 179.22	1.19

Table 3 phase 5, FCR, the results were significant for the Tukey test at 5 % ($p < 0.05$), located in the range A. In the variable percentage of laying T_3 reflects the highest value recorded with 77.86 % and T_1 the lowest value with 70.24 %. Despite the differences, the results do not present statistically significant differences ($p > 0.05$). EW, T_3 13.39 g, placing this treatment in a range A when applying the Tukey test at 5 %. The yolk color, T_3 in range A of the Tukey test at 5 % with 14.64 color scale, T_2, T_1 and T_0 (14.05, 13.86 and 13.70). kgf in range A T_3 with 1.09 kgf we have T_3 in range A with 0.24 mm being the best results.

Mortality was made a global analysis of all phases, T3 presents the lowest percentage with 0.28 %, being located in the A range as well as T_2 with 0.83%, T_1 is located in the AB range with 1.39 % and finally T_0 with the higher mortality, 3.61 %. The highest percentage of profitability was in T_3, yielding higher results, therefore improving revenues. The percentage of profit it presented was 18.67 % and knowing that in our country an acceptable profitability is within 15 and 20. The treatment with the best profitability cost benefit (PCB) is T_3 with 1.19, this means that for every dollar invested, a profit of 0.19 dollars will be obtained against production costs.

Discussion

In the study, the CA was balanced against T_0, this indicates that the formulation with ginger favors its preference, corroborated by Buenaño Buenaño[6] who mentioned that including plants for therapeutic use in the diet of birds can benefit FC, ginger with its multiple benefits, improving digestibility and therefore the use of nutrients, due to the presence of gingerols that stimulate their consumption by generating greater palatability[8] The variable helps us to know the quality of the egg expressed in its weight, because it seeks to obtain eggs with excellent weights to be marketed at a better price. Kgf depends on the quantity of broken eggs by the total quantity of eggs produced when it is the lowest, since it implies losses in the exploitation. The color of the yolk was determined with the DSM colorimetric fan. Shell thickness (mm) once the quail egg has been opened, the thickness of the shell is measured with the caliper, the less thickness it has, the less appropriate it is for commercialization due to its fragility[17].

There are marked differences in T1 and slightly with T_2 since they present a greater range of FCR, these differences are appreciated in the third phase, between weeks 5 and 6, while T_3 reported a lower FCR value compared to T_0, corroborated by Herrera Mendoza[18] who points out that there is a significant difference ($p < 0.01$) between the treatments with the inclusion of ginger flour and the control treatment, with T_3 (0.3 %) being the best FCR. Although the studies were carried out in broilers, there is agreement with what Herrera Apolo[19] mentioned that the addition of ginger in poultry diets improves FCR through the synergism at the digestive level of gingerols and shogaols that function as gastric protectors when decrease the intestinal wall and stimulate its tonicity, allowing a greater absorption of nutrients acting as a natural promoter, in addition to the presence of Borneol which together with gingerols function as a hepatic protector[8] collaborating in a greater use of nutrients.

There were no significant values in this variable, possibly because the variation in the number of eggs per day and week is practically the same, what really varies is the quality of the egg in weight, yolk color, shell resistance and thickness. However, Lopez Machado[20] points out that the normal values in percentage of quail laying go from 59.47 to 64.46 % during week 5 to 15 of life respectively, this differs with our results since they exceed the normal percentages 77.87-78.57 %, in the same period of time, with the feasibility of adding ginger to the quail diet. For this variable, the treatment that registered the best results was T_3 in relation to EW, yolk color, resistance and shell thickness, this is possibly due to the contribution of ginger as an ingredient that helps to better metabolize the necessary nutrients for the formation of eggs.

Regarding the EW, the best results were obtained in T_3 (13.39 g) gave significant differences ($p < 0.05$) compared to the other treatments, these being higher than those obtained by Lopez Machado[20] who indicates that at 20 weeks of production, the average EW was 10.89 g, in the same way, these results are lower compared to our research, so it follows that ginger can be used in poultry to reduce the cholesterol level and increase EW with an effect positive in its antioxidant status[9].

Regarding kgf, statistically significant differences were obtained ($p < 0.05$), in such a way that the thickness of the eggshell produced in T_3 (0.26 mm) during the research was higher than the rest of the treatments matches agreeing with Villacis-Vivar et al.[10] who determined statistically significant differences ($p < 0.05$), 0.2636 mm when adding fungal phytase, followed by treatments with bacterial phytases 0.2597

and 2592 mm, indicating that supplementation with phytase significantly increases ($p < 0.05$) the thickness of the shell.

For the yolk color variable, statistically significant differences ($p < 0.05$) were obtained, with T_3 (14.64) being higher than the rest of the treatments during the research, which differs from that reported by Tufiño Alulema et al.[21], reported mean values of the color of the yolk coloration for the treatments that were: 7.77, 7.93, 8.97 and 9.30 per treatment T_0 (control), T_1 (alfalfa), T_2 (carrot) and T_3 (beet) respectively, in this way the values reported in our research are higher than those of the aforementioned authors, this possibly due to the addition of ginger in the quail diets since Salcedo Ruales et al.[22] mentioned that the pigmentation of the yolk depends exclusively on the contribution of carotenes in the diets of birds, whether natural or artificial, thus ginger contains carotenes in its chemical composition, generating a higher contribution, as with this the color scale is superior, also mentions that diseases such as coccidiosis or respiratory infections can affect the intestinal mucosa, hindering the absorption of carotenes from the content of saturated fats in the diet, since they collaborate in the transport of carotenoids, causing paler yolks, taking into account the aforementioned, the antimicrobial characteristics (Sesquiterpenes, Citral, Mirceno), anti-inflammatory (Borneol), antigripal, antiviral, antifungal (Cimeno), which the ginger manage to optimize the action of carotenes, directly benefiting the coloring of the yolk[8].

In kgf, significant differences were observed ($p < 0.05$) in which T_3 with 1.12, T_2 with 1.11, followed by T_1 with 1.01, and differing with T_0 with 0.92, the results obtained differ with the investigation of Villacis-Vivar et al.[10] because they mention that the resistance of the eggshell is not statistically influenced by any treatment, although the highest average was presented with T_3 to which beet was added, for the aforementioned authors these results are justified because Some peculiarities of birds such as age, diseases, temperature can also determine the quality of the shell, in our research the resistance of the shell depends on its thickness, structure and distribution of the calcite crystals, which are of utmost importance for the correct formation and resistance of the shell[23], in the same way[21] they emphasize the existence of a negative correlation between cholesterol and calcium, which means ca that at higher levels of calcium there is a decrease in cholesterol and vice versa. For this reason, previous studies and our research have identified that a diet that includes ginger tends to lower cholesterol and this is due in part to its calcium content.

The lowest mortality rate with 0.28 % of mortality, located in the A range for Tukey at 5%, as well as T_2 with 0.83 % mortality, T_1 is located in the AB range with 1.39 % mortality and finally T_0 with the highest mortality, 3.61 % these results are justified due to the fact that the addition of ginger favors the assimilation of nutrients, it also favors the well-being in the health of quail, which translates into lower mortality in the treatments with a greater quantity of ginger, in agreement with the results of Herrera Mendoza[18] T_3 (5 %) was the one that presented the lowest percentage of mortality and was the one in which the highest percentage of ginger was added to the diet (0.3 % ginger), in the same way we agree with Medina Barriga[2] who registered mortality in the control treatment of the 0.20 %, while in the rest of the treatments no value was registered, the author mentions that the absence of chick mortality when using ginger and oregano may be mainly due to their bactericidal, acidifying and fungal properties, which made the pathogenic microorganisms that negatively influence the development of the birds will be controlled in some way.

The highest income was recorded by T_3 and this is reflected in the profitability of 18.67 % and a RBC of 1.19, this means that for every dollar invested a profit of 0.19 USD will be obtained compared to production costs, these results obtained agree cost analysis18 due to the fact that in his research, T_3 was the one that registered the highest profitability and RBC. According to the results, the inclusion of ginger flour (*Z. officinale*) at 0.4 % and 0.6 % in the quail diets presented statistical differences and efficiently influenced the productive parameters evaluated during the first stage of laying.

The inclusion of ginger flour (*Z. officinale*) in doses of 0.2 %, 0.4 % and 0.6 % in the quail diet improves the quality of the eggs produced, in the present test statistical differences are observed between T_3 and the group witness. In addition, ginger flour favors FC, especially in the final phases with all treatments (T_1, T_2 and T_3) compared to the control group. FCR shows significant differences with T_2 in the intermediate stages of production compared to the control group. The percentage of posture does not present differences significant between the treatments and the control group. The ginger flour also favors the resistance of the birds by showing significant differences especially in T_3 in mortality compared to the control group. The highest income was recorded by T_3 and this is reflected in the profitability of 18.67 % and a RBC of 1.19, this means that for every dollar invested, a profit of 0.19 dollars will be obtained against production costs.

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Conflicts of interest

The authors declare that there are no conflicts of interest.

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Ethical considerations

The research complied with ethical standards in all processes.

Authors' contribution to the article

The teamwork of the members until its completion.

Limitations in the research

There were no limitations for the development of the research.

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